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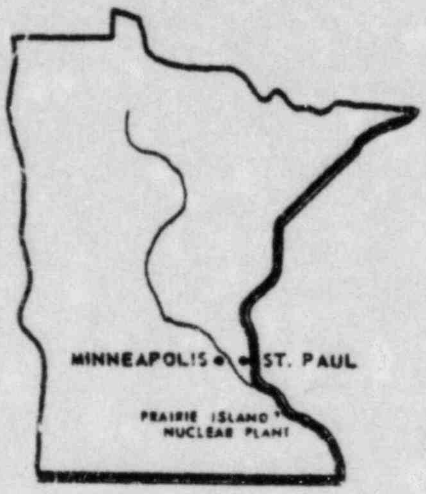
PRAIRIE ISLAND NUCLEAR GENERATING PLANT

Red Wing, Minnesota

UNITS 1 AND 2



ANNUAL REPORT

to the

UNITED STATES NUCLEAR REGULATORY COMMISSION

Radiation Environmental Monitoring Program

January 1, 1982 to December 31, 1982

NORTHERN STATES POWER COMPANY
MINNEAPOLIS, MINNESOTA

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NORTHERN STATES POWER COMPANY
MINNEAPOLIS, MINNESOTA

PRAIRIE ISLAND NUCLEAR GENERATING PLANT

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Radiation Environmental Monitoring Program
January 1, 1982 to December 31, 1982

Prepared Under Contract
by
HAZLETON ENVIRONMENTAL SCIENCES
Project No. 8010-100

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PREFACE

The staff members of the Nuclear Sciences Department of Hazleton Environmental Sciences, a Division of Hazleton Laboratories America, Inc. (HES), were responsible for the acquisition of data presented in this report. Environmental samples were collected by personnel of Northern States Power Company.

The report was prepared by C. R. Marucut, Section Supervisor, under the direction of L. G. Huebner, Director, Nuclear Sciences. She was assisted in the report preparation by L. Nicia, Group Leader, other staff members of the Nuclear Sciences Department.

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1.0 INTRODUCTION

This report summarizes and interprets results of the Radiation Environmental Monitoring Program (REMP) conducted by Hazleton Environmental Sciences at the Prairie Island Nuclear Generating Plant, Red Wing, Minnesota, during the period January - December, 1982. 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 (Hazleton Environmental Sciences, 1983) available at Northern States Power Company, Nuclear Support Services 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 1982 are summarized and discussed.

No effect on the environment due to the operation of the Prairie Island Nuclear Generating Plant is indicated.

Results obtained for gross beta in airborne particulates collected during the first quarter of 1982 show a moderate effect of fallout from the atmospheric nuclear detonation of a 200 kiloton to 1 megaton range device on 16 October 1980. Presence of other fission products, mostly strontium-90 and cesium-137 in some of the sampling media indicates a long range effect on the environment from fallout resulting from previous atmospheric nuclear tests.

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 enviornmental samples collected from the Plant site. The Plant's monitoring program includes analyses for tritium, strontium-89, strontium-90, 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, 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, 1982).

To monitor the air environment, airborne particulates are collected on membrane filters by continuous pumping at four locations. Also, airborne iodine is collected by continuous pumping through charcoal filters at three 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(Li) detector. Two of the four locations are indicators, and two are controls (P-1 and P-2). 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).

Ambient gamma radiation is monitored at the same four air sampling locations using CaF_2:Mn thermoluminescent dosimeters (TLD's). The sensors are placed in pairs at each location and are collected and measured quarterly.

In addition, as a "Lessons Learned" commitment, ambient gamma radiation is monitored at thirty-two (32) special locations, using three (3) LiF_2 chips mounted in the card: ten (10) in an inner ring in the general area of the site boundary, fifteen (15) in the outer ring within 4-5 mi radius, six (6) at special interest locations and one control location, 11.1 mi distant from the plant. They are replaced and measured quarterly. Also, a complete emergency set of TLDs for all locations, including four air sampling locations, is placed in the field at the same time as regular sets. The emergency set is returned to the HES laboratory 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. In addition, samples from the control location (P-25, Kinneman Farm) and the highest X/Q location (P-14, Gustafson Farm) are analyzed for strontium-89, strontium-90, and for gamma-emitting isotopes.

For additional monitoring of the terrestrial environment, natural vegetation (such as grass) is collected semi-annually from three locations (including the highest X/Q milk location P-14 and the milk control location P-25). Samples are analyzed for gamma-emitting isotopes including iodine-131. Cabbage is 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. Finally, topsoil is collected every three years and analyzed for strontium -90 and gamma-emitting isotopes. The latest collection of soil was made in 1982.

River water is collected weekly at two locations, one upstream of the Plant (P-5) and one downstream (P-6, Lock and Dam #3). Monthly composites are analyzed for gamma-emitting isotopes. Quarterly composites are analyzed for tritium, strontium-89, and strontium-90.

Drinking water is collected weekly from the City of Red Wing well. Monthly composites are analyzed for gross beta activity 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 macroinvertebrates, aquatic vegetation, and bottom sediments. Shoreline sedment is collected semi-annually.

3.3 Program Execution

The Program was executed as described in the preceding section with the following exception; The TLD data for the third quarter of 1982 for location P-1 because the were lost in the field (vandalized).

3.4 Laboratory Procedures

All strontium-89, strontium-90, and iodine-131 analyses in milk were made by using a sensitive radiochemical procedure which involves separation of the element of interest by use of an ion-exchange resin and subsequent beta counting.

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

Tritium levels were determined by liquid scintillation technique.

Analytical procedures used by the Nuclear Sciences Department of Hazleton Environmental Sciences are specified in detail elsewhere (Hazleton Environmental Sciences, 1981). 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).

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

3.5 Program Modifications

There were no program modifications in 1982.

3.6 Census of Milch Animals

In accordance with Technical Specification 4.10, paragraph B, several surveys of milch animals were conducted in the area of the Plant during 1982. On June 2, 1982 an extensive survey was conducted with a one mile radius of the Plant (or 15 mR/year distance). Cattle observed were used for beef rather than milk production. No new milk producing herds were found.

On June 3 and 4, 1982 a census for milk cows within a five mile radius was completed. With the assistance of the Agricultural Agent of Goodhue and Pierce Counties, it was determined that there were no changes in the milk herds in Minnesota and only location changes on the map of milk herds in Wisconsin. Current raw milk sampling locations were not affected. No new herds were identified.

