MONTICELLO NUCLEAR GENERATING PLANT

Monticello, Minnesota

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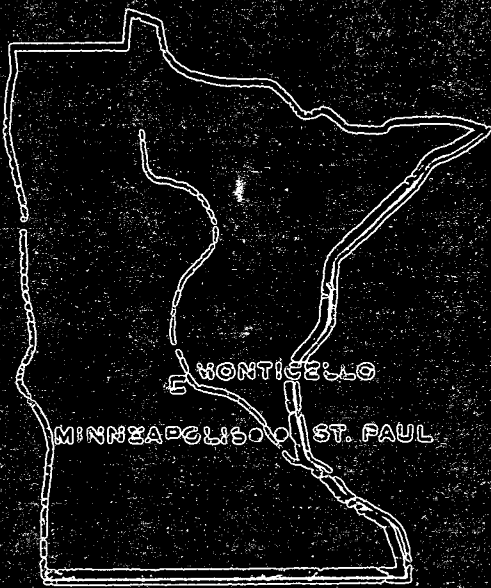

ANNUAL REPORT

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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MONTICELLO NUCLEAR GENERATING PLANT
Docket No. 50-263 License No. DPR-22

Annual Radiological Environmental Monitoring Report
1982

In accordance with the Monticello Technical Specifications, Appendix A to the Operating License DPR-22, we are submitting the Annual Radiological Environmental Monitoring Report covering the period January 1, 1982 through December 31, 1982.

Yours very truly

DM Musolf

D M Musolf, PE
Manager - Nuclear Support Services

DMM/dab

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NORTHERN STATES POWER COMPANY
MINNEAPOLIS, MINNESOTA

MONTICELLO NUCLEAR GENERATING PLANT
DOCKET NO. 50-263 LICENSE NO. DPR-22

ANNUAL REPORT TO THE UNITED STATES NUCLEAR REGULATORY COMMISSION

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

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

Approved by: L. G. Huebner
L. G. Huebner, M.S.
Director, Nuclear Sciences

21 February 1983

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PREFACE

The staff members of the Nuclear Sciences Department of Hazleton Environmental Sciences (HES), a Division of Hazleton Laboratories America, Inc. (HLA), were responsible for the acquisition of data presented in this report. 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, and other staff members of the Nuclear Sciences Department.

TABLE OF CONTENTS

LIST OF TABLES

1.0 INTRODUCTION

This report summarizes and interprets results of the Radiation Environmental Monitoring Program (REMP) conducted by Hazleton Environmental Sciences at the Monticello Nuclear Generating Plant, Monticello, 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.

Tabulation 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.

Monticello Nuclear Generating Plant is a 545 MWe boiling water reactor located on the Mississippi River in Wright County, Minnesota, and operated by Northern States Power Company. Initial criticality was achieved on 10 December 1970. Full power was achieved on 5 March 1971 and commercial operation began on 30 June 1971.

2.0 SUMMARY

The Radiation Environmental Monitoring Program (REMP) required by the U.S. Nuclear Regulatory Commission (NRC) Technical Specifications for the Monticello Nuclear Generating Plant is described. Results for 1982 are summarized and discussed.

Results obtained for gross beta in airborne particulates collected during the first quarter of 1982 show a moderate effect of fallout from 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.

No effect on the environment due to the operation of the Monticello Generating 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 Monticello 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 Monticello 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 environmental 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 as 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 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 Radiation Environmental Monitoring Program (REMP) at the Monticello Plant 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, 1982).

To monitor the air environment, airborne particulates are collected on membrane filters by continuous pumping at seven locations. Also, airborne iodine is collected by continuous pumping through charcoal filters at four 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. Five of the seven locations are indicators, and two are controls (M-1 and M-2). One of the indicators (M-6) is located in the geographical sector expected to be most susceptible to any atmospheric emissions from the Plant (highest X/Q sector).

Ambient gamma radiation is monitored at the same seven locations using CaF_2:Mn thermoluminescent dosimeters (TLDs). 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-seven (37) special locations using three (3) LiF_2 chips for each location: fourteen (14) in an inner ring in the general area of the site boundary, sixteen (16) in the outer ring within 4-5 mi radius, six (6) at special interest locations and one control location, 11.5 mi distant from the plant. They are replaced and measured quarterly. Also, a complete emergency set of TLDs for all locations, including seven airborne particulate locations, is placed in the field at the same time as regular sets. The emergency set is returned to HES 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 (M-10, Kirchenbauer) and the highest X/Q location (M-18, Olson) are analyzed for strontium-89, strontium-90 and for gamma-emitting isotopes.

Natural vegetation (such as grass) is collected semi-annually from three locations (including the highest X/Q milk location and the milk control location). Samples are analyzed for gamma-emitting isotopes including iodine-131.

Leafy green vegetables, collected annually from the garden nearest to the Plant and a control location, are analyzed for iodine-131. Corn is collected annually from the higher X/Q farm and a control location and analyzed for gamma-emitting isotopes. Potatoes are collected annually from a farm irrigated with downstream river water and a control location, and are analyzed for gamma-emitting isotopes.

The terrestrial environment is also monitored by collection of well water (quarterly), wildlife (semi-annually) and topsoil (every three years). The latest collection of soil was in 1982.

River water is collected weekly at two locations, one upstream of the Plant and one downstream. Monthly composites are analyzed for gamma-emitting isotopes. Quarterly composites are analyzed for tritium.

Drinking water is collected weekly from the City of Minneapolis water supply, which is taken from the Mississippi River downstream of the Plant. Monthly composites are analyzed for gross beta activity and gamma-emitting isotopes. Quarterly composites are analyzed for tritium, strontium-89, and strontium-90.

