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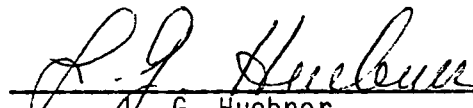
NORTHERN STATES POWER COMPANY
MINNEAPOLIS, MINNESOTA

MONTICELLO NUCLEAR GENERATING PLANT
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ANNUAL REPORT
TO THE
UNITED STATES NUCLEAR REGULATORY COMMISSION
Radiation Environmental Monitoring Program
January 1, 1991 to December 31, 1991

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by
TELEDYNE ISOTOPES MIDWEST LABORATORY
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PREFACE

The staff of Teledyne Isotopes Midwest Laboratory was responsible for the acquisition of the data presented in this report. Samples were collected by members of the staff of Nuclear Radiological Services Department. The report was prepared by L. G. Huebner, General Manager, Teledyne Isotopes Midwest Laboratory. He was assisted in the report preparation by other staff members of this laboratory.

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1.0 INTRODUCTION

This report summarizes and interprets results of the Radiation Environmental Monitoring Program (REMP) conducted by Teledyne Isotopes Midwest Laboratory at the Monticello Nuclear Generating Plant, Monticello, Minnesota, during the period January - December, 1991. 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 (Teledyne Isotopes Midwest Laboratory, 1992a) available at Northern States Power Company, Nuclear Generation 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 1991 are summarized and discussed.

Program findings show background levels of radioactivity in the environmental samples collected in the vicinity of the Monticello Nuclear Generating Plant.

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;
- (4) Industrial and medical radioactive waste; and
- (5) Fallout from nuclear accidents.

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 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, iron-59, 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 (Teledyne Isotopes Midwest Laboratory, 1991).

To monitor the air environment, airborne particulates are collected on membrane filters by continuous pumping at five locations. Also, airborne iodine is collected by continuous pumping through charcoal filters at all of these locations. Filters are changed and counted weekly.

Particulate filters are analyzed for gross beta activity and charcoal filters for iodine-131. Quarterly composites of particulate filters from each location are gamma-scanned on a HP Ge or Ge(Li) detector. One of

the five locations is a control (M-1), and four are indicators (M-2, M-3, M-4, M-5). One of the indicators is located in the geographical sector expected to be most susceptible to any atmospheric emissions from the Plant (highest D/Q sector).

As a "Lessons Learned" commitment, ambient gamma radiation is monitored at thirty-seven (37) locations using $\text{CaSO}_4:\text{Dy}$ dosimeter with four sensitive areas at 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, 11.1 mi distant from the plant. They are replaced and measured quarterly. Also, a complete emergency set of TLDs for all locations is placed in the field at the same time as regular sets. The emergency set is returned to TIML quarterly for annealing and repackaging.

Milk samples are collected monthly from five farms (four indicator and one control). The milk is collected biweekly during the growing season (May - October), because the milk animals may be on pasture. All samples are analyzed for iodine-131 and gamma-emitting isotopes.

Leafy green vegetables (cabbage) are collected annually from the highest D/Q garden and a control location (M-10) and analyzed for iodine-131. Corn and potatoes are collected annually only if the field is irrigated by water in which liquid radioactive effluent has been discharged. Analysis is for gamma-emitting isotopes.

The terrestrial environment is also monitored by collection of well water from four locations on a quarterly basis. All samples are analyzed for tritium and gamma-emitting isotopes.

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, iodine-131, and gamma-emitting isotopes. Quarterly composites are analyzed for tritium.

The aquatic environment is also monitored by semi-annual upstream and downstream collections of fish, algae or aquatic insects, and bottom sediments. Shoreline sediment is collected semi-annually from one location. All samples are analyzed for gamma-emitting isotopes.

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 Location M-12A for the fourth quarter of 1991. The TLDs were lost in the field.

Deviations from the program are summarized in Table 5.3.

3.4 Laboratory Procedures

The iodine-131 analyses in milk and drinking water were made using a sensitive radiochemical procedure which involves separation of the iodine using an ion-exchange method and solvent extraction and finally beta counting.

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

Tritium was determined by a liquid scintillation technique.

Analytical procedures used by the Teledyne Isotopes Midwest Laboratory are specified in detail elsewhere (Teledyne Isotopes Midwest Laboratory, 1985). Procedures are based on those prescribed by the National Center for Radiological Health of the U.S. Public Health Service (U.S. Public Health Service, 1967) and by the Health and Safety Laboratory of the U.S. Atomic Energy Commission (U.S. Atomic Energy Commission, 1972).

Teledyne Isotopes Midwest Laboratory has a comprehensive quality control/quality assurance program designed to assure the reliability of data obtained. Details of TIML's QA Program are presented elsewhere (Teledyne Isotopes Midwest Laboratory, 1991). The TIML QA Program includes participation in Interlaboratory Comparison (crosscheck) Programs. Results obtained in crosscheck programs are presented in Appendix A.

3.5 Program Modifications

During the growing season, milk producers were monitored to determine when the dairy animals were on pasture or fresh cut feed. The frequency of milk samples was increased to semimonthly at four indicator locations (Peterson, Høglund, Witschen, and Weinand), plus the control location (Kirchenbauer), at various times during the period because animals were on pasture or fresh cut feed. In August 1991, the Witschen Dairy Farm (M-18) went out of business. The Holthaus Dairy Farm (M-29) was included into the program at this time.

3.6 Land Use Census

In accordance with the Technical Specifications 4.16 Paragraph B1 a land use census shall be conducted and shall identify the location of the nearest milk animal, the nearest residence, and the nearest garden of greater than 500 ft² producing fresh leafy vegetables, in each of the 16 meteorological sectors within a distance of 5 miles. The census shall also identify the locations of all milk animals and all 500 ft² or greater gardens producing broad leaf vegetation in each of the meteorological sectors within a distance of three miles. This census shall be conducted at least once per year between the dates of May 1 and October 31. New locations shall be added to the radiation environmental monitoring program within 30 days and sampling locations having lower calculated doses or a lower dose commitment may be deleted from this monitoring program after October 31 of the year in which the land use census was conducted.

The 1991 land use census was completed on September 30, 1991. This census did not identify any locations of exposure pathways different from those used in the program during the first six months of the year.

The Witschen farm went out of business and was replaced by the Holthaus Dairy Farm in August, 1991. There were also four changes in garden sampling locations. The garden in the NNE sector moved 0.1 mi closer, the E sector moved 0.5 mi closer, the NE sector moved 0.6 mi further away, and the garden in the SW sector moved 0.2 mi further away.

The distance of the Ernst residence in the SSW sector was reevaluated, and determined to be 0.1 mi closer to the plant. There were no other changes in residence.

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 Atmospheric Nuclear Detonations and Nuclear Accidents

There were no reported atmospheric nuclear tests in 1991. The last reported test was conducted on October 16, 1980 by the People's Republic of China. The reported yield was in the 200 kiloton to 1 megaton range.

There were no reported accidents at nuclear reactor facilities in 1991.

4.2 Program Findings

Results obtained show background levels of radioactivity in the environmental samples collected in the vicinity of the Monticello Nuclear Generating Plant in 1991.

Ambient Radiation (TLDs)

Ambient radiation was measured in the general area of site boundary, at outer ring 4 - 5 mi distant from the Plant, at special interest areas, and at one control location. The means were nearly identical at both inner and outer rings (15.2 and 15.8 mR/91 days, respectively). The mean at special locations was 15.3 mR/91 days. The mean at the control location was 15.0 mR/91 days. The differences are not statistically significant. The dose rates measured were similar to those observed in 1978, 1983, 1984, 1985, 1986, 1987, 1988, 1989, and 1990 (12.3, 12.5, 13.6, 14.2, 15.3, 15.4, 15.2, 15.2 and 16.2 mR/91 days, respectively). No Plant effect on ambient gamma radiation was indicated.

Airborne Particulates

The average annual gross beta concentration in airborne particulates was identical at indicator and control locations (0.024 pCi/m³) and

was nearly identical or similar to the levels observed in 1982 (0.026 pCi/m³), 1983 (0.023 pCi/m³), 1984 (0.024 pCi/m³), 1985 (0.025 pCi/m³), and 1986 (0.026 pCi/m³), 1987 (0.026 pCi/m³), 1988 (0.030 pCi/m³), in 1989 (0.026 pCi/m³), and in 1990 (0.023 pCi/m³). The average of 0.026 pCi/m³ for 1986 does not include the results from May 19 to June 9, 1986, which were influenced by the accident at Chernobyl.

A spring peak in beta activity had been observed almost annually for many years (Wilson et al., 1969). It had been attributed to fallout of nuclides from the stratosphere (Gold et al., 1964). It was pronounced in 1981, occurred to a lesser degree in 1982, and did not occur in 1983, 1984, 1985, or 1987. In 1986, the spring peak could not be identified because it was overshadowed by the releases of radioactivity from Chernobyl. The highest averages for gross beta were for the months of January and December, and the first and fourth quarters, as in 1983, 1984, 1985, 1986 (exclusive of the period between May 19, 1986 and June 9, 1986), 1987, 1988, 1989, and 1990.

Two pieces of evidence indicate conclusively that the elevated activity observed during the fourth quarter was not attributable to the Plant operation. First, elevated activity of similar size occurred simultaneously at both indicator and control locations. Secondly, an identical pattern was observed at the Prairie Island Nuclear Generating Plant, about 100 miles distant from the Monticello Nuclear Generating Plant (Northern States Power Company, 1992b).

Gamma spectroscopic analysis of quarterly composites of air particulate filters yielded similar results for indicator and control locations. Beryllium-7, which is produced continuously in the upper atmosphere by cosmic radiation (Arnold and Al-Salih, 1955), was detected in all samples with an average of 0.054 pCi/m³ at both indicator and control locations. All other gamma-emitting isotopes were below their respective LLD limits.

Airborne Iodine

Weekly levels of airborne iodine-131 were below the lower limit of detection (LLD) of 0.07 pCi/m³ in all samples.

Milk

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

Cesium-137 results were below the LLD level of 15 pCi/L in all samples.

No other gamma-emitting isotopes except naturally-occurring 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 radio-

contaminants 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 1991 show no radiological effects of the plant operation.

River Water and Drinking Water

Tritium was below the LLD of 330 pCi/L in all samples. Gross beta in Minneapolis drinking water averaged 2.9 pCi/L and was identical or 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), in 1981 (3.5 pCi/L), and in 1982 (2.9 pCi/L), in 1983 (3.3 pCi/L), in 1984 (2.8 pCi/L), in 1985 (2.8 pCi/L), in 1986 (2.5 pCi/L), in 1987 (2.4 pCi/L), in 1988 (2.7 pCi/L), in 1989 (2.6 pCi/L), and in 1990 (2.2 pCi/L). Comparisons with gross beta data reported by EPA for Minneapolis drinking water sample 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.

Crops

Two samples of cabbage were collected in September and analyzed for iodine-131. The I-131 level was below 0.022 pCi/g wet weight in both samples. There was no indication of a plant effect. The field sampling personnel conducted a survey at Monticello Plant and found that there were no radioactive liquid effluents released into Mississippi River. Therefore, it was not necessary to collect and analyze corn or potato samples.

Fish

Fish samples were collected in May and October. Flesh was separated from the bones and gamma scanned. Potassium-40, the naturally-occurring isotope, was found to be similar in upstream and downstream samples (2.73 and 2.58 pCi/g wet weight, respectively). All gamma-emitting isotopes were below their respective LLD levels. There was no indication of a plant effect.

Invertebrates

Two samples were collected in July and two in November. The samples were analyzed for gamma-emitting isotopes. All of the isotopes, except naturally-occurring K-40, were below detection limits.

Potassium-40 averaged 1.92 pCi/g wet weight at the control location and 1.98 pCi/g wet weight at the indicator location. There was no indication of a plant effect.

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 upstream and two downstream bottom sediment samples, averaging 0.13 pCi/g dry weight in both upstream and downstream samples, and in two shoreline sediment samples, averaging 0.16 pCi/g dry weight, indicating the influence of fallout deposition. Similar levels of activities and distribution were observed in 1978-1990. The only other gamma-emitting isotope detected was naturally-occurring potassium-40. There was no indication of a plant effect.

5.0 TABLES

Table 5.1. Sample collection and analysis program, Monticello Nuclear Generating Plant, 1991.

