# YANKEE NUCLEAR POWER STATION

# ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

January - December 1988

April 1989

Prepared By:
Yankee Atomic Electric Company
Environmental Engineering Department
580 Main Street
Bolton, Massachusetts 01740



IE25
1/1

TABLE OF CONTENTS

## LIST OF TABLES

## LIST OF FIGURES

## 1.0 INTRODUCTION

The radiological environmental surveillance program for the Yankee Nuclear Power Station (YNPS) has been designed and carried out with specific objectives in mind. They are as follows:

- To provide an early indication of the appearance or accumulation of any radioactive material in the environment caused by the operation of the nuclear power station.

- To provide assurance to regulatory agencies and the public that the station's environmental impact is known and within anticipated limits.

- To verify the adequacy and proper functioning of station effluent controls and monitoring systems.

- To provide standby monitoring capability for rapid assessment of risk to the general public in the event of unanticipated or accidental releases of radioactive material.

During 1988, the plant staff collected all environmental samples, including environmental thermoluminescent dosimeters (TLDs). All samples were sent to the Yankee Atomic Environmental Laboratory in Westborough, Massachusetts for further processing and radionuclide analysis. TLDs were also sent to this laboratory for processing.

This report is a summary of the findings of the Radiological Environmental Surveillance Program for 1988. It is being provided in compliance with plant Technical Specification 6.9.5.a.

## 2.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

In this section, Table 2.1 outlines the monitoring program as required by plant Technical Specification 3/4.12.1. Table 2.2 lists the sampling stations and their specific locations (distances are measured from the center of the containment building). The sampling locations are shown on maps in Figures 2.1 through 2.7.

Table 2.1

Radiological Environmental Monitoring Program

Yankee Nuclear Power Station

| Media | Sampling Frequency | Required Analyses |
|---|---|---|
| Air Particulate (AP) | - Weekly<br>- Quarterly Composite | Gross beta<br>Gamma spectroscopy |
| Charcoal Filter (CF) | - Weekly | I-131 |
| Milk (TM) | - Monthly; once per 2 weeks from June 1 to Nov. 1 | Gamma spectroscopy, I-131 |
| Food Crop (TF) | - Annually (Harvest) | Gamma spectroscopy |
| Broad Leaf Vegetation (TV) | - Annually (Harvest) | I-131 |
| Groundwater (WG) | - Quarterly | Gamma spectroscopy, H-3 |
| River Water (WR) | - Monthly (Composite)<br>- Quarterly Composite | Gross beta, Gamma spectroscopy<br>H-3 |
| Sediment (SE) | - Semiannually | Gamma spectroscopy |
| Fish (FH) | - Seasonal or Semiannually | Gamma spectroscopy |
| Direct Radiation (GM) | - Quarterly (Outer ring TLDs)<br>- Quarterly (All other TLDs) | De-dose only<br>Integrated gamma dose |

Table 2.2

Radiological Environmental Monitoring Locations

Yankee Nuclear Power Station

| Station Code (Media - Sta. No.) | Station Description | Zone* | Distance From Plant (km) | Direction From Plant |
|---|---|---|---|---|
| AP/CF-11 | Observation Stand | 1 | 0.5 | NW |
| AP/CF-12 | Monroe Bridge | 1 | 1.1 | SW |
| AP/CF-13 | Rowe School | 1 | 4.2 | SE |
| AP/CF-14 | Harriman Station | 1 | 3.2 | N |
| AP/CF-21 | Williamstown, MA | 2 | 22.2 | W |
| AP/CF-31** | YAEC Visitor's Information Center (Furlon House) | 1 | 0.8 | SW |
| AP/CF-32** | Heartwellville, VT | 2 | 12.6 | NNW |
| TM-12 | Readsboro, VT | 1 | 6.1 | N |
| TM-13 | Whitingham, VT | 1 | 8.4 | ENE |
| TM-21 | Williamstown, MA | 2 | 21.0 | WSW |
| TF-11 | Monroe Bridge, MA | 1 | 1.3 | SW |
| TF-13 | Monroe, MA | 1 | 1.9 | WNW |
| TF-21 | Williamstown, MA | 2 | 21.0 | WSW |
| TF-32 (Maple Syrup)** | Whitingham, VT | 1 | 8.4 | ENE |
| TF-33 (Maple Syrup)** | Rowe, MA | 1 | 2.4 | S |
| TF-42 (Maple Syrup)** | Williamstown, MA | 2 | 28.3 | WSW |
| TV-11 | Monroe Bridge, MA | 1 | 1.3 | SW |
| WG-11 | Plant Potable | 1 | On-Site | -- |
| WG-12 | Sherman Spring | 1 | 0.2 | NW |
| WR-11 | Bear Swamp Lower Res. | 1 | 6.3 | Downriver |
| WR-21 | Harriman Reservoir | 2 | 10.1 | Upriver |
| SE-11 | No. 4 Station | 1 | 36.2 | Downriver |
| SE-21 | Harriman Reservoir | 2 | 10.1 | Upriver |
| FH-11 | Sherman Pond | 1 | 1.5 | N |
| FH-21 | Harriman Reservoir | 2 | 10.1 | Upriver |
| GM-1 | YAEC Visitor's Information Center (Furlon House) | 1 | 0.8 | SW |
| GM-2 | Observation Stand | 1 | 0.5 | NW |
| GM-3 | Rowe School | 1 | 4.2 | SE |
| GM-4 | Harriman Station | 1 | 3.2 | N |