On June 3 and 4, 1982 a census of goat herds within a 15 mile radius of the Plant was completed. After visits with three county agricultural agents, it was determined that there were no reliable suppliers of goat milk in the area. Milk from several goats in the area was used by the families. However, milk production was sporadic. Although goat milk sampling is not a part of the routine program, certain goat milk samples, when available, were collected and analyzed.

On September 7, 1982, the mid-season census of milch producing animals was completed. No new herds were identified. Mr. Albert Dosdahl (2.5 miles NE of station), went out of the dairy business. Another dairy herd close to the Dosdahl Farm, the R Johnson Farm (2.6 miles ENE of station) was chosen as a replacement. The change took place in October 1982. (The NRC was informed by letter dated October 26, 1982.)

4.0 RESULTS AND DISCUSSION

All collections and analyses were made as scheduled (see 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 The Effect of Chinese Atmospheric Nuclear Detonation

There were no reported atmospheric nuclear tests in 1982. 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.

There was a moderate residual effect of this test on the gross beta levels in airborne particulates. The annual mean gross beta activity was about four times lower than in 1981. The highest mean activity was reached in the month of January and in the first quarter and then by the end of 1982 declined steadily to the level observed in 1980.

4.2 Program Findings

A number of program findings reflect effects of the latest Chinese and previous worldwide atmospheric nuclear tests. The chief environmental indicators of test effects were airborne particulates. To a limited extent, some residual effect of previous nuclear tests was detected in milk, river water, bottom sediments, and soil (radiostrontium and cesium -137).

Ambient Radiation (TLDs)

At four regular air sampling locations, indicator TLDs averaged 12.1 mR/91 days and control TLDs averaged 15.2 mR/91 days. The doses measured by control TLDs were about 25% higher than indicator TLDs. Higher readings at control locations are due to higher readings at location P-2, which historically yielded about 30% higher readings than the second control location, P-1. The means at special locations were similar to those measured at regular air sampling locations and ranged from 12.0 mR/91 days at inner ring locations to 13.0 mR/91 days at outer ring locations. 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), and in 1981 (13.0 and 14.5 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 similar at both indicator and control locations (0.024 pCi/m^3) and control locations (0.026 pCi/m^3) and was about four times lower than in 1981 (0.111 pCi/m^3). The decrease in activity is attributable to the cleansing of the atmosphere of radioactive debris produced by the nuclear test conducted on 16 October 1980. The highest averages for gross beta were for the month of January and February and the first quarter, then gradually decreased to the 1980 level by the end of the year.

The elevated activity in January and the first quarter was due to residual fallout from the nuclear test conducted October 16, 1980. The spring peak, which usually is observed in April - May (2nd quarter) was somewhat obscured by the elevated activity during the first quarter. This peak has been observed almost annually (1976, 1979, and 1980 were 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 first 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, 1983).

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 on 0.25 pCi/l in all samples.

Strontium-90 results were nearly identical at both indicator and control locations (2.6 and 3.3 pCi/l, respectively) and were in the range of 1.6 to 5.0 pCi/l, a range consistent with 1976, 1977, 1978, 1979, 1980 and 1981 observations at Prairie Island. Strontium-90 levels in this range are attributable to worldwide fallout from previous atmospheric nuclear tests and reflect the long half-life (28.6 years) of this isotope. Cesium-137 results were below the LLD level of 15 pCi/l in all samples. Cesium-137 is also a long-lived component (with a half-life of 30.24 years) of worldwide fallout and is found in the environment in trace quantities. Finally, all strontium-89 results in 1982 were >2.6 pCi/l, in agreement with 1976, 1977, 1978, 1979, 1980, and 1981 measurements.

No significant changes were seen in strontium-90 levels in milk. Levels were similar to those observed in 1981. This absence of an effect is consistent with the low initial production of this isotope in nuclear explosions (Eisenbud, 1963). Also 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 1982 show no radiological effects of the Plant operation, but the presence of strontium-90 in milk samples does exhibit a long range residual effect of previous atmospheric nuclear tests.

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. As with the other well water samples, all analyses for gamma-emitting isotopes yielded results below detection limits. Gross beta averaged 8.9 pCi/l and was similar to the levels observed in 1979 (10.5 pCi/l), 1980 (11.8 pCi/l, and 1981 (10.7 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, strontium-89, and strontium-90. All gamma-emitting isotopes and strontium-89 were below their respective detection limits. Strontium-90 was detected in all upstream and downstream samples. The mean activity was nearly identical in both the upstream samples (1.1 pCi/l) and the downstream samples (1.0 pCi/l). 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 three quarterly samples and ranged from <380 to 590 pCi/l, averaging 460 pCi/l.

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

Crops

Cabbage samples were collected on August 23, 1982, and analyzed for iodine-131. Corn samples were also collected on August 23, 1982, and analyzed for gamma-emitting isotopes. All results, except for potassium -40, were below detection limits. There was no indication of a Plant effect.

Natural Vegetation

Natural vegetation was collected on May 10 and August 23, 1982. No iodine-131 was observed in any of the samples collected. All other gamma-emitting isotopes, except for beryllium-7, which is constantly produced in the upper atmosphere by cosmic rays, and naturally-occuring potassium-40 were below their respective LLD's. Thus, no Plant effect is indicated.

Topsoil

Soil is collected every three years and was collected in 1979 prior to the August 23, 1982 collection. Strontium-90 was detected in all soil samples, and averaged 0.187 and 0.261 pCi/g dry weight in indicator and control samples, respectively. Cesium-137 was also detected in all samples and averaged 0.61 and 0.83 pCi/g dry weight in indicator and control samples, respectively. The other gamma-emitting isotope detected was potassium-40. No Plant effect is indicated.

Fish

Fish samples were collected in May and September, 1982. 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 (macroinvertebrates) and periphyton were collected on June 15 and October 13, 1982. The samples were analyzed for strontium-89, strontium-90 and gamma-emitting isotopes. Strontium-89 was below the limits of detection in all samples. Mean strontium-90 levels were very low and averaged 0.043 pCi/g wet weight in the upstream (control) sample and 0.072 pCi/g wet weight in the downstream sample. The difference between the downstream and upstream samples was not statistically significant since uncertainty in the measurement is about at the same magnitude as the difference. All other gamma-emitting isotopes, except for naturally-occuring potassium-40, were below their respective LLD's. No Plant effect was indicated.