Medium	No.	Locations	Collection Type and Frequency ^b	Analysis Type and Frequency ^c
		Codes (and Type) ^a		
Ambient Radiation (TLDs)	37	M-01A - M-14A M-01B - M-16B M-01S - M-06S M-01C	C/Q	Ambient Gamma
Airborne Particulates	5	M-1(C), M-2, M-3, M-4, M-5	C/W	GB, GS (QC of each location)
Airborne Iodine	5	M-1(C), M-2, M-3, M-4, M-5	C/W	I-131
Milk	5	M-10(C), M-18, M-24 M-26, M-28 ^a , M-29	G/M ^d	I-131, GS
River Water	2	M-8(C), M-9	G/W	GS(MC), H-3(QC)
Drinking Water	1	M-14	G/W	GB(MC), I-131(MC) GS(MC), H-3(QC)
Well Water	4	M-10(C), M-11, M-12, 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 ^e	1	M-19	G/A	GS
Edible Cultivated Crops - Potatoes ^e	1	M-21	G/A	GS
Fish (One Species, Edible Portion)	2	M-8(C), M-9	G/SA	GS
Algae or Aquatic Insects	2	M-8(C), M-9	G/SA	GS

^a M-28 (Witschen Dairy Farm) was replaced by M-29 (Holthaus Dairy Farm) in August, 1991.

Table 5.1. Sample collection and analysis program, Monticello Nuclear Generating Plant, 1991 (continued)

Medium	Locations		Collection Type and Frequency ^b	Analysis Type and Frequency ^c
	No.	Codes (and Type) ^a		
Bottom Sediment	2	M-8(C), M-9	G/SA	GS
Shoreline Sediment	1	M-15	G/SA	GS

^a Location codes are defined in Table 5.2. Control stations are indicated by (C). All other stations are indicators.

^b Collection type is coded as follows: C/ = continuous, G/ = Grab. Collection frequency is coded as follows: W = weekly, M = monthly, Q = quarterly, SA = semi-annually, A = annually.

^c Analysis type is coded as follows: GB = gross beta, GS = gamma spectroscopy, H-3 = tritium, I-131 = iodine-131. Frequency is coded as follows: MC = monthly composite, QC = quarterly composite.

^d Milk is collected biweekly during the grazing season (May - October) if milch animals are on pasture.

^e Collected only if the field is irradiated by water in which liquid radioactive effluent has been discharged.

Table 5.2. Sampling locations, Monticello Nuclear Generating Plant, 1991

Code	Type ^a	Collection Site	Type of Sample ^b	Distance and Direction from Site Stack
M-1	C	Air Station M-1	AP, AI	11.1 mi @ 306°/NW
M-2		Air Station M-2	AP, AI	0.8 mi @ 140°/SE
M-3		Air Station M-3	AP, AI	0.6 mi @ 104°/ESE
M-4		Air Station M-4	AP, AI	0.9 mi @ 150°/SSE
M-5		Air Station M-5	AP, AI	2.7 mi @ 136°/SE
M-8	C	Upstream of Plant	RW, BS, BO, F	0.2 mi @ 285°/WNW
M-9		Downstream of Plant	RW, BS, BO, F	0.2 mi @ 62°/ENE
M-10	C	Kirchenbauer Farm	M, WW, VE	11.5 mi @ 323°/NW
M-11		City of Monticello	WW	3.2 mi @ 128°/SE
M-12		Plant Well #1	WW	0.2 mi @ 267°/W
M-13		Ernst Residence	WW	0.6 mi @ 202°/SSW
M-14		City of Minneapolis	DW	36 mi @ 128°/SE
M-15		Montissippi Park	SS	1.6 mi @ 117°/ESE
M-18		Witschen Farm	M	3.0 mi @ 260°/W
M-19		River Irrigated Corn Field ^c		
M-21		River Irrigated Potato Field ^c		
M-24		Weinand Farm	M	4.8 mi @ 180°/S
M-26		Peterson Farm	M	2.5 mi @ 111°/ESE
M-27		Wise Residence - Highest D/Q Garden	VE	0.7 mi @ 208°/SSW
M-28		Hoglund Farm	M	3.7 mi @ 300°/WNW
M-29		Holthaus Farm	M	4.1 mi @ 173°/S

General Area of the Site Boundary

M-01A		North Boundary Road	TLD	0.7 mi @ 353°/N
M-02A		North Boundary Road	TLD	0.8 mi @ 23°/NNE
M-03A		North Boundary Road	TLD	1.0 mi @ 43°/NE
M-04A		Biology Station Road	TLD	0.7 mi @ 92°/E
M-05A		Biology Station Road	TLD	0.6 mi @ 112°/ESE
M-06A		Biology Station Road	TLD	0.6 mi @ 133°/SE
M-07A		County Road 75	TLD	0.5 mi @ 158°/SSE
M-08A		County Road 75	TLD	0.5 mi @ 183°/S
M-09A		County Road 75	TLD	0.4 mi @ 203°/SSW
M-10A		County Road 75	TLD	0.3 mi @ 225°/SW
M-11A		County Road 75	TLD	0.4 mi @ 250°/WSW
M-12A		County Road 75	TLD	0.7 mi @ 273°/W
M-13A		North Boundary Road	TLD	1.1 mi @ 317°/NW
M-14A		North Boundary Road	TLD	0.8 mi @ 338°/NNW

Table 5.2. Sampling locations, Monticello Nuclear Generating Plant, 1991 (continued)

Code	Type ^a	Collection Site	Type of Sample ^b	Distance and Direction from Site Stack
<u>Approximately 4 to 5 miles Distant from the Plant</u>				
M-01B		Sherco #1 Air Station	TLD	4.6 mi @ 02°/N
M-02B		County Road 11	TLD	4.4 mi @ 17°/NNE
M-03B		Intersection of County Road & Route 81	TLD	4.5 mi @ 49°/NE
M-04B		Sherco #6 Air Station	TLD	4.2 mi @ 67°/ENE
M-05B		City of Big Lake	TLD	4.4 mi @ 87°/E
M-06B		County Road #14 & 196th Street	TLD	4.3 mi @ 116°/ESE
M-07B		Monte Industrial Drive	TLD	4.4 mi @ 135°/SE
M-08B		Dale K. Larson Residence	TLD	4.6 mi @ 162°/SSE
M-09B		Norbert Weinand Farm	TLD	4.7 mi @ 180°/S
M-10B		John Reisewitz Farm	TLD	4.4 mi @ 206°/SSW
M-11B		Clifford Vanlith Farm	TLD	4.2 mi @ 225°/SW
M-12B		Lake Maria State Park	TLD	4.4 mi @ 253°/WSW
M-13B		Bridgewater Station	TLD	4.1 mi @ 271°/W
M-14B		Richard K Anderson Residence	TLD	4.5 mi @ 228°/WNW
M-15B		Gary Williamson Residence	TLD	4.5 mi @ 308°/NW
M-16B		Sand Plain Research Farm	TLD	4.3 mi @ 338°/NNW
<u>Special Interest Locations</u>				
M-01S		Dickson Residence	TLD	0.5 mi @ 166°/SSE
M-02S		Edgar Klucas Residence	TLD	0.7 mi @ 142°/SE
M-03S		Big Oaks Park	TLD	1.3 mi @ 89°/E
M-04S		Pinewood School	TLD	2.3 mi @ 132°/SE
M-05S		Roman Greener Residence	TLD	2.5 mi @ 112°/ESE
M-06S		Monte Service Center	TLD	2.7 mi @ 136°/SE
M-01C	C	Kirchenbauer Farm	TLD	11.5 mi @ 323°/NW

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

^b Sample codes:

AP = Airborne particulate	WW = Well water
AI = Airborne iodine	BS = Bottom (river) sediments
M = Milk	SS = Shoreline sediments
VE = Vegetation/vegetables	BO = Bottom organisms (periphyton or macroinvertebrates)
DW = Drinking water	F = Fish
RW = River water	

^c Collected only if the field is irrigated by water in which liquid radioactive effluent has been discharged.

Table 5.3. Missed collections and analyses for 1991 at Monticello Nuclear Generating Plant. All required samples were collected and analyzed except the following.

Sample	Location	Collection Date or Period	Comments
TLD	M-12A	4th Qtr. 1991	TLD lost in the field.

Table 5.4. Radiological Environmental Monitoring Program Summary

Name of Facility Monticello Nuclear Generating Plant Docket No. 50-263
 Location of Facility Wright, Minnesota Reporting Period January - December 1991
 (County, State)

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) ^c Range ^c	Number of Non-routine Results ^e
					Location ^d	Mean (F) ^c Range ^c		
TLD (mR/91 days) (Inner Ring, General Area of Site Boundary)	Gamma	55	3.0	15.2 (56/56) (11.5-18.0)	M-12A, County Road 75, 0.7 mi @ 273°/W	16.5 (3/4) (15.4-17.6)	(See control below.)	0
TLD (mR/91 days) (Outer ring, 4 - 5 miles distant)	Gamma	64	3.0	15.8 (62/62) (12.1-22.4)	M-05B, City of Big Lake 4.4 mi @ 87°/E	20.8 (4/4) (18.1-22.4)	(See control below.)	0
TLD (mR/91 days) (Special Interest Areas)	Gamma	24	3.0	15.3 (23/23) (13.0-18.0)	M-06S, Monte Service Center 2.7 mi @ 136°/SE	16.7 (4/4) (16.0-18.0)	(See control below)	0
TLD (mR/91 days) (Control)	Gamma	4	3.0	None	M-01C, Kirchenbauer Farm, 11.5 mi @ 323°/NW	15.0 (4/4) (14.1-15.9)	15.0 (4/4) (14.1-15.9)	0
Airborne Particulates (pCi/m ³)	GB	260	0.003	0.024 (208/208) (0.004-0.070)	M-5 ^f , Station M-5 2.7 mi @ 136°/SE	0.024 (52/52) (0.006-0.069)	0.024 (52/52) (0.008-0.071)	0
					M-4, Station M-4 0.9 mi @ 150°/SSE	0.024 (52/52) (0.008-0.070)		0
	GS	20						
	Be-7		0.020	0.054 (16/16) (0.038-0.079)	M-4, Station M-4 0.9 mi @ 150°/SSE	0.058 (4/4) (0.039-0.079)	0.054 (4/4) (0.043-0.063)	0
	Mn-54		0.0012	<LLD	-	-	<LLD	0
	Co-58		0.0014	<LLD	-	-	<LLD	0
	Co-60		0.0015	<LLD	-	-	<LLD	0
	Zn-65		0.0026	<LLD	-	-	<LLD	0
	Zr-Nb-95		0.0027	<LLD	-	-	<LLD	0
	Ru-103		0.0012	<LLD	-	-	<LLD	0
Ru-106		0.011	<LLD	-	-	<LLD	0	
Cs-134		0.0010	<LLD	-	-	<LLD	0	

Table 5.4. Radiological Environmental Monitoring Program Summary (continued)

Name of Facility Monticello Nuclear Generating Plant Docket No. 50-263
 Location of Facility Wright, Minnesota Reporting Period January - December 1991
 (County, State)

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) ^c Range ^c	Number of Non-routine Results ^e
				Location ^d	Mean (F) ^c Range ^c		
Airborne Particulates (pCi/m ³) (continued)	GS						
	Cs-137	0.0010	<LLD	-	-	<LLD	0
	Ba-La-140	0.0039	<LLD	-	-	<LLD	0
	Ce-141	0.0022	<LLD	-	-	<LLD	0
	Ce-144	0.0068	<LLD	-	-	<LLD	0
Airborne Iodine (pCi/m ³)	I-131 260	0.07	<LLD	-	-	<LLD	0
Milk (pCi/L)	I-131 90	1.0	<LLD	-	-	<LLD	0
	GS 90						
	K-40	200	1280 (72/72) (1000-1560)	M-26, Peterson Farm 2.3 mi @ 111°/ESE	1310 (18/18) (1140-1560)	1270 (18/18) (1090-1380)	0
	Cs-134	15	<LLD	-	-	<LLD	0
	Cs-137	15	<LLD	-	-	<LLD	0
	Ba-La-140	15	<LLD	-	-	<LLD	0
River Water (pCi/L)	H-3 8	330	<LLD	-	-	<LLD	0
	GS 24						
	Mn-54	15	<LLD	-	-	<LLD	0
	Fe-59	30	<LLD	-	-	<LLD	0
	Co-58	15	<LLD	-	-	<LLD	0
	Co-60	15	<LLD	-	-	<LLD	0

Table 5.4. Radiological Environmental Monitoring Program Summary (continued)

Name of Facility Monticello Nuclear Generating Plant Docket No. 50-263
 Location of Facility Wright, Minnesota Reporting Period January - December 1991
 (County, State)

Sample Type (Units)	Type and Number of Analyses ^a		LLDb	Indicator Locations Mean (F) ^c Range ^c	Location with Highest Annual Mean		Control Locations Mean (F) ^c Range ^c	Number of Non-routine Results ^e
					Location ^d	Mean (F) ^c Range ^c		
River Water (pCi/L) (continued)	Zn-65	30		<LLD	-	-	<LLD	0
	Zr-Nb-95	15		<LLD	-	-	<LLD	0
	Cs-134	15		<LLD	-	-	<LLD	0
	Cs-137	18		<LLD	-	-	<LLD	0
	Ba-La-140	15		<LLD	-	-	<LLD	0
	Ce-144	53		<LLD	-	-	<LLD	0
Drinking Water (pCi/L)	GB	12	1.0	2.9 (12/12) (1.4-3.4)	M-14, Minneapolis 36 mi @ 128°/SE	2.2 (12/12) (1.4-3.4)	None	0
	I-131	12	1.0	<LLD	-	-	None	0
	H-3	4	330	<LLD	-	-	None	0
	GS	12						
	Mn-54	15		<LLD	-	-	None	0
	Fe-59	30		<LLD	-	-	None	0
	Co-58	15		<LLD	-	-	None	0
	Co-60	15		<LLD	-	-	None	0
	Zn-65	30		<LLD	-	-	None	0
	Zr-Nb-95	15		<LLD	-	-	None	0
	Cs-134	10		<LLD	-	-	None	0
	Cs-137	10		<LLD	-	-	None	0
	Ba-La-140	15		<LLD	-	-	None	0
	Ce-144	72		<LLD	-	-	None	0