The aquatic environment is also monitored by semi-annual upstream and downstream collections of fish, algae or aquatic insects, aquatic vegetation, and bottom sediments. Shoreline sediment is collected semi-annually.

3.3 Program Execution

The Program was executed as described in the preceding section with the following exceptions:

(1) There were no TLD data for the third quarter, 1982, for locations M-10A, M-11A, M-12A because they were lost in the field (vandalized).

(2) Algae or aquatic insects and aquatic vegetation were not collected in the fall of 1982 from locations M-8 (Upstream) and M-9 (Downstream) because the river was too high.

Deviations from the program are summarized in Table 5.3.

3.4 Laboratory Procedures

All strontium-89, strontium-90, and iodine-131 analyses in milk were made 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 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.

4.0 RESULTS AND DISCUSSION

All of the scheduled collections and analyses were made except those 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 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 a recent test effects were airborne particulates. The residual effect of previous nuclear tests was detected in some of the milk, wildlife, natural vegetation, periphyton, bottom sediments, and soil samples (radiostrontium and cesium-137).

Ambient Radiation (TLDs)

At seven regular air sampling locations, indicator TLDs averaged 13.6 mR/91 days and control TLDs averaged 13.7 mR/91 days. The location with the highest mean (15.1 mR/91 days) was location M-7, 2.7 mi SE of the Plant.

The means at special locations were similar to those measured at regular locations and ranged from 12.3 mR/91 days for the inner ring to 12.6 mR/91 days for the outer ring and special interest areas. The differences are not statistically significant. The dose rates observed were similar to those observed in 1978, 1979, 1980, and 1981. No Plant effect on ambient gamma radiation was indicated.

Air Particulates

The average annual gross beta activity in airborne particulates was essentially identical at indicator locations (0.027 pCi/m^3) and control locations (0.026 pCi/m^3) and was about four times lower than in 1981 (0.113 pCi/m^3)and about the same as in 1980 (0.032 pCi/m^3). The decrease in the activity is attributable to the cleansing of the atmosphere from 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 the first quarter, then decreased gradually 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 16 October 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). It was more pronounced in 1981 because of the addition of radioactive debris from the latest nuclear test. The spring peak in 1982 was somewhat obscured by higher than normal activity in January and the first quarter of 1982.

Two pieces of evidence indicate conclusively that the elevated observed activity 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 Prairie Island Nuclear Generating Plant, about 100 miles distant from the Monticello Generating Plant (Northern States Power Company, 1983).

Except for beryllium-7, 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 0.25 pCi/l in all samples.

Strontium-90 results averaged slightly higher at indicator location (M-18). The annual means were 6.3 pCi/l and 5.3 pCi/l at indicator and control locations respectively. The difference is not statistically significant. All results were in the range 4.3 - 10.5 pCi/l; a range consistent with 1976, 1977, 1978, 1979, 1980, and 1981 observations at Monticello. Strontium-90 levels in this range are attributable to worldwide fallout from previous atmospheric nuclear tests and reflect the long half-life (28.64 yrs.) 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 amounts. Finally, all strontium-89 results in 1982, except one, were less than 2.0 pCi/l, in agreement with 1976, 1977, 1978, 1979, 1980, and 1981 measurements. The detected activity was 5.4 pCi/l in a control sample.

No significant changes were seen in strontium-90 levels which were similar to those observed in 1978, 1979, 1980, and 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 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 presence of strontium-90 in the milk data for 1982 is not due to the effects of Plant operation as explained above, but rather is the result of the long range residual effect of previous atmospheric nuclear tests.

River Water and Drinking Water

Tritium was below the LLD level of 330 pCi/l in all samples. Strontium-89 and strontium-90 were below the detection limits of 2.3 pCi/l and 1.4 pCi/l respectively in all drinking water samples. Gross beta in Minneapolis drinking water averaged 2.9 pCi/l and was similar to the average

level observed in 1977 (3.4 pCi/l), in 1978 (3.8 pCi/l). in 1979 (3.4 pCi/l), in 1980 (3.2 pCi/l), and in 1981 (3.5 pCi/l). Comparison with gross beta and strontium-90 data reported by EPA for Minneapolis drinking water samples collected in 1975, 1976, 1977, and 1978 indicates that concentrations of these nuclides are remaining fairly constant and are in the range of drinking water levels in other parts of the country (U.S. Environmental Protection Agency, 1975, 1976, 1977, 1978). Gamma-emitting isotopes were below detection limits in all surface water samples. There was no indication of a Plant effect.

Well Water

The tritium level was below the LLD level of 330 pCi/l in all samples. All of the gamma scan results were below detection limits. There was no indication of a Plant effect on the results.

Crops

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

Small Game Animals

Rabbits were collected in February, October, and November. Cesium-137 was detected in the flesh of two rabbits: in one rabbit collected at indicator location M-16 (0.11 pCi/g wet weight) and in one collected at control location M-17 (0.17 pCi/g wet weight). All other gamma-emitting isotopes, except potassium-40, were below their respective LLD's. In all samples, potassium-40 results averaged 3.61 pCi/g wet weight in flesh and 4.98 pCi/g wet weight in liver. Thus, no Plant effect is indicated.

Natural Vegetation

In natural vegetation, cesium-137 (0.09 pCi/g wet weight) was detected in one sample collected at control location M-10. The level was similar to that observed at this location in 1980 (0.10 pCi/g wet weight) and in 1981 (0.13 pCi/g wet weight). All other gamma emitting isotopes, except 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

In soil, strontium-90 was detected in all samples, and averaged 0.103 and 0.070 pCi/g dry weight in indicator and control samples, respectively. Cesium-137 was also detected in all samples and averaged 0.377 pCi/g dry

weight at indicator locations and 0.916 pCi/g dry weight. The only other gamma-emitting isotope detected was naturally-occuring potassium-40. The mean activity of potassium-40 was identical at both indicator and control locations (12.8 pCi/g dry weight). There was no indication of a plant effect.