Aquatic Vegetation

Aquatic vegetation was collected on June 25 and August 31, 1982 and analyzed for gamma-emitting isotopes. All results, except for potassium -40, were below detection limits. No Plant effect was indicated.

Bottom and Shoreline Sediments

Sediment collections were made on May 24 and August 31, 1982. The samples were analyzed for strontium-90 and gamma-emitting isotopes. Strontium-90 was below the LLD of 0.014 pCi/g dry weight in all but two samples. Cerium-137 was detected in three bottom sediment samples and averaged 0.096 pCi/g dry weight in indicator samples and was 0.153 pCi/g dry weight in one 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, 1982. Prairie Island

Medium	Locations No.	Locations Codes (and Type)[a]	Collection Type and Frequency[b]	Analysis Type (and Frequency)[c]
Ambient Radiation (TLD's)	4	P-1(C), P-2(C), P-3, P-4	C/Q	Ambient gamma
	32	P-01A - P10A P-01B - P-15B P-01S - P-06S P-01(C)	C/Q	Ambient gamma
Airborne particulates	4	P-1(C), P-2(C), P-3, P-4	C/W	GB, GS (MC of all locations)
Airborne iodine	3	P-1(C), P-3, P-4	C/W	I-131
Milk	3	P-16 to P-18	G/M	I-131
	2	P-25(C), P-14	G/M	I-131, Sr-89, Sr-90, GS
River water	2	P-5(C), P-6	G/W	GS(MC), H-3(QC) Sr-89 (QC) Sr-90 (QC)
Drinking Water	1	P-11	G/W	GB, GS(MC), H-3 (QC)
Well water	4	P-25(C), P-8 to P-10	G/Q	H-3, GS
Edible cultivated crops - green leafy 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
Natural Vegetation	3	P-25(C), P-14, P-15	G/SA	I-131, GS
Fish (two species, edible portion)	2	P-5(C), P-6	G/SA	GS
Periphyton or Macroinvertebrates	2	P-5(C), P-6	G/SA	Sr-89, Sr-90 GS
Aquatic Vegetation	2	P-5(C), P-6	G/SA	GS
Bottom Sediment	2	P-5(C), P-6	G/SA	GS, Sr-90
Shoreline Sediment	1	P-12	G/SA	GS, Sr-90
Topsoil[d]	9	P-1(C), P-2(C) P-3, P-4, P-19 to P-23	G/ETY	GS, Sr-90

[a] Location codes are defined in Table D-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, ETY = every three years.

[c] Analysis type is coded as follows: GB = gross beta, GS = gamma spectroscopy, H-3 = tritium, Sr-89 = strontium-89, Sr-90 = strontium-90, I-131 = iodine-131. Analysis frequency is coded as follows: MC = monthly composite, QC = quarterly composite.

[d] The last collection was done in 1982. Previous collection was done in 1979.

Table 5.2 Sampling locations. Prairie Island

Code	Type[a]	Name	Location
P-1	C	Station P-1 (Control-Air)	16.5 mi @ 348°/NNW
P-2	C	Station P-2 (Control-Air)	10.9 mi @ 47°/NE
P-3		Station P-3 (X/Q res, Comm-Air)	0.8 mi @ 313°/NW
P-4		Station P-4 (X/Q-Air)	1.6 mi @ 129°/SE
P-5		Upstream of Plant (1000')	0.6 mi @ 60°/ENE
P-6		Lock & Dam #3	1.6 mi @ 129°/SE
P-7[b]	C	Most Farm Well	11.4 mi @ 320°/NW
P-8		Kinney Store	2.0 mi @ 280°/W
P-9		Plant Well #2 (on-site)	0.3 mi @ 306°/NW
P-10		Lock & Dam #3 Well	1.6 mi @ 129°/SE
P-11		City of Red Wing (Drinking Water)	7.1 mi @ 135°/SE
P-12		Recreational Area	3.4 mi @ 116°/ESE
P-13[b]	C	Most Farm (Prescott)	11.4 mi @ 320°/NW
P-14		Gustafson Farm (X/Q-milk)	2.2 mi @ 168°/SSE
P-15		Downwind Field	0.6 mi @ 162°/SSE
P-16		A. Dosdahl 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-19		Commissary Point Park	1.0 mi @ 156°/SSE
P-20		Meteorology Station	0.4 mi @ 296°/WNW
P-21		Sturgeon Lake Access	0.4 mi @ 344°/NNW
P-22		Former TLD #14 Location	0.5 mi @ 230°/SW
P-23		Former TLD #15 Location	0.5 mi @ 184°/S
P-24		H. Larson Residence (Nearest Garden)	1.6 mi @ 287°/WNW
P-25[c]	C	Kinneman Farm (Control-Milk, etc)	11.1 mi @ 331°/NNW
P-26[d]		Augustine Farm	5.7 mi @ 24°/NNE
P-27[d]		Murphy Farm	2.8 mi @ 42°/NE
P-01A		Property Line	North Sector. Sampler is on the side of the fence adjacent to corps of Engineers public access parking area and facing the plant.
P-02A		Property Line	NNE Sector. Sampler at a corner of the property line fence near the biology station.
P-03A		Property Line	South Sector. Sampler is adjacent the SE end of a guard rail along the road near a power pole.
P-04A		Property Line	SSW Sector. Sampler is adjacent to the NW end of a guard rail along the roadway next to a small access road.
P-05A		Property Line	SW Sector. Sampler is inside the fence area adjacent to a transmission tower.