Table 2.2
(Continued)

Radiological Environmental Monitoring Locations

Yankee Nuclear Power Station

| Station Code (Media - Sta. No.) | Station Description | Zone* | Distance From Plant (km) | Direction From Plant |
|---|---|---|---|---|
| GM-5 | Monroe Bridge | 1 | 1.1 | SW |
| GM-6 | Readsboro Road Barrier | 1 | 1.3 | N |
| GM-7 | Whitingham Line | 1 | 3.5 | NE |
| GM-8 | Monroe Hill Barrier | 1 | 1.8 | S |
| GM-9 | Dunbar Brook | 1 | 3.2 | SW |
| GM-10 | Cross Road | 1 | 3.5 | E |
| GM-11 | Adams High Line | 1 | 2.1 | WNW |
| GM-12 | Readsboro, VT | 1 | 5.5 | NNW |
| GM-13 | Restricted Area Fence | F | 0.08 | WSW |
| GM-14 | Restricted Area Fence | F | 0.11 | WNW |
| GM-15 | Restricted Area Fence | F | 0.08 | NNW |
| GM-16 | Restricted Area Fence | F | 0.13 | NNE |
| GM-17 | Restricted Area Fence | F | 0.14 | ENE |
| GM-18 | Restricted Area Fence | F | 0.14 | ESE |
| GM-19 | Restricted Area Fence | F | 0.16 | SE |
| GM-20 | Restricted Area Fence | F | 0.16 | SSE |
| GM-21 | Restricted Area Fence | F | 0.11 | SSW |
| GM-22 | Heartwellville, VT | 2 | 12.6 | NNW |
| GM-23 | Williamstown Substation | 2 | 22.2 | W |
| GM-24 | Harriman Dam | 0 | 7.3 | N |
| GM-25 | Whitingham, VT | 0 | 7.7 | NNE |
| GM-26 | Sadoga Road | 0 | 7.6 | NE |
| GM-27 | Number 9 Road | 0 | 7.6 | ENE |
| GM-28 | Number 9 Road | 0 | 6.0 | E |
| GM-29 | Route 8A | 0 | 8.2 | ESE |
| GM-30 | Route 8A | 0 | 9.4 | SE |
| GM-31 | Legate Hill Road | 0 | 7.6 | SSE |
| GM-32 | Rowe Road | 0 | 7.9 | S |
| GM-33 | Zoar Road | 0 | 6.9 | SSW |
| GM-34 | Fife Brook Road | 0 | 6.4 | SW |
| GM-35 | Whitcomb Summit | 0 | 8.6 | WSW |
| GM-36 | Tilda Road | 0 | 6.6 | W |
| GM-37 | Turner Hill Road | 0 | 6.7 | WNW |
| GM-38 | West Hill Road | 0 | 6.6 | NW |
| GM-39 | Route 100 | 0 | 6.8 | NNW |
| GM-40 | Readsboro Road | 1 | 0.5 | W |

* 1 = Indicator Stations; 2 = Control Stations; 0 = Outer Ring Incident Response TLD; F = Fenceline.