Fish

Fish samples were collected in June and September. Flesh was separated from the bones and gamma scanned. Potassium-40 was the only isotope detected and the results were similar in upstream and downstream samples (3.12 and 3.54 pCi/g wet weight, respectively). There was no indication of a Plant effect.

Algae and Periphyton

Two samples were collected in June. Though there was a second scheduled collection in November, it was not done because the river was too high. The samples were analyzed for strontium-89, strontium-90, and gamma-emitting isotopes. Most of the isotopes were below detection limits. Cesium-137 was detected in one upstream sample (0.28 pCi/g wet weight).

Strontium-89 was below the detection limit of 0.13 pCi/g wet weight in both samples. Strontium-90 was detected in both samples and was slightly higher at the indicator location (0.134 pCi/g wet weight) than at the control location (0.094 pCi/g wet weight). Except for constantly produced beryllium-7 and naturally-occurring potassium-40, no other gamma-emitting isotopes were detected. There was no indication of a Plant effect.

Aquatic Vegetation

Aquatic vegetation was also collected in June. The second scheduled collection for November was not done due to a high water level in the river. The samples were analyzed for gamma-emitting isotopes. Except for naturally-occuring potassium-40, no other isotopes were detected. No Plant effect was indicated.

Bottom and Shoreline Sediments

Bottom and shoreline sediment collections were made in June and October, and analyzed for gamma-emitting isotopes. Cesium-137 was detected in two bottom sediment samples one upstream and one downstream (0.16 pCi/g dry weight, average) and the activity was slightly lower than in two shoreline sediment samples (0.28 pCi/g dry weight, Montissippi Park), indicating the influence of fallout deposition. Similar levels of activities and distribution were observed in 1978, 1979, 1980, and 1981. The only other gamma-emitting isotope detected was naturally-occuring potassium-40. There was no indication of a Plant effect.

5.0 TABLES

Table 5.1 Sample collection and analysis program, 1982. <u>Monticello</u>

Medium	Locations No.	Locations Codes (and Type)[a]	Collection Type and Frequency[b]	Analysis Type (and Frequency)[c]
Ambient Radiation (TLD's)	7	M-1(C), M-2(C), M-3 to M-7	C/Q	Ambient gamma
	37	M-01A - M14A M-01B - M-16B M-01S - M-06S M-01(C)	C/Q	Ambient gamma
Airborne particulates	7	M-1(C), M-2(C), M-3 to M-7	C/W	GB, GS (MC of all locations)
Airborne iodine	3	M-1(C), M-5, M-6[d], M-7	C/W	I-131
Milk	3	M-24, M-25 or M-28d[e], M-26	G/M	I-131
	2	M-10(C), M-18	G/M	I-131, Sr-89, Sr-90, GS
River water	2	M-8(C), M-9	G/W	GS(MC), H-3(QC)
Drinking Water	1	M-14	G/W	GB, GS(MC), H-3 (QC), SR-89,(QC), SR-90(QC)
Well water	4	M-10(C), M-11 to M-13	G/Q	H-3, GS
Edible cultivated crops - cabbage	2	M-10(C), M-27	G/A	I-131
Edible cultivated crops - corn	2	M-10(C), M-18	G/A	GS

Table 5.1 (continued) Monticello

Medium	Locations No.	Locations Codes (and Type)[a]	Collection Type and Frequency[b]	Analysis Type (and Frequency)[c]
Edible cultivated crops - potatoes	2	M-10(C), M-22	G/A	GS
Small game animals (Liver and Flesh)	2	M-16, M-17(C)	G/SA	GS
Natural Vegetation	3	M-10(C), M-18, M-19	G/SA	I-131, GS
Fish (two species, edible portion)	2	M-8(C), M-9	G/SA	GS
Algae or Aquatic Insects	2	M-8(C), M-9	G/SA	Sr-89, Sr-90 GS
Aquatic Vegetation	2	M-8(C), M-9	G/SA	GS
Bottom Sediment	2	M-8(C), M-9	G/SA	GS
Shoreline Sediment	1	M-15	G/SA	GS
Topsoil	12	M-1(C), M-2 to M-7, M-18 to M-21, M-26	G/ETY	GS, Sr-90

[a] Location codes are defined in Table A-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] Sampling for airborne iodine started at M-6 on 24 February, 1981.

e M-28d replaced M28c effective March 1981.