Table 5.2 (continued) Prairie Island

Code	Type[a]	Name	Location
P-06A		Property Line	WSW Sector. Sampler is inside the fenced area adjacent to a telephone junction box and south of an underground cable warning sign.
P-07A		Property Line	West Sector. Sampler is inside the fenced area about 75 feet North of the railroad entrance gate adjacent to a fence sign.
P-08A		Property Line	WNW Sector. Sampler is adjacent to the last power pole that serves the Meteorological station along the property fence line.
P-09A		Property Line	NW Sector. Sampler is in north west corner of the property fenced area, just inside the fence and facing the plant.
P-10A		Property Line	NNW Sector. Sampler is inside the fence west of the north entrance gate facing the plant adjacent to a transmission tower.
P-01B		Thomas Killian Residence	North Sector. Sampler is adjacent to a power pole north of the driveway.
P-02B		Ray Kinneman Farm	NNE Sector. Sampler is south of of the driveway adjacent to a telephone junction box.
P-03B		Wayne Anderson Farm	NE Sector. Sampler is in the front yard adjacent to a power pole facing toward the plant.
P-04B		Nelson Drive (Road)	ENE Sector. Sampler is adjacent to a power pole and a telephone junction box, about 15 feet south of the road.
P-05B		Country Road E near Goodwin Coulee Road	East Sector. Sampler is north of Country Road E and about 300 ft. NW of the Goodwin Coulee Road (near a power pole that has a "Danger High Voltage" sign on it and about 25 ft. NW of the Richard Enberg mail box).
P-06B		William Hauschildt Residence	ESE Sector. Sampler is between a power pole and telephone junction box on the east side of the driveway.

Table 5.2 (continued) Prairie Island

Code	Type[a]	Name	Location
P-07B		Red Wing Service Center	SE Sector. (North Highway 61 on Tyler Road) Sampler is adjacent to a corner transmission pole and the Railroad right-of-way close to a chain link fence.
P-08B		David Wnuk Residence	SSE Sector. Sampler is on the west edge of property adjacent to a telephone control pole and a road sign "DO NOT PASS".
P-09B		Highway 19, South of 61	South Sector. Sampler is adjacent to a pole supporting a telephone junction box and opposite a new bridge on the east side of highway 19.
P-10B		Cannondale Farm (Lesson Lane-James Byron)	SSW Sector. Sampler is adjacent to a corner fence post and near a "Speed Limit 30" road sign.
P-11B		Wallace Weberg Farm	SW Sector. (Farm is on top of the bluff). Sampler is adjacent to a power pole and the telephone junction box facing the plant (east of driveway).
P-12B		Ray Gergen, Jr. Farm	WSW Sector. Sampler is south of driveway in the farmyard near a power pole.
P-13B		Thomas O'Rourke Fa	West Sector. Sampler is adjacent to a power pole and a telephone junction box outside a stock fence area.
P-14B		David J. Anderson Farm	NW Sector. Sampler is near the front yard south of a red cedar tree (not located near the main road for protection).
P-15B		Holst Farm	NNW Sector. Sampler is east of residence near a corner post of a fenced area.
P-01S		Federal Lock & Dam #3	SE Sector. Sampler is north of the fenced air sampling station (#4) and facing the plant.
P-02S		Charles Suter Residence	SSE Sector. Sampler on the north side of a power pole in the farm yard and facing the plant.

Table 5.2 (continued) Prairie Island

Code	Type[a]	Name	Location
P-03S		Carl Gustafson Farm	SSE Sector. Sampler is near the north side of the road in the last curve before the farmyard.(Close to the corner power pole and a fence post).
P-04S		Near Richard Burt Residence	SW Sector Sampler is next to a tree about 15 ft. away from the curve in the road.
P-05S		Kenney Store - Trailer Park	West Sector. Sampler is at the north end of a redwood fence and adjacent to a telephone junction box.
P-06S		Earl Flynn Farm	WNW Sector. Sampler is on the east side of the house adjacent to a huge stump and facing the plant.
P-01C		Robert Kinneman Farm	NNW Sector. Sampler is about 250 ft. east of the residence adjacent to a corner fence post and facing the plant.

[a] "C" denotes control location. All other locations are indicators.
[b] P-13 discontinued after March 1978.
[c] P-25 added in April 1978.
[d] P-26 and P-27 added in July 1978 (Goat's Milk).

Table 5.3. Missed collections and analyses, 1982; 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-1	3rd Qtr. 1982	Lost in the field (vandalized).