** Not required by Radiological Effluent Technical Specifications or the Off-Site Dose Calculation Manual.

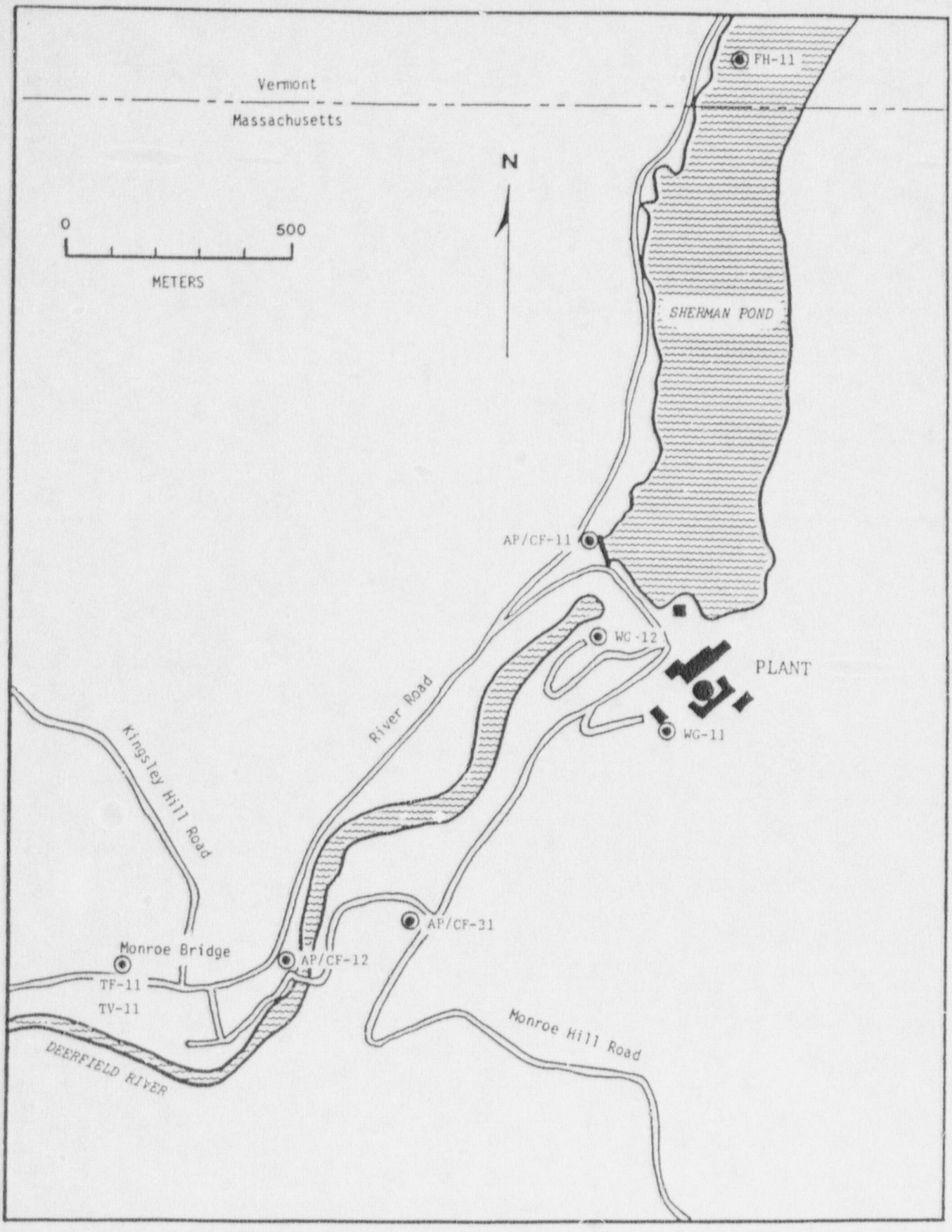



Figure 2.1 Yankee Plant Radiological Environmental Monitoring Locations Within 1 Mile (Airborne, Waterborne and Ingestion Pathways)