Table 5.2 Sampling locations. Monticello

Code	Type[a]	Name	Location
M-1	C	Station M-1 (Control-Air)	11.1 mi @ 306°/NW
M-2	C	Station M-2 (Control-Air)	8.8 mi @ 39°/NE
M-3		Station M-3	0.7 mi @ 353°/N
M-4		Station M-4	0.8 mi @ 23°/NNE
M-5		Station M-5 (Nearest Res.-Air)	0.5 mi @ 181°/S
M-6		Station M-6 (X/Q-Air)	0.9 mi @ 150°/SSE
M-7		Station M-7 (Closest Comm.-Air)	2.7 mi @ 136°/SE
M-8	C	Upstream of Plant (1,000 ft.)	0.19 mi @ 285°/WNW
M-9		Downstream of Plant (1,000 ft.)	0.19 mi @ 62°/ENE
M-10	C	Kirchenbauer Farm (Control)	11.5 mi @ 323°/NW
M-11		City of Monticello	3.2 mi @ 128°/SE
M-12		Plant Well #1 (on-site)	0.2 mi @ 267°/W
M-13		Trunnel Farm	0.3 mi @ 214°/SW
M-14		City of Minneapolis	36 mi @ 128°/SE
M-15		Montisippi Park (Rec. Area)	1.6 mi @ 117°/ESE
M-16		Plant Site (on-site)	On-site
M-17	C	Heberling Farm	12 mi @ 258°/WSW
M-18		Olson Farm (X/Q-Milk)	2.5 mi @ 24 °/NNE
M-19		Plant Site Area	1.0 mi @ 323°/NW
M-20		Gillespie Residence	1.2 mi @ 134°/SE
M-21		Ewing Farm (Irrigated Field)	4.9 mi @ 115°/ESE
M-22		Dechene Farm	4.7 mi @ 118°/ESE
M-23		Bohanon Farm	1.2 mi @ 156°/SSE
M-24		Nelson Farm	2.4 mi @ 269°/W
M-24a[b]		Witschen Farm	3.2 mi @ 260°/W
M-25		Shovelain Farm	3.0 mi @ 250°/WSW
M-26		Peterson Farm	2.3 mi @ 111°/ESE
M-27		Hageman Residence (Nearest Garden)	1.4 mi @ 131°/SE
M-28b[c]		Wipper Farm	3.2 mi @ 173°/S
M-28c[d]		Michaelis Farm	3.2 mi @ 223°/SW
M-28d[e]		Dolly Farm	3.9 mi @ 206°/SSW
M-01A		North Boundary Road	North Sector Sampler is on the south side of the road near pole #485 and it is outside the fenced area of north sector air sampling station.
M-02A		North Boundary Road	NNE Sector Sampler is on the south side of the road between poles #474 and #475 and is outside the fenced area of the NNE Sector air sampling station.
M-03A		North Boundary Road	NE Sector Sampler is on the south side of the road between poles 455 & 456.

Table 5.2 (continued) Monticello

Code	Type[a]	Name	Location
M-04A		Road to Biology Station	East Sector Sampler is next to a corner fence post around the first curve at the bottom of the road.
M-05A		Road to Biology Station	ESE Sector Sampler is next to fence post opposite the road that leads to the Meteorological tower.
M-06A		Road to Biology Station	SE Sector Sampler is next to a fence post at the first curve in the road.
M-07A		County Road 75	SSE Sector Sampler is on the north side of the road adjacent to a sign that reads "Left Turn Traffic 600 Feet".
M-08A		County Road 75	South Sector Sampler on the north side of the road opposite the west side of the bridge over Highway 94.
M-09A		County Road 75	SSW Sector Sampler is on the east side of the fenced area of the air sampling station between County Road 75 and Hwy 94.
M-10A		County Road 75	SW Sector Sampler is adjacent to the mail box of a trailer home north of County Road 75.
M-11A		County Road 75	WSW Sector Sampler is on the south side of the monitoring building facing the Monticello Plant (Sherburne County Rd. #4 east of the town of Becker about 1 mile).
M-12A		County Road 75	West Sector Sampler is adjacent to a railroad communication pole and about 600 ft. west of an unused service road entrance (plant).
M-13A		North Boundary Road	NW Sector Sampler is on the south side of the road between poles 497 & 498 near an existing fence post.
M-14A		North Boundary Road	NNW Sector Sampler is located on the south side of the road between poles 491 & 492.

Table 5.2 (continued) Monticello

Code	Type[a]	Name	Location
M-01B		Sherco #1 Air Monitoring Station	North Sector. Sampler is on the south side of the monitoring building facing the Monticello Plant (Sherburne County Rd. #4 east of the town of Becker, about 1 mile).
M-02B		County Road 11 and 55th Avenue	NNE Sector. Sampler is near the street sign post behind the telephone junction box facing the plant.
M-03B		Intersection of County Road and 81	NE Sector. Sampler is behind the telephone junction box and faces the direction of the plant (on County Road #73).
M-04B		Sherco #6 Air Monitoring Station	ENE Sector Sampler is south of monitoring building adjacent to the power pole facing the direction of the Monticello plant.
M-05B		City of Big Lake Garage	East Sector County Road #73 and Hwy. 10 (NE Corner) Sampler is on the south-west corner of the building about 6 ft. away and facing the plant.
M-06B		At Junction of County Road #14 and 196th St.	ESE Sector Sampler is located on the northwest corner of the intersection midway between the street sign and a tree facing the plant.
M-07B		Industrial Drive	SE Sector Sampler is adjacent to NSP power pole #21 and facing the plant.
M-08B		Dale K. Larson Res.	SSE Sector - Hwy. #25 and approximately 1/4 mile south of County Road #106. Sampler is adjacent to the residence power pole and facing the plant.
M-09B		Near Norbert Weinand Farm	South Sector Sampler is adjacent to power pole #44 and about 6 ft. south of it facing the plant.
M-10B		Near the John Reisewitz Farm	SSW Sector Sampler is near the road adjacent to pole #EM204, facing the Monticello Plant.

Table 5.2 (continued) Monticello

Code	Type[a]	Name	Location
M-11B		Near the Clifford Vanlith Farm	SW Sector Sampler is north of the road adjacent to the mail box and near pole #35.
M-12B		Lake Maria State Park Entrance	WSW Sector - Sampler is on the (south) side of the entrance road between a "State Park" sign and a tree.
M-13B		Near Bridgewater Switching Station	West Sector (Enfield Exchange) -Sampler is outside the south-east corner of the fenced area and facing the Monticello Plant.
M-14B		Near the Richard K Anderson Residence	WNW Sector Sampler is on the west side of the road adjacent to the mail boxes.
M-15B		Near the Gary Williamson Residence	NW Sector Sampler is located on the west side of the road adjacent the mail boxes.
M-16B		Sand Plain Research Farm (U of M)	NNW Sector Sampler is located behind the signboard and facing the Monticello Plant.
M-01S		Floyd Hartung Residence	SSW Sector Sampler is east of driveway next to a fence post.
M-02S		Near Monticello Service Center	SE Sector Sampler is adjacent to a pole with a night light on it next to the driveway.
M-03S		Big Oaks Park	East Sector (on County road # 11) Sampler is near the sign post on the north side of the entrance road and facing the plant.
M-04S		Pinewood Elementary	SSE Sector Sampler is adjacent to the northeast corner of the tennis court fence.
M-05S		Roman Greener Residence	ESE Sector (near County #50 and 208 St.) Sampler is near flag pole on the residence property.
M-06S		Near Monticello Service Center	SE Sector Sampler is adjacent to the air monitoring station west of the building.
M-01C		Kirchenbauer Farm	NW Sector Sampler is located adjacent to the mail boxes.