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 1982

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]
TLD (mR/91 days)	Gamma 15	1.0	12.1 (8/8) (9.9-14.2)	P-2, Station P-2 10.9 mi @ 47°/NE	17.0 (4/4) (13.6-19.3)	15.2 (7/7) (12.2-19.3)	0
TLD (mR/91 days) (Inner Ring, General Area at Site Boundary)	Gamma 40	3.0	12.0 (40/40) (10.0-14.0)	P-04A, Property Line SWW Sector	12.3 (4/4) (10.6-14.0)	(See control below)	0
				P-08A, Property Line WNW Sector	12.3 (4/4) (11.4-13.1)		
				P-09A, Property Line NW Sector	12.3 (4/4) (11.2-13.8)		
TLD (mR/91 days (Outer ring, 4-5 miles distant)	Gamma 60	3.0	13.0 (60/60) (7.5-16.0)	P-15, Holst Farm Station NNW Sector	15.0 (4/4) (14.6-16.0)	(See control below)	0
TLD (mR/91 days (Special Interest Areas)	Gamma 24	3.0	11.7 (24/24) (8.1-15.3)	P-04S Near Richard Burt Residence SW Sector	13.6 (4/4) (11.6-15.3)	(See control below)	0
TLD (mR/91 days) (control)	Gamma 4	3.0	None	P-01C-R, Kinneman Farm NNW Sector	13.8 (4/4) (13.3-14.7)	13.8 (4/4) (13.3-14.7)	0
Airborne Particulates (pCi/m^3)	GB 212	0.002	0.024 (106/106) (0.008-0.053)	P-2, Station P-2 (Control Air) 10.9 mi @ 47°/NE	0.029 (53/53) (0.014-0.059)	0.026 (106/106) (0.005-0.059)	0
	GS 12						
	Be-7	0.010	0.084 (12/12) (0.054-0.118)	NA[f]	-	None	0
	Mn-54	0.0012	<LLD	-	-	None	0
	Co-58	0.0012	<LLD	-	-	None	0
	Co-60	0.0016	<LLD	-	-	None	0
	Zn-65	0.0022	<LLD	-	-	None	0
	Nb-95	0.0019	<LLD	-	-	None	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]
Airborne Particulates (pCi/m^3) (Cont'd)	Zr-95	0.0020	<LLD	-	-	None	0
	Ru-103	0.0023	<LLD	-	-	None	0
	Ru-106	0.0140	<LLD	-	-	None	0
	Cs-134	0.0019	<LLD	-	-	None	0
	Cs-137	0.0015	<LLD	-	-	None	0
	Ba-140	0.0045	<LLD	-	-	None	0
	La-140	0.0012	<LLD	-	-	None	0
	Ce-141	0.0033	<LLD	NA	-	None	0
	Ce-144	0.0071	<LLD	-	-	None	0
Airborne Iodine (pCi/m^3)	I-131 159	0.07	<LLD	-	-	<LLD	0
Milk	I-131 66	0.25	<LLD	-	-	<LLD	0
	Sr-89 24	2.6	<LLD	-	-	<LLD	0
	Sr-90 24	1.0	2.6 (12/12) (1.6-3.3)	P-25, Kinneman Farm 11.1 mi @ 331°/NNW	3.3 (12/12) (2.0-5.0)	3.3 (12/12) (2.0-5.0)	0
	GS 24						
	K-40	100	1260 (12/12) (1060-1480)	P-25, Kinneman Farm 11.1 mi @ 331°/NNW	1280 (12/12) (1140-1510)	1280 (12/12) (1140-1510)	0
	Cs-134	15	<LLD	-	-	<LLD	0
	Cs-137	15	<LLD	-	-	<LLD	0
	Ba-La-140	21	<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	8.9 (12/12) (5.9-13.9)	P-11, City of Red Wing 7.1 mi @ 135°/SE	8.9 (12/12) (5.3-13.9)	None	0
	H-3	4	330	<LLD	-	-	None	0
	GS	12						
	Mn-54		15	<LLD	-	-	None	0
	Co-58		17	<LLD	-	-	None	0
	Co-60		15	<LLD	-	-	None	0
	Zn-65		30	<LLD	-	-	None	0
	Nb-95		26	<LLD	-	-	None	0
	Zr-95		35	<LLD	-	-	None	0
	Cs-134		15	<LLD	-	-	None	0
	Cs-137		18	<LLD	-	-	None	0
	Ba-La-140		16	<LLD	-	-	None	0
	Ce-144		121	<LLD	-	-	None	0
River Water (pCi/l)	H-3	8	330	<LLD	-	-	<LLD	0
	Sr-89	8	2.1	<LLD	-	-	<LLD	0
	Sr-90	8	0.6	1.1 (4/4) (0.9-1.3)	P-6, Lock & Dam #3 1.6 mi @ 129°/SE	1.1 (4/4) (0.9-1.3)	1.0 (4/4) (0.7-1.6)	0
	GS	24						
	Mn-54		15	<LLD	-	-	<LLD	0
	Co-58		15	<LLD	-	-	<LLD	0
	Co-60		15	<LLD	-	-	<LLD	0
	Zn-65		30	<LLD	-	-	<LLD	0
	Nb-95		24	<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[c] 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		
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		18	<LLD	-	-	<LLD	0
	Ce-144		114	<LLD	-	-	<LLD	0
Well Water (pCi/l)	H-3	16	330	460 (3/12) (380-590)	P-9, Plant Well #2 0.3 mi @ 306°/NW	460 (3/4) (380-590)	<LLD	0
	GS	16						
	Mn-54		15	<LLD	-	-	<LLD	0
	Co-58		20	<LLD	-	-	<LLD	0
	Co-60		15	<LLD	-	-	<LLD	0
	Zn-65		30	<LLD	-	-	<LLD	0
	Nb-95		28	<LLD	-	-	<LLD	0
	Zr-95		37	<LLD	-	-	<LLD	0
	Cs-134		15	<LLD	-	-	<LLD	0
	Cs-137		18	<LLD	-	-	<LLD	0
	Ba-La-140		15	<LLD	-	-	<LLD	0
	Ce-144		129	<LLD	-	-	<LLD	0
Crops-Cabbage (pCi/g wet)	I-131	2	0.048	<LLD	-	-	<LLD	0
Crops-Corn (pCi/g wet)	I-131	2	0.79	<LLD	-	-	<LLD	0
	GS	2						
	Be-7		0.51	<LLD	-	-	<LLD	0
	K-40		0.5	3.20 (1/1) -	P-14, Gustafson Farm 2.2 mi @ 168°/SSE	3.20 (1/1) -	3.13 (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/g wet) (Cont'd)	Mn-54		0.050	<LLD	-	-	<LLD	0
	Co-58		0.071	<LLD	-	-	<LLD	0
	Co-60		0.050	<LLD	-	-	<LLD	0
	Zn-65		0.11	<LLD	-	-	<LLD	0
	Nb-95		0.11	<LLD	-	-	<LLD	0
	Zr-95		0.35	<LLD	-	-	<LLD	0
	Ru-103		0.070	<LLD	-	-	<LLD	0
	Ru-106		0.32	<LLD	-	-	<LLD	0
	Cs-134		0.045	<LLD	-	-	<LLD	0
	Cs-137		0.049	<LLD	-	-	<LLD	0
	Ba-140		0.16	<LLD	-	-	<LLD	0
	La-140		0.048	<LLD	-	-	<LLD	0
	Ce-141		0.11	<LLD	-	-	<LLD	0
	Ce-144		0.27	<LLD	-	-	<LLD	0
Natural Vegetation (pCi/g wet)	I-131	6	0.050	<LLD	-	-	<LLD	0
	GS	6						
	Be-7		0.28	<LLD	P-25, Kinneman Farm 11.1 mi @ 331°/NNW	0.84 (1/2)	0.84 (1/2)	0