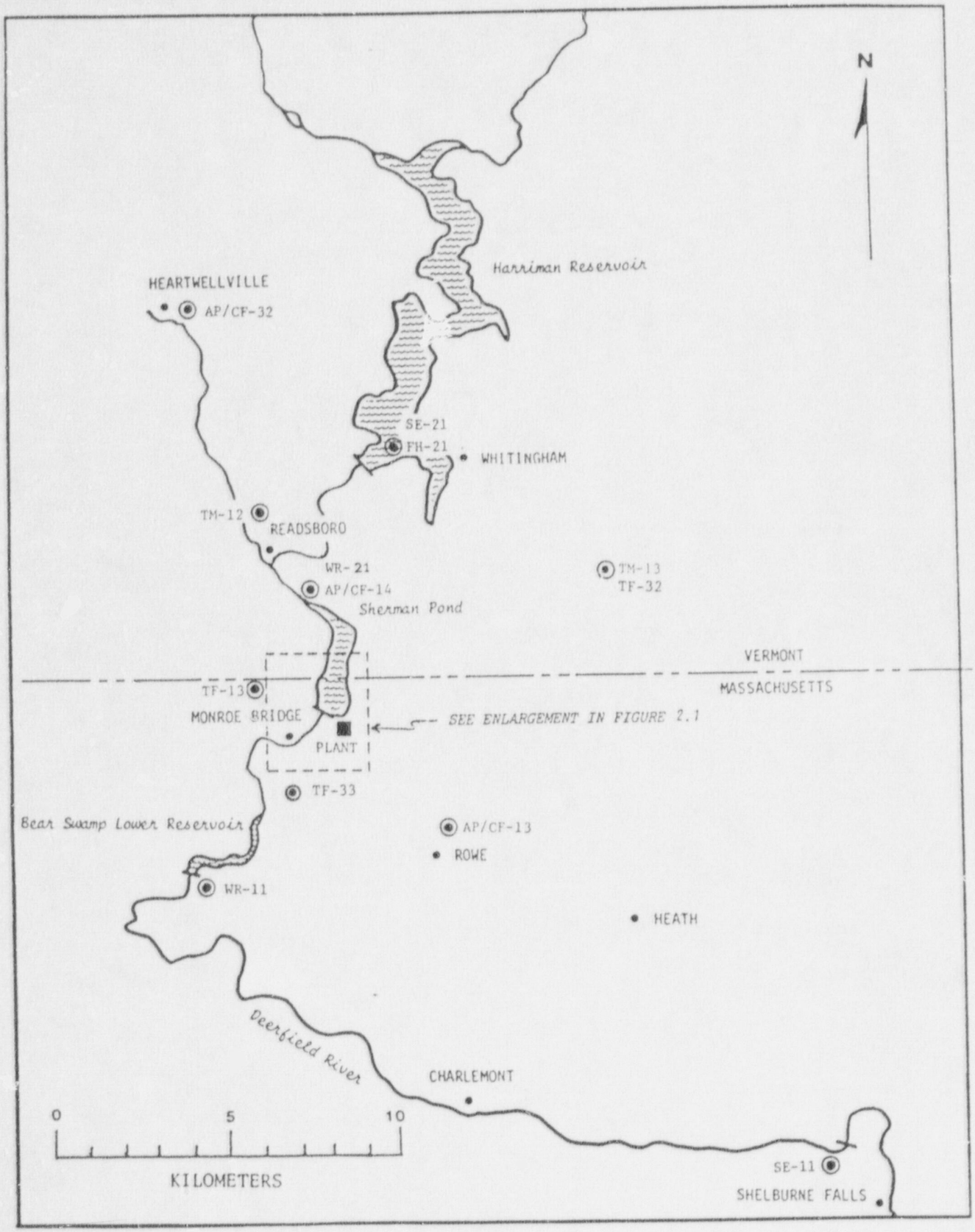



Figure 2.2 Yankee Plant Radiological Environmental Monitoring Locations Within 12 Miles (Airborne, Waterborne and Ingestion Pathways)