Table 5.4. Radiological Environmental Monitoring Program Summary (continued)

Name of Facility Monticello Nuclear Generating Plant Docket No. 50-263
 Location of Facility Wright, Minnesota Reporting Period January - December 1991
 (County, State)

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) ^c Range ^c	Number of Non-routine Results ^e
					Location ^d	Mean (F) ^c Range ^c		
Well Water (pCi/L)	H-3	16	330	<LLD	-	-	<LLO	0
	GS	16						
	Mn-54		15	<LLD	-	-	<LLD	0
	Fe-59		30	<LLD	-	-	<LLD	0
	Co-58		15	<LLD	-	-	<LLD	0
	Co-60		15	<LLD	-	-	<LLD	0
	Zn-65		30	<LLD	-	-	<LLD	0
	Zr-Nb-95		15	<LLD	-	-	<LLD	0
	Cs-134		10	<LLO	-	-	<LLD	0
	Cs-137		10	<LLD	-	-	<LLD	0
	Ba-La-140		15	<LLD	-	-	<LLD	0
Ce-144		76	<LLD	-	-	<LLD	0	
Crops-Cabbage (pCi/g wet)	I-131	2	0.022	<LLD	-	-	<LLD	0
Fish (pCi/g wet)	GS	4						
	K-40		0.1	2.58 (2/2) (2.43-2.72)	M-8, Upstream of Plant, 0.2 mi @ 258°/WNW	2.73 (2/2) (2.42-3.04)	2.73 (2/2) (2.42-3.04)	0
	Mn-54		0.023	<LLD	-	-	<LLD	0
	Fe-59		0.088	<LLD	-	-	<LLD	0
	Co-58		0.028	<LLD	-	-	<LLD	0
	Co-60		0.025	<LLD	-	-	<LLD	0

Table 5.4. Radiological Environmental Monitoring Program Summary (continued)

Name of Facility Monticello Nuclear Generating Plant Docket No. 50-263
 Location of Facility Wright, Minnesota Reporting Period January - December 1991
 (County, State)

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) ^c Range ^c	Number of Non-routine Results ^e
				Location ^d	Mean (F) ^c Range ^c		
Fish (pCi/g wet) (continued)	GS						
	Zn-65	0.056	<LLD	-	-	<LLD	0
	Zr-95	0.049	<LLD	-	-	<LLD	0
	Nb-95	0.049	<LLD	-	-	<LLD	0
	Cs-134	0.017	<LLD	-	-	<LLD	0
	Cs-137	0.024	<LLD	-	-	<LLD	0
	Ba-La-140	0.42	<LLD	-	-	<LLD	0
Invertebrates (pCi/g wet)	GS	4					
	Be-7	1.20	<LLD	-	-	<LLD	0
	K-40	2.98	1.98 (2/2) (1.48-2.49)	M-9, Downstream of Plant, 0.2 mi @ 62°/ENE	1.98 (2/2) (1.48-2.49)	1.92 (2/2) (0.70-3.15)	0
	Mn-54	0.13	<LLD	-	-	<LLD	0
	Co-58	0.14	<LLD	-	-	<LLD	0
	Co-60	0.12	<LLD	-	-	<LLD	0
	Zn-65	0.29	<LLD	-	-	<LLD	0
	Zr-Nb-95	0.29	<LLD	-	-	<LLD	0
	Ru-103	0.17	<LLD	-	-	<LLD	0
	Ru-106	1.13	<LLD	-	-	<LLD	0
	Cs-134	0.10	<LLD	-	-	<LLD	0
	Cs-137	0.12	<LLD	-	-	<LLD	0
	Ba-La-140	0.83	<LLD	-	-	<LLD	0
	Ce-141	0.29	<LLD	-	-	<LLD	0
Ce-144	0.71	<LLD	-	-	<LLD	0	

Table 5.4. Radiological Environmental Monitoring Program Summary (continued)

Name of Facility Monticello Nuclear Generating Plant Docket No. 50-263
 Location of Facility Wright, Minnesota Reporting Period January - December 1991
 (County, State)

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) ^c Range ^c	Number of Non-routine Results ^e
				Location ^d	Mean (F) ^c Range ^c		
Bottom and Shoreline Sediments (pCi/g dry)	GS 6						
	Be-7	0.44	<LLD	M-8, Upstream of Plant, 0.2 mi @ 285°/WNN	0.58 (1/2)	0.58 (1/2)	0
	K-40	0.5	10.36 (4/4) (9.15-12.41)	M-8, Upstream of Plant, 0.2 mi @ 285°/WNN	11.79 (2/2) (11.63-11.95)	11.79 (2/2) (11.63-11.95)	0
	Mn-54	0.035	<LLD	-	-	<LLD	0
	Co-58	0.041	<LLD	-	-	<LLD	0
	Co-60	0.048	<LLD	-	-	<LLD	0
	Zn-65	0.097	<LLD	-	-	<LLD	0
	Zr-95	0.087	<LLD	-	-	<LLD	0
	Nb-95	0.071	<LLD	-	-	<LLD	0
	Ru-103	0.055	<LLD	-	-	<LLD	0
	Ru-106	0.29	<LLD	-	-	<LLD	0
	Cs-134	0.029	<LLD	-	-	<LLD	0
	Cs-137	0.037	0.14 (4/4) (0.072-0.19)	M-15, Montissippi Park 1.6 mi @ 117°/ESE	0.16 (2/2) (0.079-0.24)	0.13 (2/2) (0.13-0.13)	0
	Ba-La-140	0.24	<LLD	-	-	<LLD	0
	Ce-141	0.099	<LLD	-	-	<LLD	0
Ce-144	0.20	<LLD	-	-	<LLD	0	

a GB = Gross beta; GS = gamma scan.

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

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

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

e Non-routine results are those which exceed ten times the control station value. If no control station value is available, the result is considered non-routine if it exceeds ten times the preoperational value for the location.

f Three locations had identical annual means of 0.024 pCi/m³, (M-1, M-4, and M-5). Only M-5 is detailed in this summary.

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APPENDIX A

INTERLABORATORY COMPARISON PROGRAM RESULTS

NOTE: TIML participates in intercomparison studies administered by U.S. EPA Environmental Monitoring Systems Laboratory, Las Vegas, Nevada. The results are reported in Appendix A. Also reported are results of in-house spikes and blanks. Appendix A is updated twice a year; the complete Appendix is included in January and July monthly reports only. Please refer to January and July reports for information.

January, 1992

Appendix A

Interlaboratory Comparison Program Results

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

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

The results in Table A-1 were obtained through participation in the environmental sample crosscheck program for milk, water, air filters, and food samples during the period January 1988 through November 1991. 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 (TLDs) during the period 1976, 1977, 1979, 1980, 1984, and 1985-86 through participation in the Second, Third, Fourth, Fifth, Seventh, and Eighth International Intercomparison of Environmental Dosimeters under the sponsorships listed in Table A-2. Also Teledyne testing results are listed.

Table A-3 lists results of the analyses on in-house spiked samples.

Table A-4 lists results of the analyses on in-house "blank" samples.

Attachment B lists acceptance criteria for "spiked" samples.

Addendum to Appendix A provides explanation for out-of-limit results.

Table A-1. U.S. Environmental Protection Agency's crosscheck program, comparison of EPA and Teledyne Isotopes Midwest Laboratory results for milk, water, air filters, and food samples, 1988 through 1991.^a

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/L ^b		
				TIML Result ±2σ ^c	EPA Result ^d 1s, N=1	Control Limits
STW-521	Water	Jan 1988	Sr-89	27.3±5.0	30.0±5.0	21.3-38.7
			Sr-90	15.3±1.2	15.0±1.5	12.4-17.6
STW-523	Water	Jan 1988	Gr. alpha	2.3±1.2	4.0±5.0	0.0-12.7
			Gr. beta	7.7±1.2	8.0±5.0	0.0-16.7
STF-524	Food	Jan 1988	Sr-89	44.0±4.0	46.0±5.0	37.3-54.7
			Sr-90	53.0±2.0	55.0±2.8	50.2-59.8
			I-131	102.3±4.2	102.0±10.2	84.3-119.7
			Cs-137	95.7±6.4	91.0±5.0	82.3-99.7
			K	1011±158	1230±62	1124-1336
STW-525	Water	Feb 1988	Co-60	69.3±2.3	69.0±5.0	60.3-77.7
			Zn-65	99.0±3.4	94.0±9.4	77.7-110.3
			Ru-106	92.7±14.4	105.0±10.5	86.8-123.2
			Cs-134	61.7±8.0	64.0±5.0	55.3-72.7
			Cs-137	99.7±3.0	94.0±5.0	85.3-102.7
STW-526	Water	Feb 1988	H-3	3453±103	3327±362	2700-3954
STW-527	Water	Feb 1988	Uranium	3.0±0.0	3.0±6.0	0.0-13.4
STM-528	Milk	Feb 1988	I-131	4.7±1.2	4.0±0.4	3.3-4.7
STW-529	Water	Mar 1988	Ra-226	7.1±0.6	7.6±1.1	5.6-9.6
			Ra-228	NA ^e	7.7±1.2	5.7-9.7
STW-530	Water	Mar 1988	Gr. alpha	4.3±1.2	6.0±5.0	0.0-14.7
			Gr. beta	13.3±1.3	13.0±5.0	4.3-21.7
STAF-531	Air Filter	Mar 1988	Gr. alpha	21.0±2.0	20.0±5.0	11.3-28.7
			Gr. beta	48.0±0.0	50.0±5.0	41.3-58.7
			Sr-90	16.7±1.2	17.0±1.5	14.4-19.6
			Cs-137	18.7±1.3	16.0±5.0	7.3-24.7
STW-532	Water	Apr 1988	I-131	9.0±2.0	7.5±0.8	6.2-8.8

Table A-1. (continued)

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/L ^b		
				TIML Result $\pm 2\sigma^c$	EPA Result ^d 1s, N=1	Control Limits
STW-533 534	Water (Blind)	Apr 1988				
	Sample A		Gr. alpha	ND ^f	46.0±11.0	27.0-65.0
			Ra-226	ND	6.4±1.0	4.7-8.1
			Ra-228	ND	5.6±0.8	4.2-7.0
			Uranium	6.0±6.0	6.0±6.0	0.0-16.4
	Sample B		Gr. beta	ND	57.0±5.0	48.3-65.7
			Sr-89	3.3±1.2	5.0±5.0	0.0-13.7
			Sr-90	5.3±1.2	5.0±1.5	2.4-7.6
			Co-60	63.3±1.3	50.0±3.0	41.3-58.7
			Cs-134	7.7±1.2	7.0±5.0	0.0-15.7
			Cs-137	8.3±1.2	7.0±5.0	0.0-15.7
STU-535	Urine	Apr 1988	H-3	6483±155	6202±620	5128-7276
STW-536	Water	Apr 1988	Sr-89	14.7±1.3	20.0±5.0	11.3-28.7
			Sr-90	20.0±2.0	20.0±1.5	17.4-22.6
STW-538	Water	Jun 1988	Cr-51	331.7±13.0	302.0±30.0	250.0-354.0
			Co-60	16.0±2.0	15.0±5.0	6.3-23.7
			Zn-65	107.7±11.4	101.0±10.0	83.7-118.3
			Ru-106	191.3±11.0	195.0±20.0	160.4-229.6
			Cs-134	18.3±4.6	20.0±5.0	11.3-28.7
			Cs-137	26.3±1.2	25.0±5.0	16.3-33.7
STW-539	Water	Jun 1988	H-3	5586±92	5565±557	4600-6530
STM-541	Milk	Jun 1988	Sr-89	33.7±11.4	40.0±5.0	31.3-48.7
			Sr-90	55.3±5.8	60.0±3.0	54.8-65.2
			I-131	103.7±3.1	94.0±9.0	78.4-109.6
			Cs-137	52.7±3.1	51.0±5.0	42.3-59.7
			K	1587±23	1600±80	1461-1739
STW-542	Water	Jul 1988	Gr. alpha	8.7±4.2	15.0±5.0	6.3-23.7
			Gr. beta	5.3±1.2	4.0±5.0	0.0-12.7
STF-543	Food	Jul 1988	Sr-89	ND ^f	33.0±5.0	24.3-41.7
			Sr-90	ND	34.0±2.0	30.5-37.5
			I-131	115.0±5.3	107.0±11.0	88.0-126.0
			Cs-137	52.7±6.4	49.0±3.0	40.3-57.7
			K	1190±66	1240±62	1133-1347