	K-40		0.5	5.06 (4/4) (4.64-5.47)	P-25, Kinneman Farm 11.1 mi @ 331°/NNW	7.31 (2/2) (6.33-8.29)	7.31 (2/2) (6.33-8.29)	0
	Mn-54		0.037	<LLD	-	-	<LLD	0
	Co-58		0.042	<LLD	-	-	<LLD	0
	Co-60		0.060	<LLD	-	-	<LLD	0
	Zn-65		0.067	<LLD	-	-	<LLD	0
	Nb-95		0.036	<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]
Natural Vegetation (pCi/g wet) (Cont'd)	Zr-95		0.071	<LLD	-	-	<LLD	0
	Ru-103		0.034	<LLD	-	-	<LLD	0
	Ru-106		0.34	<LLD	-	-	<LLD	0
	Cs-134		0.036	<LLD	-	-	<LLD	0
	Cs-137		0.054	<LLD	-	-	<LLD	0
	Ba-140		0.15	<LLD	-	-	<LLD	0
	La-140		0.033	<LLD	-	-	<LLD	0
	Ce-141		0.081	<LLD	-	-	<LLD	0
	Ce-144		0.26	<LLD	-	-	<LLD	0
Fish-Flesh (pCi/g wet	GS	8						
	K-40		0.1	3.23 (4/4) (2.60-3.89)	P-6, Lock & Dam #3 1.6 mi @ 129°/SE	3.23 (4/4) (2.60-3.89)	2.94 (4/4) (2.35-3.46)	0
	Mn-54		0.042	<LLD	-	-	<LLD	0
	Co-58		0.045	<LLD	-	-	<LLD	0
	Co-60		0.039	<LLD	-	-	<LLD	0
	Zn-65		0.093	<LLD	-	-	<LLD	0
	Nb-95		0.049	<LLD	-	-	<LLD	0
	Zr-95		0.076	<LLD	-	-	<LLD	0
	Cs-134		0.037	<LLD	-	-	<LLD	0
	Cs-137		0.047	<LLD	-	-	<LLD	0
	Ba-La-140		0.047	<LLD	-	-	<LLD	0
Periphyton (pCi/g wet)	Sr-89	4	0.196	<LLD	-	-	<LLD	0
	Sr-90	4	0.01	0.072 (2/2) (0.036-0.108)	P-6, Lock & Dam #3 1.6 mi @ 129°/SE	0.072 (2/2) (0.036-0.108)	0.043 (2/2) (0.032-0.054)	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		
Periphyton (pCi/g wet) (Cont'd)	GS	4						
	Be-7		2.32	<LLD	-	-	<LLD	0
	K-40		1.0	4.37 (2/2) (3.30-5.44)	P-6, Lock & Dam #3 1.6 mi @ 129°/SE	4.37 (2/2) (3.30-5.44)	2.88 (2/2) (1.59-4.17)	0
	Mn-54		0.25	<LLD	-	-	<LLD	0
	Co-58		0.23	<LLD	-	-	<LLD	0
	Co-60		0.23	<LLD	-	-	<LLD	0
	Zn-65		0.43	<LLD	-	-	<LLD	0
	Nb-95		0.20	<LLD	-	-	<LLD	0
	Zr-95		0.45	<LLD	-	-	<LLD	0
	Ru-103		0.45	<LLD	-	-	<LLD	0
	Ru-106		1.55	<LLD	-	-	<LLD	0
	Cs-134		0.25	<LLD	-	-	<LLD	0
	Cs-137		0.23	<LLD	-	-	<LLD	0
	Ba-140		0.56	<LLD	-	-	<LLD	0
	La-140		0.15	<LLD	-	-	<LLD	0
	Ce-141		0.57	<LLD	-	-	<LLD	0
	Ce-144		1.32	<LLD	-	-	<LLD	0
Aquatic Vegetation (pCi/g wet)	GS	4						
	Be-7		0.61	<LLD	-	-	<LLD	0
	K-40		0.5	2.46 (2/2) (2.30-2.62)	P-5, Upstream of Plant 0.6 mi @ 60°/ENE	2.58 (2/2) (2.26-2.90)	2.58 (2/2) (2.26-2.90)	0
	Mn-54		0.060	<LLD	-	-	<LLD	0
	Co-58		0.064	<LLD	-	-	<LLD	0
	Co-60		0.065	<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		
Aquatic Vegetation (pCi/g wet) (Cont'd)	Zn-65		0.14	<LLD	-	-	<LLD	0
	Nb-95		0.11	<LLD	-	-	<LLD	0
	Zr-95		0.17	<LLD	-	-	<LLD	0
	Ru-103		0.090	<LLD	-	-	<LLD	0
	Ru-106		0.50	<LLD	-	-	<LLD	0
	Cs-134		0.056	<LLD	-	-	<LLD	0
	Cs-137		0.062	<LLD	-	-	<LLD	0
	Ba-La-140		0.13	<LLD	-	-	<LLD	0
	Ce-141		0.12	<LLD	-	-	<LLD	0
	Ce-144		0.32	<LLD	-	-	<LLD	0
Bottom and Shoreline Sediments (pCi/g dry)	Sr-90	6	0.014	0.021 (1/4)	P-5, Upstream of Plant 0.6 mi @ 60°/ENE	0.030 (1/2) -	0.030 (1/2) -	0
	GS	6						
	Be-7		0.67	<LLD	-	-	<LLD	0
	K-40		1.0	8.97 (4/4) (6.83-10.01)	P-5, Upstream of Plant 0.6 mi @ 60°/ENE	10.53 (2/2) (10.00-11.05)	10.53 (2/2) (10.00-11.05)	0
	Mn-54		0.042	<LLD	-	-	<LLD	0
	Co-58		0.037	<LLD	-	-	<LLD	0
	Co-60		0.042	<LLD	-	-	<LLD	0
	Zn-65		0.11	<LLD	-	-	<LLD	0
	Nb-95		0.043	<LLD	-	-	<LLD	0
	Zr-95		0.11	<LLD	-	-	<LLD	0
	Ru-130		0.095	<LLD	-	-	<LLD	0
	Ru-106		0.31	<LLD	-	-	<LLD	0
	Cs-134		0.062	<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		
Bottom and Shoreline Sediments (pCi/g dry) (Cont'd)	Cs-137		0.040	0.096 (2/4) (0.055-0.010)	P-6, Lock & Dam #3 1.6 mi @ 129°/SE	0.153 (1/2)	0.153 (1/2)	0
	Ba-140		0.13	<LLD	-	-	<LLD	0
	La-140		0.037	<LLD	-	-	<LLD	0
	Ce-141		0.084	<LLD	-	-	<LLD	0
	Ce-144		0.37	<LLD	-	-	<LLD	0
Top Soil (pCi/g dry)	Sr-90	9	0.020	0.187 (7/7) (0.109-0.357)	P-1, Station P-1 16.5 mi @ 348°/NNW	0.357 (1/1)	0.261 (2/2) (0.165-0.357)	0
	GS	9						
	Be-7		C.84	<LLD	-	-	<LLD	0
	K-40		1.0	12.35 (7/7) (10.93-16.82)	P-14, Gustafson Farm 2.2 mi @ 168°/SSE	16.82 (1/1)	15.34 (2/2) (12.51-18.17)	0
	Mn-54		0.070	<LLD	-	-	<LLD	0
	Co-58		0.071	<LLD	-	-	<LLD	0
	Co-60		0.093	<LLD	-	-	<LLD	0
	Zn-65		0.13	<LLD	-	-	<LLD	0
	Nb-95		0.53	<LLD	-	-	<LLD	0
	Zr-95		0.17	<LLD	-	-	<LLD	0
	Ru-103		0.14	<LLD	-	-	<LLD	0
	Ru-106		0.76	<LLD	-	-	<LLD	0
	Cs-134		0.078	<LLD	-	-	<LLD	0
	Cs-137		0.10	0.61 (7/7) (0.45-0.82)	P-1, Station P-1 16.5 mi @ 358°/NNW	1.05 (1/1)	0.83 (2/2) (0.61-1.05)	0
	Ba-140		0.22	<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		
Top Soil (pCi/g dry) (Cont'd)	La-140	0.17	<LLD	-	-	<LLD	0
	Ce-141	0.25	<LLD	-	-	<LLD	0
	Ce-144	0.43	<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 locations 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.
[f] Monthly composites from all locations were gamma scanned together. Thus the location with the highest annual mean cannot be identified.