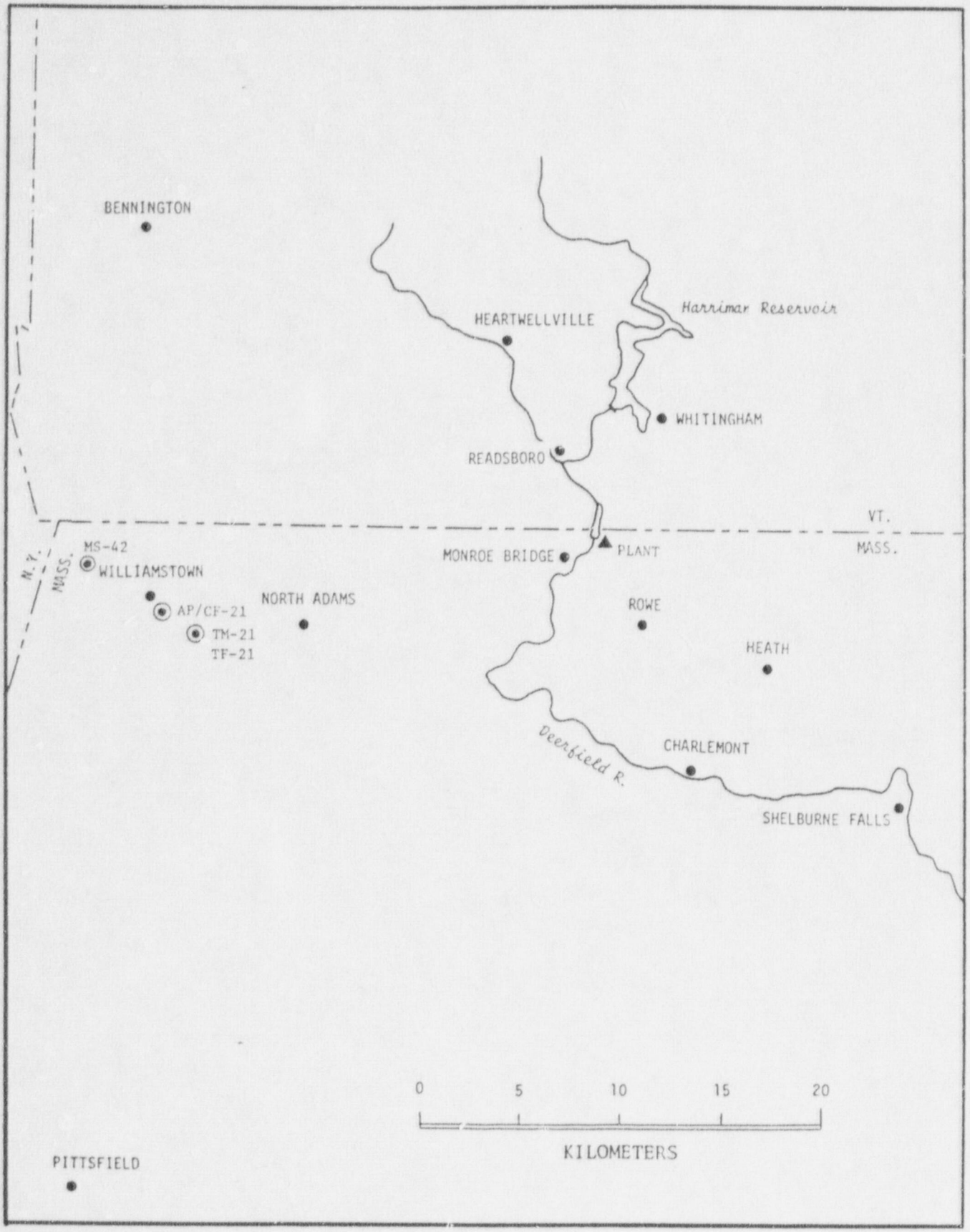



Figure 2.3 Yankee Plant Radiological Environmental Monitoring Locations Outside 12 Miles (Airborne, Waterborne and Ingestion Pathways)