[a] "C" denotes control location. All other locations are indicators.
[b] Witschen Farm (M-24a) replaces Nelson Farm (M-24) which went out of business on 10 November 1981.
[c] M-28b (Wipper Farm) replaced M-25 (Shovelain Farm) effective September 1979.
[d] M-28c (Michaelis Farm) replaced M-28b (Wipper Farm) effective October 1980.
[e] M-28d (Dolly Farm) replaced M-28c (Michaelis Farm) effective March 1981.

Table 5.3. Missed collections and analyses for 1982, at Monticello NGP. All required samples were collected and analyzed except the following:

Sample	Location	Analysis	Collection Date or Period	Comments
Thermoluminescent Dosimeters (TLDs)	M-10A M-11A M-12A	Ambient Radiation	3rd Qtr. 1982	Lost in the field, vandalized.
Algae or Aquatic Insects	M-8 M-9	Gamma Isotopic	November 1982	River too high.
Aquatic Vegetation	M-8 M-9	Gamma Isotopic	November 1982	River too high

Table 5.4 Environmental Radiological Monitoring Program Summary.

Name of facility Monticello Nuclear Generating Plant Docket No. 50-263

Location of facility Wright, 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 28	1.0	13.6 (20/20) (10.6-17.0)	M-7, Station M-7 2.7 mi @ 136°/SE	15.1 (4/4) (14.2-17.0)	13.7 (8/8) (12.0-15.0)	0
TLD (mR/91 days) (Inner Ring, General Area at Site Boundary)	Gamma 53	3.0	12.3 (53/53) (8.9-15.2)	M-14A, North Boundary Road SE Sector	13.2 (4/4) (10.8-15.2)	(See control below)	0
TLD (mR/91 days (Outer ring, 4-5 miles distant)	Gamma 64	3.0	12.6 (64/64) (8.7-17.1)	M-05B, City of Big Lake Garage East Sector	15.9 (4/4) (13.0-17.1)	(See control below)	0
TLD (mR/91 days (Special Interest Areas)	Gamma 24	3.0	12.5 (24/24) (9.8-15.0)	M-02S, Near Monticello Service Center SE Sector	12.9 (4/4) (9.9-15.0)	(See control below)	0
TLD (mR/91 days) (Control)	Gamma 4	3.0	None	M-01C, Kirchenbauer Farm NW Sector	12.0 (4/4) (10.1-13.2)	12.0 (4/4) (10.1-13.2)	0
Airborne Particulates (pCi/m^3)	GB 364	0.002	0.027 (255/260) (0.011-0.063)	M-2, Station M-2 (Control Air) 8.8 mi @ 39°/NE	0.028 (52/52) (0.011-0.061)	0.026 (104/104) (0.009-0.061)	0
				M-6, Station M-6 (X/Q air) 0.9 mi @ 150°/SE	0.028 (51/52) (0.012-0.056)		
				M-7, Station M-7 (Closest Comm. Air) 2.7 mi @ 136°/SE	0.028 (50/52) (0.012-0.063)		
Monthly Composites of all Locations (pCi/m^3)	GS 12						
	Be-7	0.040	0.089 (12/12) (0.049-0.189)	NA[f]	-	None	0
	Mn-54	0.0007	<LLD	-	-	None	0
	Co-58	0.0010	<LLD	-	-	None	0
	Co-60	0.0005	<LLD	-	-	None	0

Table 5.4 (Continued)
Name of facility Monticello 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 Monthly Composites of all Locations (pCi/m^3) (Cont'd)	Zn-65	0.0013	<LLD	-	-	None	0
	Nb-95	0.0010	<LLD	-	-	None	0
	Zr-95	0.0030	<LLD	-	-	None	0
	Ru-103	0.0028	<LLD	-	-	None	0
	Ru-106	0.0073	<LLD	-	-	None	0
	Ba-134	0.0007	<LLD	-	-	None	0
	Cs-137	0.0006	<LLD	-	-	None	0
	Ba-140	0.0057	<LLD	-	-	None	0
	La-140	0.0034	<LLD	-	-	None	0
	Ce-141	0.0060	<LLD	-	-	None	0
	Ce-144	0.0039	<LLD	-	-	None	0
Airborne Iodine (pCi/m^3)	I-131 212	0.07	<LLD	-	-	<LLD	0
Milk (pCi/l)	I-131 60	0.25	<LLD	-	-	<LLD	0
	Sr-89 24	2.0	<LLD	M-10, Kirchenbauer Farm 11.5 mi @ 323°/NW	5.4 (1/12) -	5.4 (1/12) -	0
	Sr-90 24	1.0	6.3 (12/12) (4.3-10.5)	M-18, Olson 2.5 mi @ 24°/NNE	6.3 (12/12) (4.3-10.5)	5.3 (12/12) (4.3-6.6)	0
	GS 24						
	K-40	200	1190 (12/12) (1080-1450)	M-10, Kirchenbauer Farm 11.5 mi @ 323°/NW	1280 (12/12) (1090-1520)	1280 (12/12) (1090-1520)	0
	Cs-134	15	<LLD	-	-	<LLD	0
	Cs-137	15	<LLD	-	-	<LLD	0
	Ba-La-140	18	<LLD	-	-	<LLD	0