6.0 REFERENCES CITED

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Appendix A

Crosscheck Program Results

Appendix A

Crosscheck Program Results

The Nuclear Sciences Department of 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 1975 through 1982. 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 Hazleton ES results for milk and water samples, 1975 through 1982[a].

Lab Code	Sample Type	Date Coll.	Analysis	Concentration in pCi/l[b] HES Result ±2σ [c]	EPA Result ±3σ, n=1[d]
STM-40	Milk	Jan. 1975	Sr-89	<2	0±15
			Sr-90	73±2.5	75±11.4
			I-131	99±4.2	101±15.3
			Cs-137	76±0.0	75±15
			Ba-140	<3.7	0±15.0
			K(mg/l)	1470±5.6	1510±228
STW-45	Water	Apr. 1975	Cr-51	<14	0
			Co-60	421±6	425±63.9
			Zn-65	487±6	497±74.7
			Ru-106	505±16	497±74.7
			Cs-134	385±3	400±60.0
			Cs-137	468±3	450±67.5
STW-47	Water	Jun. 1975	H-3	1459±144	1499±1002
STW-48	Water	Jun. 1975	H-3	2404±34	2204±1044
STW-49	Water	Jun. 1975	Cr-51	<14	0
			Co-60	344±1	350±53
			Zn-65	330±5	327±49
			Ru-106	315±7	325±49
			Cs-134	291±1	304±46
			Cs-137	387±2	378±57
STW-53	Water	Aug. 1975	H-3	3317±64	3200±1083
STW-54	Water	Aug. 1975	Cr-51	223±11	225±38
			Co-60	305±1	307±46
			Zn-65	289±3	281±42
			Ru-106	346±5	279±57
			Cs-134	238±1	256±38
			Cs-137	292±2	307±46
STW-58	Water	Oct. 1975	H-3	1283±80	1203±988

Table A-1. (continued)

Lab Code	Sample Type	Date Coll.	Analysis	Concentration in pCi/l[b] HES Result ±2σ [c]	EPA Result ±3σ, n=1[d]
STM-61	Milk	Nov. 1975	Sr-90	68.9±2.1	74.6±11.2
			I-131	64.6±3.8	75±15
			Cs-137	75.6±20	75±15
			Ba-140	<3.7	0
			K(Mg/l)	1435±57	1549±233
STW-63	Water	Dec. 1975	H-3	1034±39	1002±972
STW-64	Water	Dec. 1975	Cr-51	<14	0
			Co-60	221±1	203±30.5
			Zn-65	215±6	201±30.2
			Ru-106	171±9	181±27.2
			Cs-134	198±2	202±30.3
			Cs-137	152±4	151±22.7
STW-68	Water	Feb. 1976	H-3	1124±31	1080±978
STW-78	Water	Jun. 1976	H-3	2500±44	2502±1056
STW-84	Water	Aug. 1976	H-3	3097±21	3100±1080
STM-91	Milk	Nov. 1976	I-131	83±0.6	85±15
			Ba-140	<4	0
			Cs-137	12±1.7	11±15
			K(mg/l)	1443±31	1510±228
STW-93	Water	Dec. 1976	Cr-51	105±15	104±15
			Co-60	<4	0
			Zn-65	97±4	102±15
			Ru-106	87±3	99±15
			Cs-134	85±4	93±15
			Cs-137	103±4	101±15
STW-94	Water	Dec. 1976	H-3	2537±15	2300±1049
STM-97	Milk	Mar. 1977	I-131	55±2.5	51±15
			Ba-140	<6	0
			Cs-137	34±1	29±15
			K(mg/l)	1520±35	1550±233
STW-101	Water	Apr. 1977	H-3	1690±62	1760±1023

Table A-1. (continued)

Lab Code	Sample Type	Date Coll.	Analysis	Concentration in pCi/l[b] HES Result ±2σ [c]	EPA Result ±3σ , n=1[d]
STM-130	Milk	May 1977	Sr-89	38±2.6	44±15
			Sr-90	12±2.1	10±4.5
			I-131	59±2.1	50±15
			Ba-140	53±4.4	72±15
			Cs-137	14±1.2	10±15
			K(mg/l)	1533±21	1560±234
STW-105	Water	Jun. 1977	Cr-51	<14	0
			Co-60	29±1	29±15
			Zn-65	74±7	74±15
			Ru-106	64±8	62±15
			Cs-134	41±1	44±15
			Cs-137	35±3	35±15
STW-107	Water	Jun. 1977	Ra-226	4.7±0.3	5.1±2.42
STW-113	Water	Aug. 1977	Sr-89	13±0[e]	14±15
			Sr-90	10±2[e]	10±4.5
STW-116	Water	Sep.1977	Gross Alpha	12±6	10±15
			Gross Beta	32±6	30±15
STW-118	Water	Oct. 1977	H-3	1475±29	1650±1017
STW-119	Water	Oct. 1977	Cr-51	132±14	153±24
			Co-60	39±2	38±15
			Zn-65	51±5	53±15
			Ru-106	63±6	74±15
			Cs-134	30±3	30±15
			Cs-137	26±1	25±15
STW-136	Water	Feb. 1978	H-3	1690±270	1680±1020
STW-137	Water	Feb. 1978	Cr-51	<27	0
			Co-60	36±2	34±15
			Zn-65	32±4	29±15
			Ru-106	41±2	36±15
			Cs-134	47±2	52±15
			Cs-137	<2	0