Table A-1. (continued)

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/L ^b		
				TIML Result $\pm 2\sigma^c$	EPA Result ^d 1s, N=1	Control Limits
STW-544	Water	Aug 1988	I-131	80.0 \pm 0.0	76.0 \pm 8.0	62.1-89.9
STW-545	Water	Aug 1988	Pu-239	11.0 \pm 0.2	10.2 \pm 1.0	8.5-11.9
STW-546	Water	Aug 1988	Uranium	6.0 \pm 0.0	6.0 \pm 6.0	0.0-16.4
STAF-547	Air Filter	Aug 1988	Gr. alpha	8.0 \pm 0.0	8.0 \pm 5.0	0.0-16.7
			Gr. beta	26.3 \pm 1.2	29.0 \pm 5.0	20.3-37.7
			Sr-90	8.0 \pm 2.0	8.0 \pm 1.5	5.4-10.6
			Cs-137	13.0 \pm 2.0	12.0 \pm 5.0	3.3-20.7
STW-548	Water	Sep 1988	Ra-226	9.3 \pm 0.5	8.4 \pm 2.6	6.2-10.6
			Ra-228	5.8 \pm 0.4	5.4 \pm 1.6	4.0-6.8
STW-549	Water	Sep 1988	Gr. alpha	7.0 \pm 2.0	8.0 \pm 5.0	0.0-16.7
			Gr. beta	11.3 \pm 1.2	10.0 \pm 5.0	1.3-18.7
STW-550	Water	Oct 1988	Cr-51	252.0 \pm 14.0	251.0 \pm 25.0	207.7-294.3
			Co-60	26.0 \pm 2.0	25.0 \pm 5.0	16.3-33.7
			Zn-65	158.3 \pm 10.2	151.0 \pm 15.0	125.0-177.0
			Ru-106	153.0 \pm 9.2	152.0 \pm 15.0	126.0-178.0
			Cs-134	28.7 \pm 5.0	25.0 \pm 5.0	16.3-33.7
			Cs-137	16.3 \pm 1.2	15.0 \pm 5.0	6.3-23.7
STW-551	Water	Oct 1988	H-3	2333 \pm 127	2316 \pm 350	1710-2927
STW-552 553	Water (Blind)	Oct 1988				
			Sample A	Gr. alpha	38.3 \pm 8.0	41.0 \pm 10.0
			Ra-226	4.5 \pm 0.5	5.0 \pm 0.8	3.6-6.4
			Ra-228	4.4 \pm 0.6	5.2 \pm 0.8	3.6-6.4
			Uranium	4.7 \pm 1.2	5.0 \pm 6.0	0.0-15.4
	Sample B		Gr. beta	51.3 \pm 3.0	54.0 \pm 5.0	45.3-62.7
			Sr-89	3.7 \pm 1.2	11.0 \pm 5.0	2.3-19.7
			Sr-90	10.7 \pm 1.2	10.0 \pm 1.5	7.4-12.6
			Cs-134	15.3 \pm 2.3	15.0 \pm 5.0	6.3-23.7
			Cs-137	16.7 \pm 1.2	15.0 \pm 5.0	6.3-23.7

Table A-1. (continued)

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/L ^b		
				TIML Result $\pm 2\sigma^c$	EPA Result ^d 1s, N=1	Control Limits
STM-554	Milk	Oct 1988	Sr-89	40.3±7.0	40.0±5.0	31.3-48.7
			Sr-90	51.0±2.0	60.0±3.0	54.8-65.2
			I-131	94.0±3.4	91.0±9.0	75.4-106.6
			Cs-137	45.0±4.0	50.0±5.0	41.3-58.7
			K	1500±45	1600±80	1461-1739
STU-555	Urine	Nov 1988	H-3	3030±209	3025±359	2403-3647
STW-556	Water	Nov 1988	Gr. alpha	9.0±3.5	9.0±5.0	0.3-17.7
			Gr. beta	9.7±1.2	9.0±5.0	0.3-17.7
STW-557	Water	Dec 1988	I-131	108.7±3.0	115.0±12.0	94.2-135.8
STW-559	Water	Jan 1989	Sr-89	40.0±8.7	40.0±5.0	31.3-48.7
			Sr-90	24.3±3.1	25.0±1.5	22.4-27.6
STW-560	Water	Jan 1989	Pu-239	5.8±1.1	4.2±0.4	3.5-4.9
STW-561	Water	Jan 1989	Gr. alpha	7.3±1.2	8.0±5.0	0.0-16.7
			Gr. beta	5.3±1.2	4.0±5.0	0.0-12.7
STW-562	Water	Feb 1989	Cr-51	245±46	235±24	193.4-276.6
			Co-60	10.0±2.0	10.0±5.0	1.3-18.7
			Zn-65	170±10	159±16	139.2-186.7
			Ru-106	181±7.6	178±18	146.8-209.2
			Cs-134	9.7±3.0	10.0±5.0	1.3-18.7
			Cs-137	11.7±1.2	10.0±5.0	1.3-18.7
STW-563	Water	Feb 1989	I-131	109.0±4.0	106.0±11.0	86.9-125.1
STW-564	Water	Feb 1989	H-3	2820±20	2754±356	2137-3371
STW-565	Water	Mar 1989	Ra-226	4.2±0.3	4.9±0.7	3.7-6.1
			Ra-228	1.9±1.0	1.7±0.3	1.2-2.2
STW-566	Water	Mar 1989	U	5.0±0.0	5.0±6.0	0.0-15.4
STAF-567	Air Filter	Mar 1989	Gr. alpha	21.7±1.2	21.0±5.0	12.3-29.7
			Gr. beta	68.3±4.2	62.0±5.0	53.3-70.7
			Sr-90	20.0±2.0	20.0±1.5	17.4-22.6
			Cs-137	21.3±1.2	20.0±5.0	11.3-28.7

Table A-1. (continued)

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/L ^b		
				TIML Result $\pm 2\sigma^c$	EPA Result ^d 1s, N=1	Control Limits
STW-568 569	Water (Blind)	Apr 1989				
	Sample A		Gr. alpha	22.7 \pm 2.3	29.0 \pm 7.0	16.9-41.2
			Ra-226	3.6 \pm 0.6	3.5 \pm 0.5	2.6-4.4
			Ra-228	2.6 \pm 1.0	3.6 \pm 0.5	2.7-4.5
			U	3.0 \pm 0.0	3.0 \pm 6.0	0.0-13.4
	Sample B		Gr. beta	52.3 \pm 6.1	57.0 \pm 5.0	43.3-65.7
			Sr-89	9.3 \pm 5.4	8.0 \pm 5.0	0.0-16.7
			Sr-90	7.0 \pm 0.0	8.0 \pm 1.5	5.4-10.6
			Cs-134	21.0 \pm 5.2	20.0 \pm 5.0	11.3-28.7
			Cs-137	23.0 \pm 2.0	20.0 \pm 5.0	11.3-28.7
STM-570	Milk	Apr 1989	Sr-89	26.0 \pm 10.0	39.0 \pm 5.0	30.3-47.7
			Sr-90	45.7 \pm 4.2	55.0 \pm 3.0	49.8-60.2
			Cs-137	54.0 \pm 6.9	50.0 \pm 5.0	41.3-58.7
			K-40	1521 \pm 208	1600 \pm 80	1461-1739
STW-5718	Water	May 1989	Sr-89	<0.7	6.0 \pm 5.0	0.0-14.7
			Sr-90	5.0 \pm 1.0	6.0 \pm 1.5	3.4-8.6
STW-572	Water	May 1989	Gr. alpha	24.0 \pm 2.0	30.0 \pm 8.0	16.1-43.9
			Gr. beta	49.3 \pm 15.6	50.0 \pm 5.0	41.3-58.7
STW-573	Water	Jun 1989	Ba-133	50.7 \pm 1.2	49.0 \pm 5.0	40.3-57.7
			Co-60	31.3 \pm 2.3	31.0 \pm 5.0	22.3-39.7
			Zn-65	167 \pm 10	165 \pm 17	135.6-194.4
			Ru-106	123 \pm 9.2	128 \pm 13	105.5-150.5
			Cs-134	40.3 \pm 1.2	39 \pm 5	30.3-47.7
			Cs-137	22.3 \pm 1.2	20 \pm 5	11.3-28.7
STW-574	Water	Jun 1989	H-3	4513 \pm 136	4503 \pm 450	3724-5282
STW-575	Water	Jul 1989	Ra-226	16.8 \pm 3.1	17.7 \pm 2.7	13.0-22.4
			Ra-228	13.8 \pm 3.7	18.3 \pm 2.7	13.6-23.0
STW-576	Water	Jul 1989	U	40.3 \pm 1.2	41.0 \pm 6.0	30.6 \pm 51.4
STW-577	Water	Aug 1989	I-131	84.7 \pm 5.8	83.0 \pm 8.0	69.1-96.9
STAF-579	Air Filter	Aug 1989	Gr. alpha	6.0 \pm 0.0	6.0 \pm 5.0	0.0-14.7
			Cs-137	10.3 \pm 2.3	10.0 \pm 5.0	1.3-18.7

Table A-1. (continued)

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/L ^b		
				TIML Result $\pm 2\sigma^c$	EPA Result ^d 1s, N=1	Control Limits
STW-580	Water	Sep 1989	Sr-89	14.7±1.2	14.0±5.0	5.3-22.7
			Sr-90	9.7±1.2	10.0±1.5	7.4-12.6
STW-581	Water	Sep 1989	Gr. alpha	5.0±0.0	4.0±5.0	0.0-12.7
			Gr. beta	8.7±2.3	6.0±5.0	0.0-14.7
STW-583	Water	Oct 1989	Ba-133	60.3±10.0	59.0±6.0	48.6-69.4
			Co-60	29.0±4.0	30.0±5.0	21.1-38.7
			Zn-65	132.3±6.0	129.0±13.0	106.5-151.5
			Ru-106	155.3±6.1	161.0±16.0	133.3-188.7
			Cs-134	30.7±6.1	29.0±5.0	20.3-37.7
			Cs-137	66.3±4.6	59.0±5.0	50.3±67.7
STW-584	Water	Oct 1989	H-3	3407±150	3496±364	2866±4126
STW-585 586	Water (Blind)	Oct 1989				
	Sample A		Gr. alpha	41.7±9.4	49.0±12.0	28.2-69.8
		Ra-226	7.9±0.4	8.4±1.3	6.2-10.6	
		Ra-228	4.4±0.8	4.1±0.6	3.1-5.1	
		U	12.0±0.0	12.0±6.0	1.6-22.4	
	Sample B		Gr. beta	31.7±2.3	32.0±5.0	23.3-40.7
		Sr-89	13.3±4.2	15.0±5.0	6.3-23.7	
		Sr-90	7.0±2.0	7.0±3.0	4.4-9.6	
		Cs-134	5.0±0.0	5.0±5.0	0.0-13.7	
		Cs-137	7.0±0.0	5.0±5.0	0.0-13.7	
STW-587	Water	Nov 1989	Ra-226	7.9±0.4	8.7±1.3	6.4-11.0
			Ra-228	8.9±1.2	9.3±1.2	6.9-11.7
STW-588	Water	Nov 1989	U	15.0±0.08	15.0±6.0	4.6-25.4
STW-589	Water	Jan 1990	Sr-89	22.7±5.0	25.0±5.0	16.3-33.7
			Sr-90	17.3±1.2	20.0±1.5	17.4-22.6
STW-591	Water	Jan 1990	Gr. alpha	10.3±3.0	12.0±5.0	3.3-20.7
			Gr. beta	12.3±1.2	12.0±5.0	3.3-20.7

Table A-1. (continued)