Table 5.4 (Continued)
Name of facility Monticello 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)	H-3	8	330	<LLD	-	-	<LLD	0
	GS	24						
	Mn-54		15	<LLD	-	-	None	0
	Co-58		15	<LLD	-	-	None	0
	Co-60		15	<LLD	-	-	None	0
	Zn-65		30	<LLD	-	-	None	0
	Nb-95		17	<LLD	-	-	None	0
	Zr-95		34	<LLD	-	-	None	0
	Cs-134		15	<LLD	-	-	None	0
	Cs-137		18	<LLD	-	-	None	0
	Ba-La-140		21	<LLD	-	-	None	0
	Ce-144		114	<LLD	-	-	None	0
Drinking Water (pCi/l)	GB	12	1.0	2.9 (12/12) (2.3-4.0)	M-14, Minneapolis 36 mi @ 128°/SE	2.9 (12/12) (2.3-4.0)	None	0
	H-3	4	330	<LLD	-	-	None	0
	Sr-89	4	2.3	<LLD	-	-	None	0
	Sr-90	4	1.4	<LLD	-	-	None	0
	GS	12						
	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
	Zr-95		34	<LLD	-	-	<LLD	0

Table 5.4 (Continued)
Name of facility Monticello 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) (Cont'd)	Cs-134	15	<LLD	-	-	<LLD	0
	Cs-137	18	<LLD	-	-	<LLD	0
	Ba-La-140	15	<LLD	-	-	<LLD	0
	Ce-144	107	<LLD	-	-	<LLD	0
Well Water (pCi/l)	H-3 16	330	<LLD	-	-	<LLD	0
	GS 16						
	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	22	<LLD	-	-	<LLD	0
	Zr-95	27	<LLD	-	-	<LLD	0
	Cs-134	15	<LLD	-	-	<LLD	0
	Cs-137	18	<LLD	-	-	<LLD	0
	Ba-La-140	21	<LLD	-	-	<LLD	0
	Ce-144	122	<LLD	-	-	<LLD	0
Crops-Potatoes (pCi/g wet)	GS 2						
	Be-7	0.31	<LLD	-	-	<LLD	0
	K-40	0.5	2.79 (1/1) -	M-10, Kirchenbauer 11.5 mi @ 323°/NW	4.48 (1/1) -	4.48 (1/1) -	0
	Mn-54	0.041	<LLD	-	-	<LLD	0
	Co-58	0.028	<LLD	-	-	<LLD	0
	Co-60	0.037	<LLD	-	-	<LLD	0
	Zn-65	0.071	<LLD	-	-	<LLD	0

Table 5.4 (Continued)
Name of facility Monticello 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]
Crops-Potatoes (pCi/g wet) (Cont'd)	Nb-95	0.040	<LLD	-	-	<LLD	0
	Zr-95	0.042	<LLD	-	-	<LLD	0
	Ru-103	0.048	<LLD	-	-	<LLD	0
	Ru-106	0.19	<LLD	-	-	<LLD	0
	I-131	0.62	<LLD	-	-	<LLD	0
	Cs-134	0.020	<LLD	-	-	<LLD	0
	Cs-137	0.028	<LLD	-	-	<LLD	0
	Ba-140	0.072	<LLD	-	-	<LLD	0
	La-140	0.026	<LLD	-	-	<LLD	0
	Ce-141	0.076	<LLD	-	-	<LLD	0
	Ce-144	0.23	<LLD	-	-	<LLD	0
Crops-Cabbage (pCi/g wet	I-131 2	0.025	<LLD	-	-	<LLD	0
Crops-Corn (pCi/g wet)	GS 2						
	Be-7	0.34	<LLD	-	-	<LLD	0
	K-40	0.5	2.63 (1/1) -	M-10, Kirchenbauer 11.5 mi @ 323°/NW	2.75 (1/1) -	2.75 (1/1) -	0
	Mn-54	0.031	<LLD	-	-	<LLD	0
	Co-58	0.042	<LLD	-	-	<LLD	0
	Co-60	0.022	<LLD	-	-	<LLD	0
	Zn-65	0.053	<LLD	-	-	<LLD	0
	Nb-95	0.033	<LLD	-	-	<LLD	0
	Zr-95	0.074	<LLD	-	-	<LLD	0
	Ru-103	0.098	<LLD	-	-	<LLD	0
	Ru-106	0.26	<LLD	-	-	<LLD	0

Table 5.4 (Continued)
Name of facility Monticello 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]
Crops-Corn (pCi/g wet) (Cont'd)	I-131	0.70	<LLD	-	-	<LLD	0
	Cs-134	0.025	<LLD	-	-	<LLD	0
	Cs-137	0.022	<LLD	-	-	<LLD	0
	Ba-140	0.093	<LLD	-	-	<LLD	0
	La-140	0.015	<LLD	-	-	<LLD	0
	Ce-141	0.084	<LLD	-	-	<LLD	0
	Ce-144	0.17	<LLD	-	-	<LLD	0
Small Game Animals-Flesh (pCi/g wet)	GS 4						
	K-40	0.1	3.71 (2/2) (3.51-3.90)	M-16, Plant Site Area On Site	3.71 (2/2) (3.51-3.90)	3.50 (2/2) (2.94-4.05)	0
	Mn-54	0.076	<LLD	-	-	<LLD	0
	Co-58	0.096	<LLD	-	-	<LLD	0
	Co-60	0.051	<LLD	-	-	<LLD	0
	Zn-65	0.13	<LLD	-	-	<LLD	0
	Nb-95	0.12	<LLD	-	-	<LLD	0
	Zr-95	0.19	<LLD	-	-	<LLD	0
	Cs-134	0.068	<LLD	-	-	<LLD	0
	Cs-137	0.074	0.106 (1/2) -	M-17, Heberling Farm 12 mi @ 258°/WSW	0.174 (1/2) -	0.174 (1/2) -	0
	Ba-140	0.20	<LLD	-	-	<LLD	0
	La-140	0.053	<LLD	-	-	<LLD	0
Small Game Animals-Liver (pCi/g wet)	GS 4						
	K-40	2.0	4.54 (2/2) (2.23-6.86)	M-16, Plant Site Area, on-site	4.54 (2/2) (2.73-6.86)	4.42 (2/2) (3.30-5.54)	0
	Mn-54	0.15	<LLD	-	-	<LLD	0