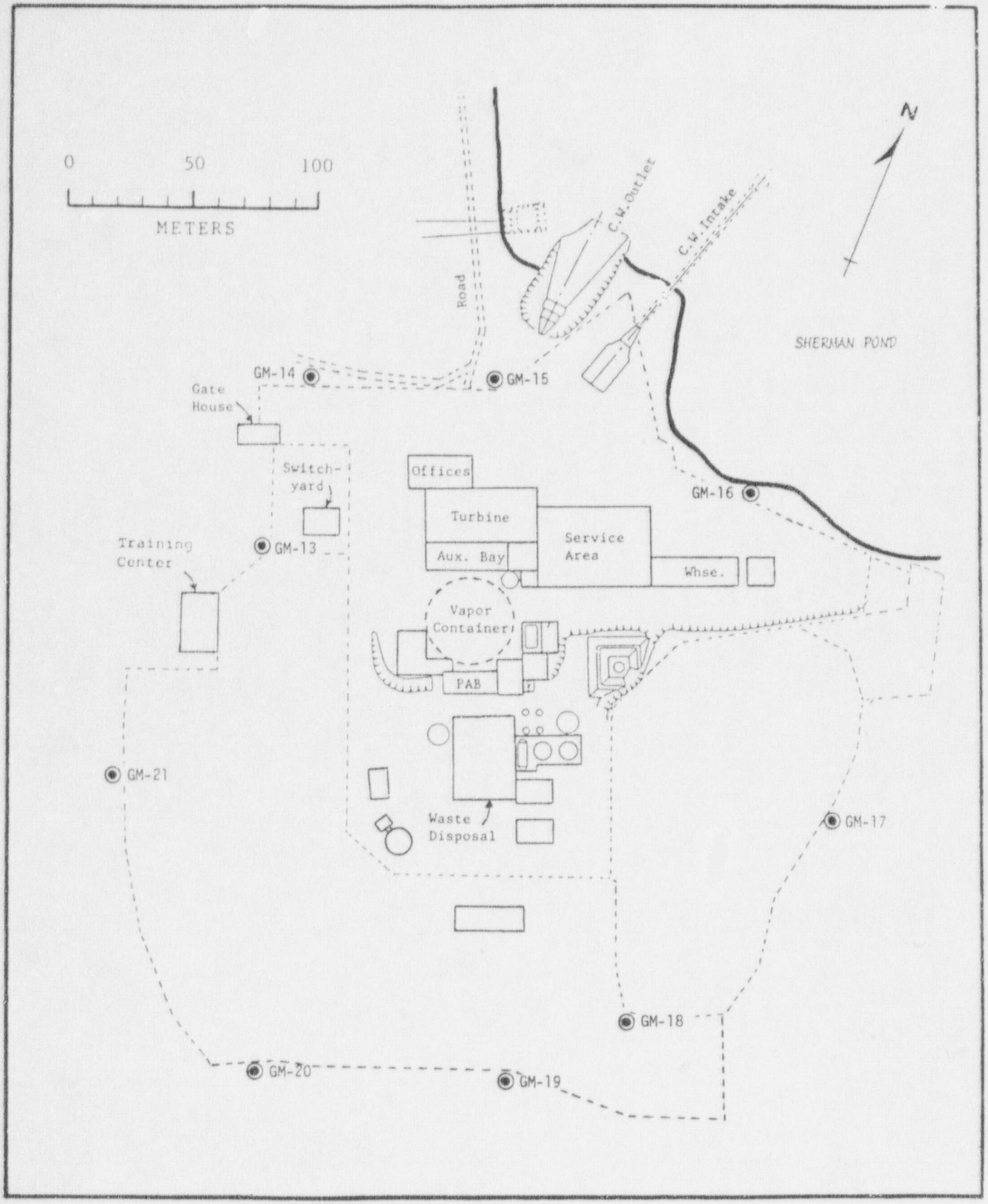



Figure 2.4 Yankee Plant Radiological Environmental Monitoring Locations at the Restricted Area Fence (Direct Radiation Pathway)

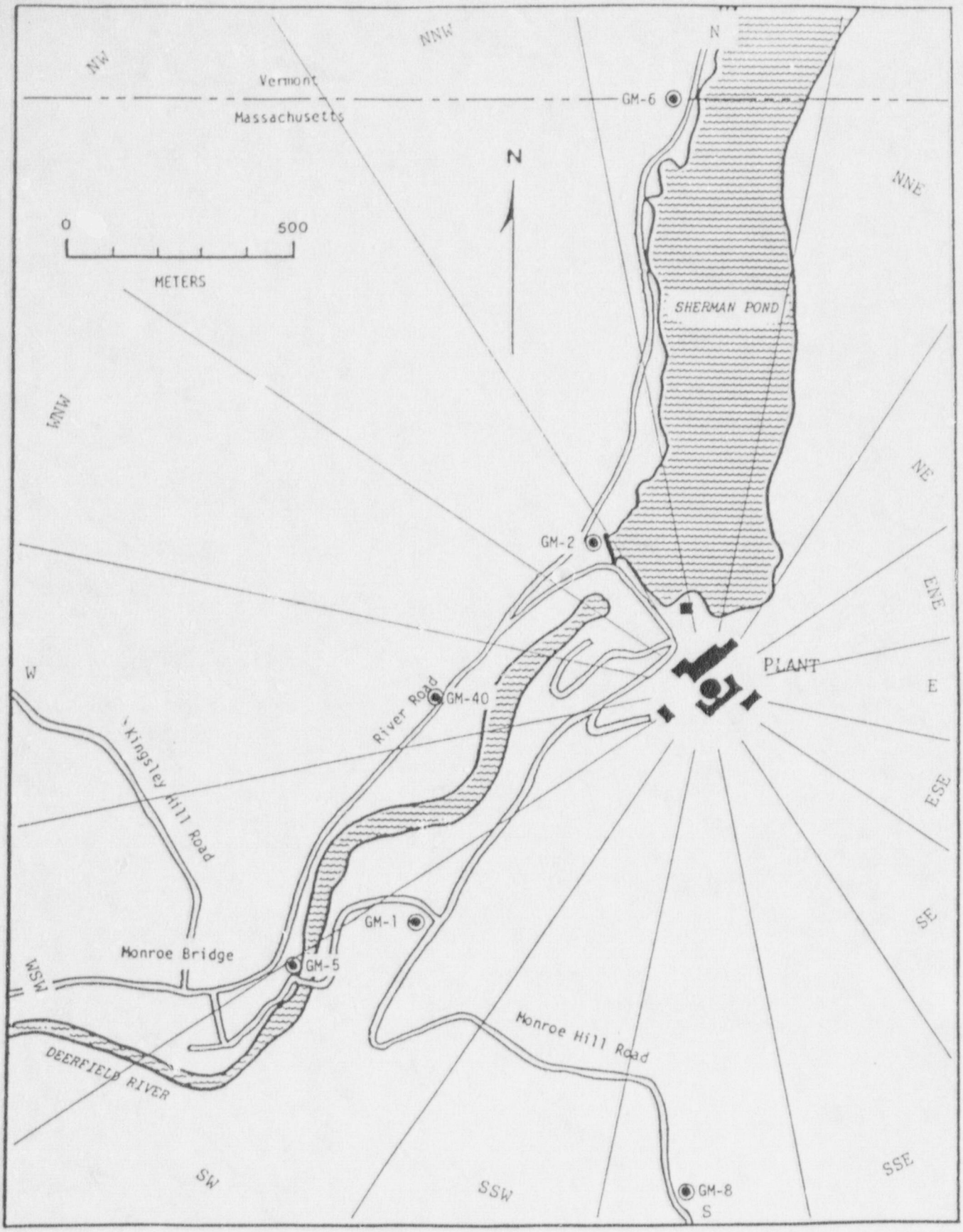



Figure 2.5 Yankee Plant Radiological Environmental Monitoring Locations Within 1 Mile (Direct Radiation Pathway)