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/L ^b					
				TIML Result $\pm 2\sigma^c$	EPA Result ^d				
					1s, N=1	Control Limits			
STW-592	Water	Jan 1990	Co-60	14.7 \pm 2.3	15 \pm 5.0	6.3-23.7			
			Zn-65	135.0 \pm 6.9	139.0 \pm 14.0	114.8-163.2			
			Ru-106	133.3 \pm 13.4	139.0 \pm 14.0	114.8-163.2			
			Cs-134	17.3 \pm 1.2	18.0 \pm 5.0	9.3-26.7			
			Cs-137	19.3 \pm 1.2	18.0 \pm 5.0	9.3-26.7			
			Ba-133	78.0 \pm 0.0	74.0 \pm 7.0	61.9-86.1			
STW-593	Water	Feb 1990	H-3	4827 \pm 83	4976 \pm 498	4113-5839			
STW-594	Water	Mar 1990	Ra-226	5.0 \pm 0.2	4.9 \pm 0.7	4.1-5.7			
			Ra-228	13.5 \pm 0.7	12.7 \pm 1.9	9.4-16.0			
STW-595	Water	Mar 1990	U	4.0 \pm 0.0	4.0 \pm 6.0	0.0-14.4			
STAF-596	Air Filter	Mar 1990	Gr. alpha	7.3 \pm 1.2	5.0 \pm 5.0	0.0-13.7			
			Gr. beta	34.0 \pm 0.0	31.0 \pm 5.0	22.3-39.7			
			Sr-90	10.0 \pm 0.0	10.0 \pm 1.5	7.4-12.6			
			Cs-137	9.3 \pm 1.2	10.0 \pm 5.0	1.3-18.7			
STW-597 598	Water (Blind)	Apr 1990	Sample A						
			Gr. alpha	81.0 \pm 3.5	90.0 \pm 23.0	50.1-129.9			
			Ra-226	4.9 \pm 0.4	5.0 \pm 0.8	3.6-6.4			
			Ra-228	10.6 \pm 0.3	10.2 \pm 1.5	7.6-12.8			
			U	18.7 \pm 3.0	20.0 \pm 6.0	9.6-30.4			
			Sample B						
			Gr. beta	51.0 \pm 10.1	52.0 \pm 5.0	43.3-60.7			
			Sr-89	9.3 \pm 1.2	10.0 \pm 5.0	1.3-18.7			
			Sr-90	10.3 \pm 3.1	10.0 \pm 1.5	8.3-11.7			
			Cs-134	16.0 \pm 0.0	15.0 \pm 5.0	6.3-23.7			
			Cs-137	19.0 \pm 2.0	15.0 \pm 5.0	6.3-23.7			
			STM-599	Milk	Apr 1990	Sr-89	21.7 \pm 3.1	23.0 \pm 5.0	14.3-31.7
						Sr-90	21.0 \pm 7.0	23.0 \pm 5.0	14.3-31.7
						I-131	98.7 \pm 1.2	99.0 \pm 10.0	81.7-116.3
Cs-137	26.0 \pm 6.0	24.0 \pm 5.0				15.3-32.7			
K	1300.0 \pm 69.2	1550.0 \pm 78.0				1414.7-1685.3			
STW-600	Water	May 1990	Sr-89	6.0 \pm 2.0	7.0 \pm 5.0	0.0-15.7			
			Sr-90	6.7 \pm 1.2	7.0 \pm 5.0	0.0-15.7			
STW-601	Water	May 1990	Gr. alpha	11.0 \pm 2.0	22.0 \pm 6.0	11.6-32.4			
			Gr. beta	12.3 \pm 1.2	15.0 \pm 5.0	6.3-23.7			

Table A-1. (continued)

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/L ^b		
				TIML Result $\pm 2\sigma^c$	EPA Result ^d	
					1s, N=1	Control Limits
STW-602	Water	Jun 1990	Co-60	25.3±2.3	24.0±5.0	15.3-32.7
			Zn-65	155.0±10.6	148.0±15.0	130.6-165.4
			Ru-106	202.7±17.2	210.0±21.0	173.6-246.4
			Cs-134	23.7±1.2	24.0±5.0	18.2-29.8
			Cs-137	27.7±3.1	25.0±5.0	16.3-33.7
			Ba-133	100.7±8.1	99.0±10.0	81.7-116.3
STW-603	Water	Jun 1990	H-3	2927±306	2933±358	2312-3554
STW-604	Water	Jul 1990	Ra-226	11.8±0.9	12.1±1.8	9.0-15.2
			Ra-228	4.1±1.4	5.1±1.3	2.8-7.4
STW-605	Water	Jul 1990	U	20.3±1.7	20.8±3.0	15.6-26.0
STW-606	Water	Aug 1990	I-131	43.0±1.2	39.0±6.0	28.6±49.4
STW-607	Water	Aug 1990	Pu-239	10.0±1.7	9.1±0.9	7.5-10.7
STAF-608	Air Filter	Aug 1990	Gr. alpha	14.0±0.0	10.0±5.0	1.3-18.7
			Gr. beta	65.3±1.2	62.0±5.0	53.3-70.7
			Sr-90	19.0±6.9	20.0±5.0	11.3-28.7
			Cs-137	19.0±2.0	20.0±5.0	11.3-28.7
STW-609	Water	Sep 1990	Sr-89	9.0±2.0	10.0±5.0	1.3-18.7
			Sr-90	9.0±2.0	9.0±5.0	0.3-17.7
STW-610	Water	Sep 1990	Gr. alpha	8.3±1.2	10.0±5.0	1.3-18.7
			Gr. beta	10.3±1.2	10.0±5.0	1.3-18.7
STM-611	Milk	Sep 1990	Sr-89	11.7±3.1	16.0±5.0	7.3-24.7
			Sr-90	15.0±0.0	20.0±5.0	11.3-28.7
			I-131	63.0±6.0	58.0±6.0	47.6-68.4
			Cs-137	20.0±2.0	20.0±5.0	11.3-28.7
			K	1673.3±70.2	1700.0±85.0	1552.5-1847.5
STW-612	Water	Oct 1990	Co-60	20.3±3.1	20.0±5.0	11.3-28.7
			Zn-65	115.3±12.2	115.0±12.0	94.2-135.8
			Ru-106	152.0±8.0	151.0±15.0	125.0-177.0
			Cs-134	11.0±0.0	12.0±5.0	3.3-20.7
			Cs-137	14.0±2.0	12.0±5.0	3.3-20.7
			Ba-133	116.7±9.9	110.0±11.0	90.9-129.
STW-613	Water	Oct 1990	H-3	7167±330	7203±720	5954-8452

Table A-1. (continued)

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/L ^b		Control Limits				
				TIML Result $\pm 2\sigma^c$	EPA Result ^d 1s, N=1					
STW-614 615	Water	Oct 1990	Gr. alpha	68.7 \pm 7.2	62.0 \pm 16.0	34.2-89.8				
				Ra-226	12.9 \pm 0.3	13.6 \pm 2.0	10.1-17.1			
	Sample A			Ra-228	4.2 \pm 0.6	5.0 \pm 1.3	2.7-7.3			
				U	10.4 \pm 0.6	10.2 \pm 3.0	5.0-15.4			
				Sample B			Gr. beta	55.0 \pm 8.7	53.0 \pm 5.0	44.3-61.7
							Sr-89	15.7 \pm 2.9	20.0 \pm 5.0	11.3-28.7
							Sr-90	12.0 \pm 2.0	15.0 \pm 5.0	6.3-23.7
							Cs-134	9.0 \pm 1.7	7.0 \pm 5.0	0.0-15.7
	Cs-137	7.7 \pm 1.2	5.0 \pm 5.0				0.0-13.7			
	STW-616	Water	Nov 1990	Ra-226	6.8 \pm 1.0	7.4 \pm 1.1	5.5-9.3			
Ra-228				5.3 \pm 1.7	7.7 \pm 1.9	4.4-11.0				
STW-6178	Water	Nov 1990	U	35.0 \pm 0.4	35.5 \pm 3.6	29.3 \pm 41.7				
STW-618	Water	Jan 1991	Sr-89	4.3 \pm 1.2	5.0 \pm 5.0	0.0-13.7				
			Sr-90	4.7 \pm 1.2	5.0 \pm 5.0	0.0-13.7				
STW-619	Water	Jan 1991	Pu-239	3.6 \pm 0.2	3.3 \pm 0.3	2.8-3.8				
STW-620	Water	Jan 1991	Gr. alpha	6.7 \pm 3.0	5.0 \pm 5.0	0.0-13.7				
			Gr. beta	6.3 \pm 1.2	5.0 \pm 5.0	0.0-13.7				
STW-621	Water	Feb 1991	Co-60	41.3 \pm 8.4	40.0 \pm 5.0	31.3-48.7				
			Zn-65	166.7 \pm 19.7	149.0 \pm 15.0	123.0-175.0				
			Ru-106	209.7 \pm 18.6	186.0 \pm 19.0	153.0-219.0				
			Cs-134	9.0 \pm 2.0	8.0 \pm 5.0	0.0-16.7				
			Cs-137	9.7 \pm 1.2	8.0 \pm 5.0	0.0-16.7				
			Ba-133	85.7 \pm 9.2	75.0 \pm 8.0	61.1-88.9				
			STW-622	Water	Feb 1991	I-131	81.3 \pm 6.1	75.0 \pm 8.0	61.1-88.9	
STW-623	Water	Feb 1991	H-3	4310.0 \pm 144.2	4418.0 \pm 442.0	3651.2-5184.8				
STW-624	Water	Mar 1991	Ra-226	31.4 \pm 3.2	31.8 \pm 4.8	23.5-40.1				
			Ra-228	ND ^h	21.1 \pm 5.3	11.9-30.3				
STW-625	Water	Mar 1991	U	6.7 \pm 0.4	7.6 \pm 3.0	2.4-12.8				

Table A-1. (continued)

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/L ^b		
				TIML Result $\pm 2\sigma^c$	EPA Result ^d 1s, N=1	Control Limits
STAF-626	Air Filter	Mar 1991	Gr. alpha	38.7 \pm 1.2	25.0 \pm 6.0	14.6-35.4
			Gr. beta	130.0 \pm 4.0	124.0 \pm 6.0	113.6-134.4
			Sr-90	35.7 \pm 1.2	40.0 \pm 5.0	31.3-48.7
			Cs-137	33.7 \pm 4.2	40.0 \pm 5.0	31.3-48.7
STW-627 628	Water Sample A	Apr 1991	Gr. alpha	51.0 \pm 6.0	54.0 \pm 14.0	29.7-78.3
			Ra-226	7.0 \pm 0.8	8.0 \pm 1.2	5.9-10.1
			Ra-228	9.7 \pm 1.9	15.2 \pm 3.8	8.6-21.8
			U	27.7 \pm 2.4	29.8 \pm 3.0	24.6-35.0
	Water Sample B	Apr 1991	Gr. beta	93.3 \pm 6.4	115.0 \pm 17.0	85.5-144.5
			Sr-89	21.0 \pm 3.5	28.0 \pm 5.0	19.3-36.7
			Sr-90	23.0 \pm 0.0	26.0 \pm 5.0	17.3-34.7
			Cs-134	27.3 \pm 1.2	24.0 \pm 5.0	15.3-32.7
			Cs-137	29.0 \pm 2.0	25.0 \pm 5.0	16.3-33.7
STM-629	Milk	Apr 1991	Sr-89	24.0 \pm 8.7	32.0 \pm 5.0	23.3-40.7
			Sr-90	28.0 \pm 2.0	32.0 \pm 5.0	23.3-40.7
			I-131	65.3 \pm 14.7	60.0 \pm 6.0	49.6-70.4
			Cs-137	54.7 \pm 11.0	49.0 \pm 5.0	40.3-57.7
			K	1591.7 \pm 180.1	1650.0 \pm 83.0	1506.0-1794.0
STW-630	Water	May 1991	Sr-89	40.7 \pm 2.3	39.0 \pm 5.0	30.3-47.7
			Sr-90	23.7 \pm 1.2	24.0 \pm 5.0	15.3-32.7
STW-631	Water	May 1991	Gr. alpha	27.7 \pm 5.8	24.0 \pm 6.0	13.6-34.4
			Gr. beta	46.0 \pm 0.0	46.0 \pm 5.0	37.3-54.7
STW-632	Water	Jun 1991	Co-60	11.3 \pm 1.2	10.0 \pm 5.0	1.3-18.7
			Zn-65	119.3 \pm 16.3	108.0 \pm 11.0	88.9-127.1
			Ru-106	162.3 \pm 19.0	149.0 \pm 15.0	123.0-175.0
			Cs-134	15.3 \pm 1.2	15.0 \pm 5.0	6.3-23.7
			Cs-137	16.3 \pm 1.2	14.0 \pm 5.0	5.3-22.7
			Ba-133	74.0 \pm 6.9	62.0 \pm 6.0	51.6-72.4
STW-633	Water	Jun 1991	H-3	13470.0 \pm 385.8	12480.0 \pm 1248.0	10314.8-14645.2
STW-634	Water	Jul 1991	Ra-226	14.9 \pm 0.4	15.9 \pm 2.4	11.7-20.1
			Ra-228	17.6 \pm 1.8	16.7 \pm 4.2	9.4-24.0

Table A-1. (continued)