Table 5.4 (Continued)
Name of facility Monticello 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]
Small Game Animals-Liver (pCi/g wet) (Cont'd)	Co-58	0.28	<LLD	-	-	<LLD	0
	Co-60	0.14	<LLD	-	-	<LLD	0
	Zn-65	0.40	<LLD	-	-	<LLD	0
	Nb-95	0.56	<LLD	-	-	<LLD	0
	Zr-95	0.49	<LLD	-	-	<LLD	0
	Cs-134	0.13	<LLD	-	-	<LLD	0
	Cs-137	0.14	<LLD	-	-	<LLD	0
	Ba-140	0.39	<LLD	-	-	<LLD	0
	La-140	0.13	<LLD	-	-	<LLD	0
Natural Vegetation (pCi/g wet)	GS 6						
	Be-7	0.57	2.43 (3/4) (1.68-2.73)	M-18, Olson Farm 2.5 mi @ 24°/NNE	2.73 (1/2) -	2.11 (2/2) (1.79-2.43)	0
	K-40	0.5	3.82 (4/4) (1.56-5.19)	M-10, Kirchenbauer Farm 11.5 mi @ 323°/NW	4.88 (2/2) (4.06-5.69)	4.88 (2/2) (4.06-5.69)	0
	Mn-54	0.045	<LLD	-	-	<LLD	0
	Co-58	0.061	<LLD	-	-	<LLD	0
	Co-60	0.041	<LLD	-	-	<LLD	0
	Zn-65	0.12	<LLD	-	-	<LLD	0
	Nb-95	0.057	<LLD	-	-	<LLD	0
	Zr-95	0.082	<LLD	-	-	<LLD	0
	Ru-103	0.055	<LLD	-	-	<LLD	0
	Ru-106	0.36	<LLD	-	-	<LLD	0
	I-131	0.086	<LLD	-	-	<LLD	0
	Cs-134	0.060	<LLD	-	-	<LLD	0
	Cs-137	0.054	<LLD	M-10, Kirchenbauer Farm 11.5 mi @ 323°/NW	0.086 (1/2) -	0.086 (1/2) -	0

Table 5.4 (Continued)
Name of facility Monticello 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)	Ba-140		0.20	<LLD	-	-	<LLD	0
	La-140		0.043	<LLD	-	-	<LLD	0
	Ce-141		0.085	<LLD	-	-	<LLD	0
	Ce-144		0.34	<LLD	-	-	<LLD	0
Fish (pCi/g wet)	GS	8						
	K-40		0.1	3.54 (4/4) (2.83-3.91)	M-9, Downstream of Plant 0.19 mi @ 62°/ENE	3.54 (4/4) (2.83-3.91)	3.12 (4/4) (2.74-3.49)	0
	Mn-54		0.10	<LLD	-	-	<LLD	0
	Co-58		0.076	<LLD	-	-	<LLD	0
	Co-60		0.071	<LLD	-	-	<LLD	0
	Zn-65		0.12	<LLD	-	-	<LLD	0
	Nb-95		0.079	<LLD	-	-	<LLD	0
	Zr-95		0.20	<LLD	-	-	<LLD	0
	Cs-134		0.070	<LLD	-	-	<LLD	0
	Cs-137		0.072	<LLD	-	-	<LLD	0
	Ba-140		0.26	<LLD	-	-	<LLD	0
	La-140		0.065	<LLD	-	-	<LLD	0
Periphyton (pCi/g wet)	Sr-89	2	0.13	<LLD	-	-	<LLD	0
	Sr-90	2	0.041	0.134 (1/1) -	M-9, Downstream of Plant 0.19 mi @ 62°/ENE	0.134 (1/1) -	0.094 (1/1) -	0
	GS	2						
	Be-7		0.87	<LLD	M-8, Upstream of Plant 0.19 mi @ 285°/NW	1.65 (1/1) -	1.65 (1/1) -	0
	K-40		1.0	3.00 (1/1) -	M-8, Upstream of Plant 0.19 mi @ 285°/NW	3.43 (1/1) -	3.43 (1/1) -	0
	Mn-54		0.073	<LLD	-	-	<LLD	0

Table 5.4 (Continued)
Name of facility Monticello 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]
Periphyton (pCi/g wet) (Cont'd)	Co-58	0.067	<LLD	-	-	<LLD	0
	Co-60	0.071	<LLD	-	-	<LLD	0
	Zn-65	0.12	<LLD	-	-	<LLD	0
	Nb-95	0.090	<LLD	-	-	<LLD	0
	Zr-95	0.19	<LLD	-	-	<LLD	0
	Ru-103	0.088	<LLD	-	-	<LLD	0
	Ru-106	0.57	<LLD	-	-	<LLD	0
	Cs-134	0.098	<LLD	-	-	<LLD	0
	Cs-137	0.085	<LLD	M-8, Upstream of Plant 0.19 mi @ 285°/WNW	0.278 (1/1) -	0.278 (1/1) -	0
	Ba-140	0.17	<LLD	-	-	<LLD	0
	La-140	0.062	<LLD	-	-	<LLD	0
	Ce-141	0.19	<LLD	-	-	<LLD	0
	Ce-144	0.43	<LLD	-	-	<LLD	0
Aquatic Vegetation (pCi/g wet)	GS 2						
	Be-7	0.20	<LLD	-	-	<LLD	0
	K-40	1.38	2.99 (1/1) -	M-9, Downstream of Plant 0.19 mi @ 62° ENE	2.99 (1/1) -	1.69 (1/1) -	0
	Mn-54	0.017	<LLD	-	-	<LLD	0
	Co-58	0.028	<LLD	-	-	<LLD	0
	Co-60	0.034	<LLD	-	-	<LLD	0
	Zn-65	0.040	<LLD	-	-	<LLD	0
	Nb-95	0.019	<LLD	-	-	<LLD	0
	Zr-95	0.039	<LLD	-	-	<LLD	0
	Ru-103	0.020	<LLD	-	-	<LLD	0