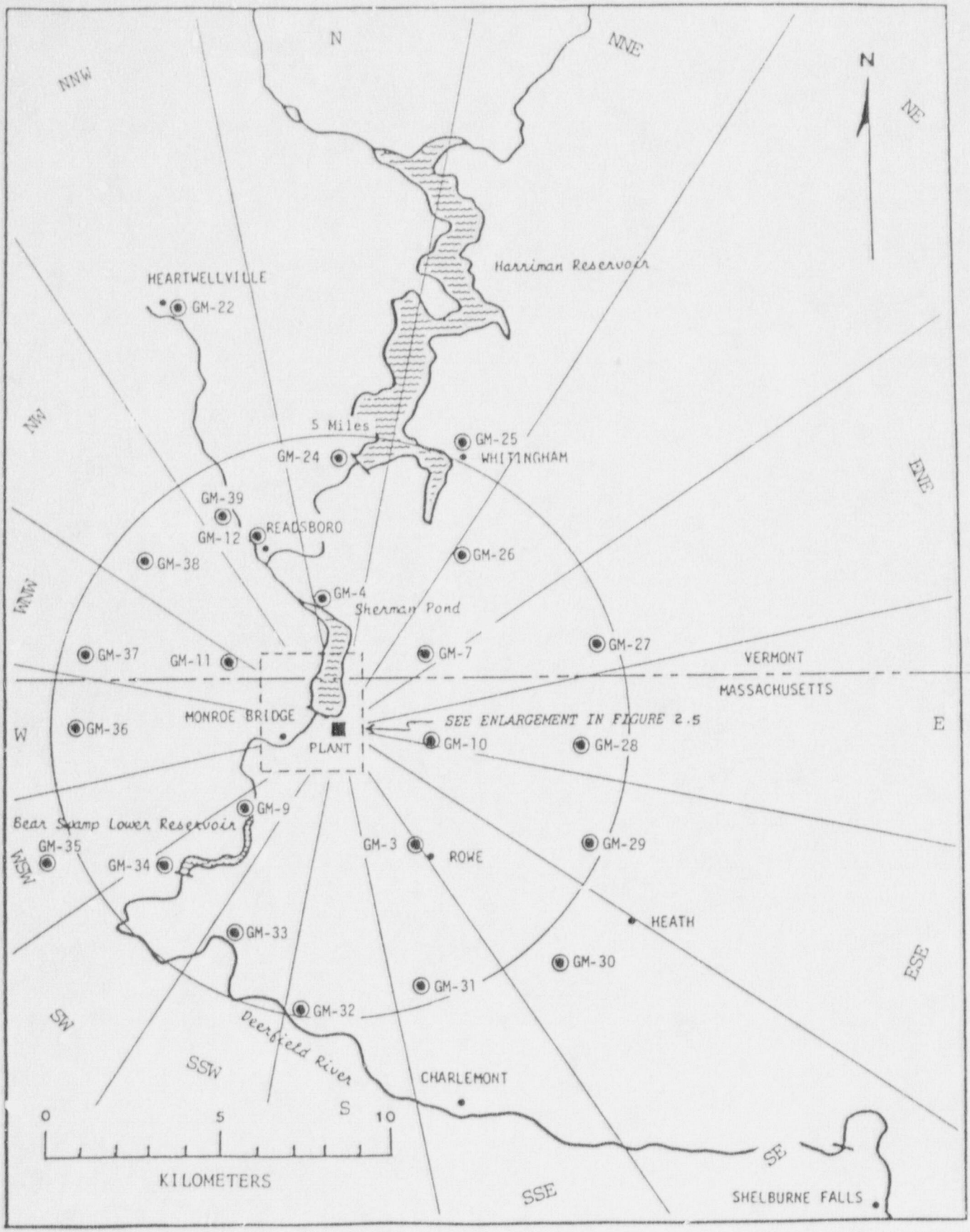



Figure 2.6 Yankee Plant Radiological Environmental Monitoring Locations Within 12 Miles (Direct Radiatic Pathway)