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/L ^b			
				TIML Result $\pm 2\sigma^c$	EPA Result ^d		
					1s, N=1	Control Limits	
STW-635	Water	Jul 1991	U	12.8±0.1	14.2±3.0	9.0-19.4	
STW-636	Water	Aug 1991	I-131	19.3±1.2	20.0±6.0	9.6-30.4	
STW-637	Water	Aug 1991	Pu-239	21.4±0.5	19.4±1.9	16.1-22.7	
STAF-638	Air Filter	Aug 1991	Gr. alpha	33.0±2.0	25.0±6.0	14.6-35.4	
			Gr. beta	88.7±1.2	92.0±10.0	80.4-103.6	
			Sr-90	27.0±4.0	30.0±5.0	21.3-38.7	
			Cs-137	26.3±1.2	30.0±5.0	21.3-38.7	
STW-639	Water	Sep 1991	Sr-89	47.0±10.4	49.0±5.0	40.3-57.7	
			Sr-90	24.0±2.0	25.0±5.0	16.3-33.7	
STW-640	Water	Sep 1991	Gr. alpha	12.0±4.0	10.0±5.0	1.3-18.7	
			Gr. beta	20.3±1.2	20.0±5.0	11.3-28.7	
STM-641	Milk	Sep 1991	Sr-89	20.3±5.0	25.0±5.0	16.3-33.7	
			Sr-90	19.7±3.1	25.0±5.0	16.3-33.7	
			I-131	130.7±16.8	108.0±11.0	88.9-127.1	
			Cs-137	33.7±3.2	30.0±5.0	21.3-38.7	
			K	1743.3±340.8	1740.0±87.0	1589.1-1890.9	
STW-642	Water	Oct 1991	Co-60	29.7±1.2	29.0±5.0	20.3-37.7	
			Zn-65	75.7±8.3	73.0±7.0	60.9-85.1	
			Ru-106	196.3±15.1	199.0±20.0	164.3-233.7	
			Cs-134	9.7±1.2	10.0±5.0	1.3-18.7	
			Cs-137	11.0±2.0	10.0±5.0	1.3-18.7	
			Ba-133	94.7±3.1	98.0±10.0	80.7-115.3	
STW-643	Water	Oct 1991	H-3	2640.0±156.2	2454.0±352.0	1843.3-3064.7	
STW-644 645	Water Sample A	Oct 1991	Gr. alpha	73.0±13.1	82.0±21.0	45.6-118.4	
			Ra-226	20.9±2.0	22.0±3.3	16.3-27.7	
			Ra-228	19.6±2.3	22.2±5.6	12.5-31.9	
			U	13.5±0.6	13.5±3.0	8.3-18.7	
	Sample B			Gr. beta	55.3±3.1	65.0±10.0	47.7-82.3
				Sr-89	9.7±3.1	10.0±5.0	1.3-18.7
				Sr-90	8.7±1.2	10.0±5.0	1.3-18.7
				Co-60	20.3±1.2	20.0±5.0	11.3-28.7
				Cs-134	9.0±5.3	10.0±5.0	1.3-18.7
				Cs-137	14.7±5.0	11.0±5.0	2.3-19.7

Table A-1. (continued)

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/L ^b		Control Limits
				TIML Result $\pm 2\sigma^c$	EPA Result ^d 1s, N=1	
STW-646	Water	Nov 1991	Ra-226	5.6±1.2	6.5±1.0	4.8-8.2
			Ra-228	9.6±0.5	8.1±2.0	4.6-11.6
STW-647	Water	Nov 1991	U	24.7±2.3	24.9±3.0	19.7-30.1

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

^b All results are in pCi/l, except for elemental potassium (K) data in milk, which are in mg/l; air filter samples, which are in pCi/filter; and food, which is in mg/kg.

^c Unless otherwise indicated, the TIML results are given as the mean \pm 2 standard deviations for three determinations.

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

^e NA = Not analyzed.

^f ND = No data; not analyzed due to relocation of lab.

^g Sample was analyzed but the results not submitted to EPA because deadline was missed (all data on file).

^h ND = No data; sample lost during analyses.

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

Lab Code	TLD Type	Measurement $\pm 2\sigma^a$	mR		
			Teledyne Result Value ^c	Known Participants	Average $\pm 2\sigma^d$ (All)
<u>2nd International Intercomparison^b</u>					
115-2	CaF ₂ :Mn Bulb	Field	17.0 \pm 1.9	17.1	16.4 \pm 7.7
		Lab	20.8 \pm 4.1	21.3	18.8 \pm 7.6
<u>3rd International Intercomparison^e</u>					
115-3	CaF ₂ :Mn Bulb	Field	30.7 \pm 3.2	34.9 \pm 4.8	31.5 \pm 3.0
		Lab	89.6 \pm 6.4	91.7 \pm 14.6	86.2 \pm 24.0
<u>4th International Intercomparison^f</u>					
115-4	CaF ₂ :Mn Bulb	Field	14.1 \pm 1.1	14.1 \pm 1.4	16.0 \pm 9.0
		Lab (Low)	9.3 \pm 1.3	12.2 \pm 2.4	12.0 \pm 7.4
		Lab (High)	40.4 \pm 1.4	45.8 \pm 9.2	43.9 \pm 13.2
<u>5th International Intercomparison^g</u>					
115-5A	CaF ₂ :Mn Bulb	Field	31.4 \pm 1.8	30.0 \pm 6.0	30.2 \pm 14.6
		Lab at beginning	77.4 \pm 5.8	75.2 \pm 7.6	75.8 \pm 40.4
		Lab at the end	96.6 \pm 5.8	88.4 \pm 8.8	90.7 \pm 31.2
115-5B	LiF-100 Chips	Field	30.3 \pm 4.8	30.0 \pm 6.0	30.2 \pm 14.6
		Field at beginning	81.1 \pm 7.4	75.2 \pm 7.6	75.8 \pm 40.4
		Lab at the end	85.4 \pm 11.7	88.4 \pm 8.8	90.7 \pm 31.2
<u>7th International Comparison^h</u>					
115-7A	LiF-100 Chips	Field	75.4 \pm 2.6	75.8 \pm 6.0	75.1 \pm 29.8
		Lab (Co-60)	80.0 \pm 3.5	79.9 \pm 4.0	77.9 \pm 27.6
		Lab (Cs-137)	66.6 \pm 2.5	75.0 \pm 3.8	73.0 \pm 22.2

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

Lab Code	TLD Type	Measurement $\pm 2\sigma^a$	Teledyne Result Value ^c	mR	
				Known Participants	Average $\pm 2\sigma^d$ (All)
115-7B	CaF ₂ :Mn Bulbs	Field	71.5 \pm 2.6	75.8 \pm 6.0	75.1 \pm 29.8
		Lab (Co-60)	84.8 \pm 6.4	79.9 \pm 4.0	77.9 \pm 27.6
		Lab (Cs-137)	78.8 \pm 1.6	75.0 \pm 3.8	73.0 \pm 22.2
115-7C	CaSO ₄ :Dy Cards	Field	76.8 \pm 2.7	75.8 \pm 6.0	75.1 \pm 29.8
		Lab (Co-60)	82.5 \pm 3.7	79.9 \pm 4.0	77.9 \pm 27.6
		Lab (Cs-137)	79.0 \pm 3.2	75.0 \pm 3.8	73.0 \pm 22.2
<u>8th International Intercomparisonⁱ</u>					
115-8A	LiF-100 Chips	Field Site 1	29.5 \pm 1.4	29.7 \pm 1.5	28.9 \pm 12.4
		Field Site 2	11.3 \pm 0.8	10.4 \pm 0.5	10.1 \pm 9.06
		Lab (Cs-137)	13.7 \pm 0.9	17.2 \pm 0.9	16.2 \pm 6.8
115-8B	CaF ₂ :Mn Bulbs	Field Site 1	32.3 \pm 1.2	29.7 \pm 1.5	28.9 \pm 12.4
		Field Site 2	9.0 \pm 1.0	10.4 \pm 0.5	10.1 \pm 9.0
		Lab (Cs-137)	15.8 \pm 0.9	17.2 \pm 0.9	16.2 \pm 6.8
115-8C	CaSO ₄ :Dy Cards	Field Site 1	32.2 \pm 0.7	29.7 \pm 1.5	28.9 \pm 12.4
		Field Site 2	10.6 \pm 0.6	10.4 \pm 0.5	10.1 \pm 9.0
		Lab (Cs-137)	18.1 \pm 0.8	17.2 \pm 0.9	16.2 \pm 6.8
<u>Teledyne Testing^j</u>					
89-1	LiF-100 Chips	Lab	21.0 \pm 0.4	22.4	--
89-2	Teledyne CaSO ₄ :Dy Cards	Lab	20.9 \pm 1.0	20.3	--

Table A-2. (continued)

Lab Code	TLD Type	Measurement $\pm 2\sigma^a$	mR		
			Teledyne Result Value ^c	Known Participants)	Average $\pm 2\sigma^d$ (All
<u>Teledyne Testing^j</u>					
90-1 ^k	Teledyne CaSO ₄ :Dy Cards	Lab	20.6 \pm 1.4	19.6	--
90-1 ^l	Teledyne CaSO ₄ :Dy Cards	Lab	100.8 \pm 4.3	100.0	--
91-1 ^m	Teledyne CaSO ₄ :Dy Cards	Lab	33.4 \pm 2.0	32.0	--
			55.2 \pm 4.7	58.8	--
			87.8 \pm 6.2	85.5	--

^a Lab result given is the mean ± 2 standard deviations of three determinations.

^b Second International Intercomparison of Environmental Dosimeters conducted in April of 1976 by the Health and Safety Laboratory (HASL), 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 ± 2 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 Fourth International Intercomparison of Environmental Dosimeters conducted in summer of 1979 by the School of Public Health of the University of Texas Houston, Texas.

^g Fifth International Intercomparison of Environmental Dosimeters 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.

^h Seventh International Intercomparison of Environmental Dosimeters conducted in the spring and summer of 1984 at Las Vegas, Nevada, and sponsored by the U.S. Department of Energy, The U.S. Nuclear Regulatory Commission, and the U.S. Environmental Protection Agency.

ⁱ Eighth International Intercomparison of Environmental Dosimeters conducted in the fall and winter of 1985-1986 at New York, New York, and sponsored by the U.S. Department of Energy.

^j Chips were submitted in September 1989 and cards were submitted in November 1989 to Teledyne Isotopes, Inc., Westwood, NJ for irradiation.

^k Cards were irradiated by Teledyne Isotopes, Inc., Westwood, NJ on June 19, 1990.

^l Cards were irradiated by Dosimetry Associates, Inc., Northville, MI on October 30, 1990.

^m Irradiated cards were provided by Teledyne Isotopes, INC., Westwood, NJ. Irradiated on October 8, 1991.

Table A-3. In-house spiked samples.

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/L		
				TIML Result n=1	Known Activity	Expected Precision 1s, n=1 ^a
QC-MI-16	Milk	Feb 1988	Sr-89	31.8±4.7	31.7±6.0	8.7
			Sr-90	25.5±2.7	27.8±3.5	5.2
			I-131	26.4±0.5	23.2±5.0	10.4
			Cs-134	23.8±2.3	24.2±6.0	8.7
			Cs-137	26.5±0.8	25.1±6.0	8.7
QC-MI-17	Milk	Feb 1988	I-131	10.6±1.2	14.3±1.6	10.4
QC-W-35	Water	Feb 1988	I-131	9.7±1.1	11.6±1.1	10.4
QC-W-36	Water	Mar 1988	I-131	10.5±1.3	11.6±1.0	10.4
QC-W-37	Water	Mar 1988	Sr-89	17.1±2.0	19.8±8.0	8.7
			Sr-90	18.7±0.9	17.3±5.0	5.2
QC-MI-18	Milk	Mar 1988	I-131	33.2±2.3	26.7±5.0	10.4
			Cs-134	31.3±2.1	30.2±5.0	8.7
			Cs-137	29.9±1.4	26.2±5.0	8.7
QC-W-38	Water	Apr 1988	I-131	17.1±1.1	14.2±5.0	10.4
QC-W-39	Water	Apr 1988	H-3	4439±31	4176±500	724
QC-W-40	Water	Apr 1988	Co-60	23.7±0.5	26.1±4.0	8.7
			Cs-134	25.4±2.6	29.2±4.5	8.7
			Cs-137	26.6±2.3	26.2±4.0	8.7
QC-W-41	Water	Jun 1988	Gr. alpha	12.3±0.4	13.1±5.0	8.7
			Gr. beta	22.6±1.0	20.1±5.0	8.7
QC-MI-19	Milk	Jul 1988	Sr-89	15.1±1.6	16.4±5.0	8.7
			Sr-90	18.0±0.6	18.3±5.0	5.2
			I-131	88.4±4.9	86.6±8.0	10.4
			Cs-137	22.7±0.8	20.8±6.0	8.7
QC-W-42	Water	Sep 1988	Sr-89	48.5±3.3	50.8±8.0	8.7
			Sr-90	10.9±1.0	11.4±3.5	5.2
QC-W-43	Water	Oct 1988	Co-60	20.9±3.2	21.4±3.5	8.7
			Cs-134	38.7±1.6	38.0±6.0	8.7
			Cs-137	19.0±2.4	21.0±3.5	8.7
QC-W-44	Water	Oct 1988	I-131	22.2±0.6	23.3±3.5	10.4

Table A-3. In-house spiked samples(continued)