Table 5.4 (Continued)
Name of facility Monticello Nuclear Generating Plant

Sample Type (Units)	Type and Number of Analyses[a]	LLD[b]	Indicator Locations Mean(F) 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]
Aquatic Vegetation (pCi/g wet) (Cont'd)	Ru-106	0.17	<LLD	-	-	<LLD	0
	Cs-134	0.026	<LLD	-	-	<LLD	0
	Cs-137	0.025	<LLD	-	-	<LLD	0
	Ba-140	0.059	<LLD	-	-	<LLD	0
	La-140	0.023	<LLD	-	-	<LLD	0
	Ce-141	0.047	<LLD	-	-	<LLD	0
	Ce-144	0.13	<LLD	-	-	<LLD	0
Bottom and Shoreline Sediments (pCi/g dry)	GS 6						
	Be-7	0.54	<LLD	-	-	<LLD	0
	K-40	0.5	12.35 (4/4) (11.19-12.82)	M-8, Upstream of Plant 0.19 mi @ 285°/WNW	12.98 (2/2) (12.84-13.11)	12.98 (2/2) (12.84-13.11)	0
	Mn-54	0.051	<LLD	-	-	<LLD	0
	Co-58	0.064	<LLD	-	-	<LLD	0
	Co-60	0.056	<LLD	-	-	<LLD	0
	Zn-65	0.12	<LLD	-	-	<LLD	0
	Nb-95	0.059	<LLD	-	-	<LLD	0
	Zr-95	0.070	<LLD	-	-	<LLD	0
	Ru-103	0.070	<LLD	-	-	<LLD	0
	Ru-106	0.40	<LLD	-	-	<LLD	0
	Cs-134	0.10	<LLD	-	-	<LLD	0
	Cs-137	0.056	0.231 (3/4) (0.127-0.293)	M-15, Montissippi Park 1.6 mi @ 117°/ESE	0.284 (2/2) (0.274-0.293)	0.183 (1/2) -	0
	Ba-La-140	0.062	<LLD	-	-	<LLD	0
	Ce-141	0.11	<LLD	-	-	<LLD	0
	Ce-144	0.26	<LLD	-	-	<LLD	0

Table 5.4 (Continued)
Name of facility Monticello 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]
Top Soil (pCi/g dry)	Sr-90 12	0.02	0.103 (10/10) (0.038-0.180)	M-7, Station M-7 2.7 mi @ 136°/SE	0.180 (1/1) -	0.070 (2/2) (0.067-0.072)	0
	GS 12						
	Be-7	0.85	<LLD	-	-	<LLD	0
	K-40	1.00	12.8 (10/10) (11.5-14.4)	M-3, Station M-3 0.7 mi @ 353°/N	14.4 (1/1) -	12.8 (2/2) (11.6-13.9)	0
	Mn-54	0.074	<LLD	-	-	<LLD	0
	Co-58	0.062	<LLD	-	-	<LLD	0
	Co-60	0.082	<LLD	-	-	<LLD	0
	Zn-65	0.17	<LLD	-	-	<LLD	0
	Nb-95	0.071	<LLD	-	-	<LLD	0
	Zr-95	0.15	<LLD	-	-	<LLD	0
	Ru-103	0.13	<LLD	-	-	<LLD	0
	Ru-106	0.57	<LLD	-	-	<LLD	0
	Cs-134	0.057	<LLD	-	-	<LLD	0
	Cs-137	0.030	0.377 (10/10) (0.204-0.610)	M-1, Station M-1 11.1 mi @ 306°/NW	1.61 (1/1) -	0.916 (2/2) (0.221-1.61)	0
	Ba-140	0.17	<LLD	-	-	<LLD	0
	La-140	0.040	<LLD	-	-	<LLD	0
	Ce-141	0.16	<LLD	-	-	<LLD	0
	Ce-144	0.36	<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.

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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 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
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 $\pm 2\sigma$ [c]	EPA Result $\pm 3\sigma$, 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 $\pm 2\sigma$ 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 ±2σ [a]	mR: Known Value	mR: Average ±2σ [d] (all participants)
2nd International Intercomparison[b]					
115-2[b]	CaF_2:Mn Bulb	Gamma-Field	17.0±1.9	17.1[c]	16.4±7.7
		Gamma-Lab	20.8±4.1	21.3[c]	18.8±7.6
3rd International Intercomparison[e]					
115-3[e]	CaF_2:Mn Bulb	Gamma-Field	30.7±3.2	34.9±4.8[f]	31.5±3.0
		Gamma-Lab	89.6±6.4	91.7±14.6[f]	86.2±24.0
4th International Intercomparison[g]					
115-4[g]	CaF_2:Mn Bulb	Gamma-Field	14.1±1.1	14.1±1.4[f]	16.09.0
		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 ±2σ[a]	Known Value	Average ± 2σ[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 ±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 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	3×10^6 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.