Table A-1. (continued)

Lab Code	Sample Type	Date Coll.	Analysis	Concentration in pCi/l[b] HES Result ±2σ [c]	EPA Result ±3σ , n=1[d]
STW-138g	Water	Mar. 1978	Ra-226	5.4±0.1	5.5±0.6
			Ra-228	NA[f]	16.7±2.5
STW-150	Water	Apr. 1978	H-3	2150±220	2220±1047
STW-151	Water	Apr. 1978	Gross Alpha	20±1	20±15
			Gross Beta	56±4	59±15
			Sr-89	19±2	21±15
			Sr-90	8±1	10±4.5
			Co-60	19±3	20±15
			Cs-134	16±1	15±15
			Cs-137	<2	0
STM-152	Milk	Apr.1978	Sr-89	85±4	101±15
			Sr-90	8±1	9±4.5
			I-131	78±1	82±15
			Cs-137	29±3	23±15
			Ba-140	<11	0
			K(mg/l)	1503±90	1500±225
STW-154g	Water	May 1978	Gross Alpha	12±1	13±15
			Gross Beta	21±4	18±15
STW-157g	Water	Jun. 1978	Ra-226	4.0±1.0	3.7±0.6
			Ra-228	NA[f]	5.6±0.8
STW-159g	Water	Jul. 1978	Gross Alpha	19±3	22±6
			Gross Beta	28±3	30±5
STW-162	Water	Aug. 1978	H-3	1167±38	1230±990
STW-165g	Water	Sep. 1978	Gross Alpha	4±1	5±5
			Gross Beta	13±1	10±5

Table A-1. (continued)

Lab Code	Sample Type	Date Coll.	Analysis	Concentration in pCi/l[b] HES Result ±2σ [c]	EPA Result ±3 σ, n=1[d]
STW-167	Water	Oct. 1978	Gross Alpha	19±2	19±15
			Gross Beta	36±2	34±15
			Sr-89	9±1	10±15
			Sr-90	4±0	5±2.4
			Ra-226	5.5±0.3	5.0±2.4
			Ra-228	NA[f]	5.4±2.4
			Cs-134	10±1	10±15
			Cs-137	15±1	13±15
STW-170	Water	Dec. 1978	Ra-226	11.5±0.6	9.2±1.4
			Ra-228	NA[f]	8.9±4.5
STW-172	Water	Jan. 1979	Sr-89	11±2	14±15
			Sr-90	5±2	6±4.5
STW-175	Water	Feb. 1979	H-3	1344±115	1280±993
STW-176	Water	Feb. 1979	Cr-51	<22	0
			Co-60	10±2	9±15
			Zn-65	26±5	21±15
			Rn-106	<16	0
			Cs-134	8±2	6±15
			Cs-137	15±2	12±15
STW-178	Water	Mar. 1979	Gross Alpha	6.3±3	10±15
			Gross Beta	15±4	16±15
STW-195g	Water	Aug. 1979	Gross Alpha	6.3±1.2	5±5
			Gross Beta	42.7±7.0	40±4
STW-193	Water	Sep. 1979	Sr-89	5.0±1.2	3.0±1.5
			Sr-90	25.0±2.7	28.0±4.5
STW-196	Water	Oct. 1979	Cr-51	135±5.0	113±18
			Co-60	7.0±1.0	6±5
			Cs-134	7.3±0.6	7±15
			Cs-137	12.7±1.2	11±15
STW-198	Water	Oct. 1979	H-3	1710±140	1560±1111

Table A-1. (continued)

Lab Code	Sample Type	Date Coll.	Analysis	Concentration in pCi/l[b] HES Result ±2σ [c]	EPA Result ±3σ, n=1[d]
STW-199	Water	Oct. 1979	Gross Alpha	16.0±3.6	21±15
			Gross Beta	36.3±1.2	49±15
			Sr-89	10.7±0.6	12±15
			Sr-90	5.7±0.6	7±15
			Ra-226	11.1±0.3	11±5
			Ra-228	1.6±0.7	0
			Co-60	35.0±1.0	33±15
			Cs-134	50.7±2.3	56±15
			Cs-137	<3	0
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

Table A-1. (continued)

Lab Code	Sample Type	Date Coll.	Analysis	Concentration in pCi/l[b] HES Result ±2σ [c]	EPA Result ±3σ, n=1[d]
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[f]	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
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

Table A-1. (continued)

Lab Code	Sample Type	Date Coll.	Analysis	Concentration in pCi/l[b] HES Result ±2σ[c]	EPA Result ±3σ, n=1[d]
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±5.29	21±5.25
			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
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

Table A-1. (continued)

Lab Code	Sample Type	Date Coll.	Analysis	Concentration in pCi/l[b] HES Result ±2σ [c]	EPA Result ±3σ, n=1[d]
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 1932	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
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

Table A-1. (continued)

Lab Code	Sample Type	Date Coll.	Analysis	Concentration in pCi/l[b] HES Result ±2σ [c]	EPA Result ±3σ, n=1[d]
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

[a]Results obtained by the Nuclear Sciences Department of Hazleton Environmental Sciences 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 HES 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]Mean ± 2σ standard deviations of two determinations.

[f]NA = Not analyzed.

[g]Analyzed but not reported to the EPA.

Table A-2. Crosscheck program results, thermoluminescent dosimeters (TLD's).

Lab Code	TLD Type	Measurement	mR: Hazleton Result $\pm 2\sigma$ [a]	mR: Known Value	mR: Average $\pm 2\sigma$ [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		
			Hazleton Result $\pm 2\sigma$[a]	Known Value	Average $\pm 2\sigma$[d] (all participants)
115-5B[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 $\pm 2\sigma$ 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 $\pm 2\sigma$ 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 $\pm 2\sigma$ 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 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 = lowest 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

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.