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/L		Expected Precision 1s, n=1 ^a
				TIML Result n=1	Known Activity	
QC-W-45	Water	Oct 1988	H-3	4109±43	4153±500	724
QC-MI-20	Milk	Oct 1988	I-131	59.8±0.9	60.6±9.0	10.4
			Cs-134	49.6±1.8	48.6±7.5	8.7
			Cs-137	25.8±4.6	24.7±4.0	8.7
QC-W-46	Water	Dec 1988	Gr. alpha	11.5±2.3	15.2±5.0	8.7
			Gr. beta	26.5±2.0	25.7±5.0	8.7
QC-MI-21	Milk	Jan 1989	Sr-89	25.5±10.3	34.0±10.0	8.7
			Sr-90	28.3±3.2	27.1±3.0	5.2
			I-131	540±13	550±20	10.4
			Cs-134	24.5±2.6	22.6±5.5	8.7
			Cs-137	24.0±0.6	20.5±5.0	8.7
QC-W-47	Water	Mar 1989	Sr-89	15.2±3.8	16.1±5.0	8.7
			Sr-90	16.4±1.7	16.9±3.0	5.2
QC-MI-22	Milk	Apr 1989	I-131	36.3±1.1	37.2±5.0	10.4
			Cs-134	20.8±2.8	20.7±8.0	8.7
			Cs-137	22.2±2.4	20.4±8.0	8.7
QC-W-48	Water	Apr 1989	Co-60	23.5±2.0	25.1±8.0	8.7
			Cs-134	24.2±1.1	25.9±8.0	8.7
			Cs-137	23.6±1.2	23.0±8.0	8.7
QC-W-49	Water	Apr 1989	I-131	37.2±3.7	37.2±5.0	10.4
QC-W-50	Water	Apr 1989	H-3	3011±59	3089±500	724
QC-W-51	Water	Jun 1989	Gr. alpha	13.0±1.8	15.0±5.0	8.7
			Gr. beta	26.0±1.2	25.5±8.0	8.7
QC-MI-23	Milk	Jul 1989	Sr-89	19.4±6.5	22.0±10.0	8.7
			Sr-90	27.6±3.5	28.6±3.0	5.2
			I-131	46.8±3.2	43.4±5.0	10.4
			Cs-134	27.4±1.8	28.3±6.0	8.7
			Cs-137	24.1±1.8	20.8±6.0	8.7
QC-MI-24	Milk	Aug 1989	Sr-89	25.4±2.7	27.2±10.0	8.7
			Sr-90	46.0±1.1	47.8±9.6	8.3
QC-W-52	Water	Sep 1989	I-131	9.6±0.3	9.7±1.9	10.4

Table A-3. In-house spiked samples (continued)

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/L		
				TIML Result n=1	Known Activity	Expected Precision 1s, n=1 ^a
QC-W-53	Water	Sep 1989	I-131	19.0±0.2	20.9±4.2	10.4
QC-W-54	Water	Sep 1989	Sr-89	25.8±4.6	24.7±4.0	8.7
			Sr-90	26.5±5.3	29.7±5.0	5.2
QC-MI-25	Milk	Oct 1989	I-131	70.0±3.3	73.5±20.0	10.4
			Cs-134	22.1±2.6	22.6±8.0	8.7
			Cs-137	29.4±1.5	27.5±8.0	8.7
QC-W-55	Water	Oct 1989	I-131	33.3±1.3	35.3±10.0	10.4
QC-W-56	Water	Oct 1989	Co-60	15.2±0.9	17.4±5.0	8.7
			Cs-134	22.1±4.4	18.9±8.0	8.7
			Cs-137	27.2±1.2	22.9±8.0	8.7
QC-W-57	Water	Oct 1989	H-3	3334±22	3379±500	724
QC-W-58	Water	Nov 1989	Sr-89	10.9±1.4 ^d	11.1±1.0 ^d	8.7
			Sr-90	10.4±1.0 ^d	10.3±1.0 ^d	5.2
QC-W-59	Water	Nov 1989	Sr-89	101.0±6.0 ^d	104.1±10.5 ^d	17.5
			Sr-90	98.0±3.0 ^d	95.0±10.0 ^d	17.0
QC-W-60	Water	Dec 1989	Gr. alpha	10.8±1.1	10.6±4.0	8.7
			Gr. beta	11.6±0.5	11.4±4.0	8.7
QC-MI-26	Milk	Jan 1990	Cs-134	19.3±1.0	20.8±8.0	8.7
			Cs-137	25.2±1.2	22.8±8.0	8.7
QC-MI-27	Milk	Feb 1990	Sr-90	18.0±1.6	18.8±5.0	5.2
QC-MI-28	Milk	Mar 1990	I-131	63.8±2.2	62.6±6.0	6.3
QC-MI-61	Water	Apr 1990	Sr-89	17.9±5.5	23.1±8.7	8.7
			Sr-90	19.4±2.5	23.5±5.2	5.2
QC-MI-29	Milk	Apr 1990	I-131	90.7±9.2	82.5±8.5	10.4
			Cs-134	18.3±1.0	19.7±5.0	8.7
			Cs-137	20.3±1.0	18.2±5.0	8.7
QC-W-62	Water	Apr 1990	Co-60	8.7±0.4	9.4±5.0	8.7
			Cs-134	20.0±0.2	19.7±5.0	8.7
			Cs-137	28.7±1.4	22.7±5.0	8.7

Table A-3. In-house spiked samples (continued)

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/L		Expected Precision 1s, n=1 ^a
				TIML Result n=1	Known Activity	
QC-W-63	Water	Apr 1990	I-131	63.5±8.0	66.0±6.7	6.6
QC-W-64	Water	Apr 1990	H-3	1941±130	1826.0±350.0	724
QC-W-65	Water	Jun 1990	Ra-226	6.4±0.2	6.9±1.0	1.0
QC-W-66	Water	Jun 1990	U	6.2±0.2	6.0±6.0	6.0
QC-MI-30	Milk	Jul 1990	Sr-89	12.8±0.4	18.4±10.0	8.7
			Sr-90	18.2±1.4	18.7±6.0	5.2
			Cs-134	46.0±1.3	49.0±5.0	8.7
			Cs-137	27.6±1.3	25.3±5.0	8.7
QC-W-68	Water	Jun 1990	Gr. alpha	9.8±0.3	10.6±6.0	8.7
			Gr. beta	11.4±0.6	11.3±7.0	8.7
QC-MI-31	Milk	Aug 1990	I-131	68.8±1.6	61.4±12.3	10.4
QC-W-69	Water	Sep 1990	Sr-89	17.7±1.6	19.2±10.0	8.7
			Sr-90	13.9±1.6	17.4±10.0	5.2
QC-MI-32	Milk	Oct 1990	I-131	34.8±0.2	32.4±6.5	8.7
			Cs-134	25.8±1.2	27.3±10.0	8.7
			Cs-137	25.3±2.0	22.4±10.0	8.7
QC-W-70	Water	Oct 1990	H-3	2355±59	2276±455	605
QC-W-71	Water	Oct 1990	I-131	55.9±0.9	51.8±10.4	10.4
QC-W-73	Water	Oct 1990	Co-60	18.3±2.7	16.8±5.0	8.7
			Cs-134	28.3±2.3	27.0±5.0	8.7
			Cs-137	22.7±1.3	22.4±5.0	8.7
QC-W-74	Water	Dec 1990	Gr. alpha	21.4±1.0	26.1±6.5	11.3
			Gr. beta	25.9±1.0	22.3±5.6	9.7
QC-MI-33	Milk	Jan 1991	Sr-89	20.7±3.3	21.6±5.0	5.0
			Sr-90	19.0±1.4	23.0±3.0	3.0
			Cs-134	22.2±1.7	19.6±5.0	5.0
			Cs-137	26.1±1.6	22.3±5.0	5.0
QC-MI-34	Milk	Feb 1991	I-131	40.7±1.8	40.1±6.0	6.0
QC-W-75	Water	Mar 1991	Sr-89	18.8±1.5	23.3±5.0	5.0
			Sr-90	16.0±0.8	17.2±3.0	3.0

Table A-3. In-house spiked samples (continued)

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/L		
				TIML Result n=1	Known Activity	Expected Precision 1s, n=1 ^a
QC-W-76	Water	Apr 1991	I-131	56.5±1.7	59.0±5.9	5.9
QC-W-77	Water	Apr 1991	Co-60	16.4±2.2	15.7±5.0	5.0
			Cs-134	23.8±2.5	22.6±5.0	5.0
			Cs-137	25.0±2.4	21.1±5.0	5.0
QC-W-78	Water	Apr 1991	H-3	4027±188	4080±408	408
QC-MI-35	Milk	Apr 1991	I-131	48.0±0.8	49.2±6.0	6.0
			Cs-134	19.2±2.0	22.6±5.0	5.0
			Cs-137	22.8±2.2	22.1±5.0	5.0
QC-W-79	Water	Jun 1991	Gr. alpha	7.4±0.7	7.8±5.0	5.0
			Gr. beta	11.0±0.7	11.0±5.0	5.0
QC-MI-36	Milk	Jul 1991	Sr-89	28.1±2.1	34.0±10.0	10.0
			Sr-90	11.6±0.7	11.5±3.0	3.0
			I-131	14.4±1.9	18.3±5.0	5.0
			Cs-137	34.3±3.0	35.1±5.0	5.0
QC-W-80	Water	Oct 1991	Sr-89	27.4±6.9	24.4±5.0	5.0
			Sr-90	11.7±1.4	14.1±5.0	5.0
QC-W-81	Water	Oct 1991	I-131	19.1±0.7	20.6±4.2	4.2
QC-W-82	Water	Oct 1991	Co-60	22.6±2.7	22.1±5.0	5.0
			Cs-134	15.5±1.8	17.6±5.0	5.0
			Cs-137	17.5±2.1	17.6±5.0	5.0
QC-W-83	Water	Oct 1991	H-3	4639±137	4382±438	438
QC-MI-37	Milk	Oct 1991	I-131	23.6±3.2	25.8±5.0	5.0
			Cs-134	22.7±2.8	22.1±5.0	5.0
			Cs-137	38.3±3.0	35.1±5.0	5.0
QC-W-84	Water	Dec 1991	Gr. alpha	6.2±0.6	7.8±5.0	5.0
			Gr. beta	11.0±0.7	11.0±5.0	5.0

^a n=3 unless noted otherwise.

^b n=2 unless noted otherwise.

^c n=1 unless noted otherwise.

^d Concentration in pCi/ml.

Table A-4. In-house "blank" samples.

Lab Code	Sample Type	Date Collected	Analysis	Concentration (pCi/L)	
				Results (4.66 σ)	Acceptance Criteria (4.66 σ)
SPS-5386	Milk	Jan 1988	I-131	<0.1	<1
SPW-5448	"Dead" Water	Jan 1988	H-3	<177	<300
SPS-5615	Milk	Mar 1988	Cs-134	<2.4	<10
			Cs-137	<2.5	<10
			I-131	<0.3	<1
			Sr-89	<0.4	<5
			Sr-90	2.4±0.5 ^a	<1
SPS-5650	D.I. Water	Mar 1988	Th-228	<0.3	<1
			Th-230	<0.04	<1
			Th-232	<0.05	<1
			U-234	<0.03	<1
			U-235	<0.03	<1
			U-238	<0.03	<1
			Am-241	<0.06	<1
			Cm-241	<0.01	<1
			Pu-238	<0.08	<1
			Pu-240	<0.02	<1
SPS-6090	Milk	Jul 1988	Sr-89	<0.5	<1
			Sr-90	1.8±0.5	<1
			I-131	<0.4	<1
			Cs-137	<0.4	<10
SPW-6209	Water	Jul 1988	Fe-55	<0.8	<1
SPW-6292	Water	Sep 1988	Sr-89	<0.7	<1
			Sr-90	<0.7	<1
SPS-6477	Milk	Oct 1988	I-131	<0.2	<1
			Cs-134	<6.1	<10
			Cs-137	<5.9	<10
SPW-6478	Water	Oct 1988	I-131	<0.2	<1
SPW-6479	Water	Oct 1988	Co-60	<5.7	<10
			Cs-134	<3.7	<10
			Cs-137	<4.3	<10
SPW-6480	Water	Oct 1988	H-3	<170	<300

Table A-4. In-house "blank" samples (continued)

Lab Cede	Sample Type	Date Collected	Analysis	Concentration (pCi/L)	
				Results (4.66 σ)	Acceptance Criteria (4.66 σ)
SPW-6625	Water	Dec 1988	Gr. alpha Gr. beta	<0.7 <1.9	<1 <4
SPS-6723	Milk	Jan 1989	Sr-89 Sr-90 I-131 Cs-134 Cs-137	<0.6 1.9±0.5 ^a <0.2 <4.3 <4.4	<5 <1 <1 <10 <10
SPW-6877	Water	Mar 1989	Sr-89 Sr-90	<0.4 <0.6	<5 <1
SPS-6963	Milk	Apr 1989	I-131 Cs-134 Cs-137	<0.3 <5.9 <6.2	<1 <10 <10
SPW-7561	Water	Apr 1989	H-3	<150	<300
SPW-7207	Water	Jun 1989	Ra-226 Ra-228	<0.2 <0.6	<1 <1
SPS-7208	Milk	Jun 1989	Sr-89 Sr-90 I-131 Cs-134 Cs-137	<0.6 2.1±0.5 ^a <0.3 <6.4 <7.2	<5 <1 <1 <10 <10
SPW-7588	Water	Jun 1989	Gr. alpha Gr. beta	<0.2 <1.0	<1 <4
SPS-7322	Milk	Aug 1989	Sr-89 Sr-90 I-131 Cs-134 Cs-137	<1.4 4.8±1.0 ^a <0.2 <6.9 <8.2	<5 <1 <1 <10 <10
SPW-7559	Water	Sep 1989	Sr-89 Sr-90	<2.0 <0.7	<5 <1
SPW-7560	Water	Oct 1989	I-131	<0.1	<1
SPW-7562	Water	Oct 1989	H-3	<140	<300

Table A-4. In-house "blank" samples (continued)

Lab Code	Sample Type	Date Collected	Analysis	Concentration (pCi/L)	
				Results (4.66 σ)	Acceptance Criteria (4.66 σ)
SPS-7605	Milk	Nov 1989	I-131	<0.2	<1
			Cs-134	<8.6	<10
			Cs-137	<10	<10
SPW-7971	Water	Dec 1989	Gr. alpha	<0.4	<1
			Gr. beta	<0.8	<4
SPW-8039	Water	Jan 1990	Ra-226	<0.2	<1
SPS-8040	Milk	Jan 1990	Sr-89	<0.8	<5
			Sr-90	<1.0	<1
SPS-8208	Milk	Jan 1990	Sr-89	<0.8	<5
			Sr-90	1.6±0.5 ^a	<1
			Cs-134	<3.6	<10
			Cs-137	<4.7	<10
SPS-8312	Milk	Feb 1990	Sr-89	<0.3	<5
			Sr-90	1.2±0.3 ^a	<1
SPW-8312A	Water	Feb 1990	Sr-89	<0.6	<5
			Sr-90	<0.7	<5
SPS-8314	Milk	Mar 1990	I-131	<0.3	<1
SPS-8510	Milk	May 1990	I-131	<0.2	<1
			Cs-134	<4.6	<10
			Cs-137	<4.8	<10
SPW-8511A	Water	May 1990	H-3	<200	<300
SPS-8600	Milk	Jul 1990	Sr-89	<0.8	<5
			Sr-90	1.7±0.6 ^a	<1
			I-131	<0.3	<1
			Cs-134	<5.0	<10
			Cs-137	<7.0	<10
SPM-8877	Milk	Aug 1990	I-131	<0.2	<1
SPW-8925	Water	Aug 1990	H-3	<200	<300

Table A-4. In-house "blank" samples (continued)

Lab Code	Sample Type	Date Collected	Analysis	Concentration (pCi/L)	
				Results (4.66 σ)	Acceptance Criteria (4.66 σ)
SPW-8926	Water	Aug 1990	Gr. alpha	<0.3	<1
			Gr. beta	<0.7	<4
SPW-8927	Water	Aug 1990	U-234	<0.01	<1
			U-235	<0.02	<1
			U-238	<0.01	<1
SPW-8928	Water	Aug 1990	Mn-54	<4.0	<5
			Co-58	<4.1	<5
			Co-60	<2.4	<5
			Cs-134	<3.3	<5
			Cs-137	<3.7	<5
SPW-8929	Water	Aug 1990	Sr-89	<1.4	<5
			Sr-90	<0.6	<1
SPW-69	Water	Sep 1990	Sr-89	<1.8	<5
			Sr-90	<0.8	<1
SPW-106	Water	Oct 1990	H-3	<180	<300
			I-131	<0.3	<1
SPM-107	Milk	Oct 1990	I-131	<0.4	<1
			Cs-134	<3.3	<5
			Cs-137	<4.3	<5
SPW-370	Water	Oct 1990	Mn-54	<1.7	<5
			Co-58	<2.6	<5
			Co-60	<1.6	<5
			Cs-134	<1.7	<5
			Cs-137	<1.8	<5
SPW-372	Water	Dec 1990	Gr. alpha	<0.3	<1
			Gr. beta	<0.8	<4
SPS-406	Milk	Jan 1991	Sr-89	<0.4	<5
			Sr-90	1.8±0.4 ^a	<1
			Cs-134	<3.7	<5
			Cs-137	<5.2	<5
SPS-421	Milk	Feb 1991	I-131	<0.3	<1
SPW-451	Water	Feb 1991	Ra-226	<0.1	<1
			Ra-228	<0.9	<1

Table A-4. In-house "blank" samples (continued)

Lab Code	Sample Type	Date Collected	Analysis	Concentration (pCi/L)	
				Results (4.66 σ)	Acceptance Criteria (4.66 σ)
SPW-514	Water	Mar 1991	Sr-89	<1.1	<5
			Sr-90	<0.9	<1
SPW-586	Water	Apr 1991	I-131	<0.2	<1
			Co-60	<2.5	<5
			Cs-134	<2.4	<5
			Cs-137	<2.2	<5
SPS-587	Milk	Apr 1991	I-131	<0.2	<1
			Cs-134	<1.7	<5
			Cs-137	<1.9	<5
SPW-837	Water	Jun 1991	Gr. alpha	<0.6	<1
			Gr. beta	<1.1	<4
SPM-953	Milk	Jul 1991	Sr-89	<0.7	<5
			Sr-90	0.4±0.3 ^a	<1
			I-131	<0.2	<1
			Cs-137	<4.9	<5
SPM-1236	Milk	Oct 1991	I-131	<0.2	<1
			Cs-134	<3.7	<5
			Cs-137	<4.6	<5
SPW-1254	Water	Oct 1991	Sr-89	<2.8	<5
			Sr-90	<0.7	<1
SPW-1256	Water	Oct 1991	I-131	<0.4	<1
			Co-60	<3.6	<5
			Cs-134	<4.0	<5
			Cs-137	<3.6	<5
SPW-1259	Water	Oct 1991	H-3	<160	<300
SPW-1444	Water	Dec 1991	Gr. alpha	<0.4	<1
			Gr. beta	<0.8	<4

^a Low level of Sr-90 concentration in milk (1 - 5 pCi/L) is not unusual.

ATTACHMENT B

ACCEPTANCE CRITERIA FOR "SPIKED" SAMPLES

LABORATORY PRECISION: ONE STANDARD DEVIATION VALUES FOR VARIOUS ANALYSES^a

Analysis	Level	One Standard Deviation for Single Determination
Gamma Emitters	5 to 100 pCi/liter or kg >100 pCi/liter or kg	5 pCi/liter 5% of known value
Strontium-89 ^b	5 to 50 pCi/liter or kg >50 pCi/liter or kg	5 pCi/liter 10% of known value
Strontium-90 ^b	2 to 30 pCi/liter or kg >30 pCi/liter or kg	3.0 pCi/liter 10% of known value
Potassium	>0.1 g/liter or kg	5% of known value
Gross alpha	<20 pCi/liter >20 pCi/liter	5 pCi/liter 25% of known value
Gross beta	<100 pCi/liter >100 pCi/liter	5 pCi/liter 5% of known value
Tritium	<4,000 pCi/liter >4,000 pCi/liter	1s = (pCi/liter) = 169.85 x (known) ^{.0933} 10% of known value
Radium-226, -228	<0.1 pCi/liter	15% of known value
Plutonium	0.1 pCi/liter, gram, or sample	10% of known value
Iodine-131, Iodine-129 ^b	<55 pCi/liter >55 pCi/liter	6 pCi/liter 10% of known value
Uranium-238, Nickel-64 ^b , Technetium-99 ^b	<35 pCi/liter >35 pCi/liter	6 pCi/liter 15% of known value
Iron-55 ^b	50 to 100 pCi/liter >100 pCi/liter	10 pCi/liter 10% of known value

^a From EPA publication, "Environmental Radioactivity Laboratory Intercomparison Studies Program, Fiscal Year, 1981-1982, EPA-600/4-81-004.

^b TIML limit.

ADDENDUM TO APPENDIX A

The following is an explanation of the reasons why certain samples were outside the control limit specified by the Environmental Protection Agency for the Interlaboratory Comparisons Program starting January 1988.

Lab Code	Analysis	TIML Result (pCi/L) ^a	EPA Control Limit (pCi/L) ^a	Explanation
STF-524	K	1010.7±158.5 ^b	1123.5-1336.5 ^b	Error in transference of data. Correct data was 1105±33 mg/kg. Results in the past have been within the limits and TIML will monitor the situation in the future.
STW-532	I-131	9.0±2.0	6.2-8.8	Sample recounted after 12 days. The average result was 8.8±1.7 pCi/L (within EPA control limits). The sample was recounted in order to check the decay. Results in the past have been within the limits and TIML will continue to monitor the situation in the future.
STW-534	Co-60	63.3±1.3	41.3-58.7	High level of Co-60 was due to contamination of beaker. Beaker was discarded upon discovery of contamination and sample was recounted. Recount results were 53.2±3.6 and 50.9±2.4 pCi/L.
STM-554	Sr-90	51.0±2.0	54.8-65.2	The cause of low result was due to very high fat content of milk. It should be noted that 63% of all participants failed this test. Also, the average for all participants was 54.0 pCi/L before the Grubb and 55.8 pCi/L after the Grubb.
STW-560	Pu-239	5.8±1.1	3.5-4.9	The cause of high results is not known though it is suspected that the standard was not properly calibrated by supplier and is under investigation. New Pu-236 standard was obtained and will be used for the next test.
STW-568	Ra-228	2.6±1.0	2.7-4.5	The cause of low results is not known. Next EPA cross check results were within the control limits. No further action is planned.

ADDENDUM TO APPENDIX A (continued)

Lab Code	Analysis	TIML Result (pCi/L) ^a	EPA Control Limit (pCi/L) ^a	Explanation
STM-570	Sr-89 Sr-90	26.0±10.0 45.7±4.2	30.3-47.7 49.8-60.2	The cause of low results was falsely high recovery due to suspected incomplete calcium removal. Since EPA sample was used up, internal spike was prepared and analyzed. The results were within control limits (See table A-3, sample QC-MI-24). No further action is planned.
STW-589	Sr-90	17.3±1.2	17.4-22.6	Sample was reanalyzed in triplicate; results of reanalyses were 18.8±1.5 pCi/L. No further action is planned.
STM-599	K	1300.0±69.2 ^c	1414.7-1685.3 ^c	Sample was reanalyzed in triplicate. Results of reanalyses were 1421.7±95.3 mg/L. The cause of low results is unknown.
STW-601	Gr. alpha	11.0±2.0	11.6-32.4	Sample was reanalyzed in triplicate. Results of reanalyses were 13.4±1.0 pCi/L.
STAF-626	Gr. alpha	38.7±1.2	14.6-35.4	The cause of high results is the difference in geometry between standard used in the TIML lab and EPA filter.
STW-632	Ba-133	74.0±6.9	51.6-72.4	Sample was reanalyzed. Results of the reanalyses were 63.8±6.9 pCi/L within EPA limit.
STM-641	I-131	130.7±16.8	88.9-127.1	The cause of high result is unknown. In-house spike sample was prepared with activity of I-131 68.3±6.8 pCi/L. Result of the analysis was 69.1±9.7 pCi/L.

^a Reported in pCi/L unless otherwise noted.

^b Concentrations are reported in mg/kg.

^c Concentrations are reported in mg/L.

APPENDIX B

DATA REPORTING CONVENTIONS

Data Reporting Conventions

1.0. All activities except gross alpha and gross beta are decay corrected to collection time or the end of the collection period.

2.0. Single Measurements

Each single measurement is reported as follows:

$$x \pm s$$

where x = value of the measurement;

$s = 2\sigma$ 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 = the lower limit of detection based on 4.66σ uncertainty for a background sample.

3.0. Duplicate analyses

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

Reported result: $x \pm s$

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

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

3.2. Individual results: $<L_1$

$<L_2$

Reported result: $<L$

where L = lower of L_1 and L_2

3.3. Individual results: $x \pm s$

$<L$

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

$<L$ 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 deviation(s) of a set of n numbers $x_1, x_2 \dots x_n$ are defined as follows:

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

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

- 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 five is dropped, and the last-place figure retained is increased by one if it is an odd number or it is kept unchanged if an even number. As an example, 11.435 is rounded off to 11.44, while 11.425 is rounded off to 11.42.

APPENDIX C

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

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

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

^a Taken from Code of Federal Regulations Title 10, Part 20, Table II and appropriate footnotes. Concentrations may be averaged over a period not greater than one year.

^b From 10 CFR 20 but adjusted by a factor of 700 to reduce the dose resulting from the air-grass-cow-milk-child pathway.

^c A natural radionuclide.