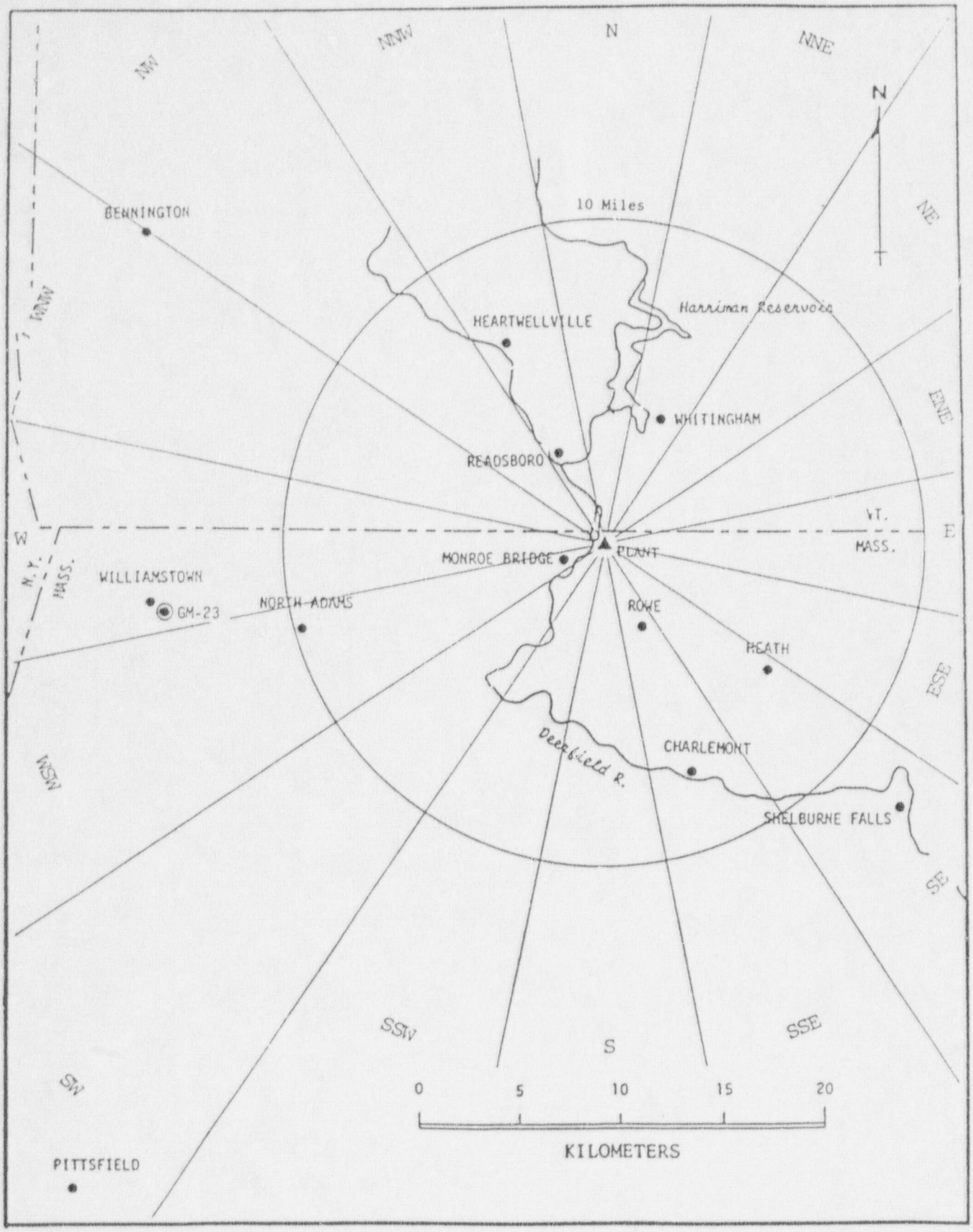



Figure 2.7 Yankee Plant Radiological Environmental Monitoring Locations Outside 12 Miles (Direct Radiation Pathway)

## 3.0 SUMMARY OF RADIOLOGICAL ENVIRONMENTAL DATA

The following pages summarize the analytical results of the environmental samples which were collected during 1988. Each environmental media category is presented as a separate subsection. A discussion of the sampling program and results is followed by a table which summarizes the year's data for each category. At the top of each table are listed the units of measurement for each medium. The left hand column contains the radionuclide which is being reported, total number of analyses of that radionuclide, and the number of measurements which exceeds ten times the yearly average for the control station(s). The latter are classified as "nonroutine" measurements. The next column lists the Lower Limit of Detection (LLD) for those radionuclides which have detection capability requirements as specified in the plant's Radiological Effluent Technical Specifications (Table 4.12-1). LLD requirements are not specified in the Technical Specifications for many of the radionuclides for which analyses are routined conducted.

Those sampling stations which are within the range of influence of the plant and which could conceivably be affected by its operation are called "indicator" or "Zone I" stations. Distant stations, which are beyond plant influence are called "Control" or "Zone II" stations. Direct radiation monitoring stations are broken down into two additional categories to aid in data analysis. These are fenceline stations and outer ring (emergency response) stations.

A set of statistical parameters is calculated for each radionuclide. These include separate analyses for (1) the indicator stations, (2) the control stations, and (3) the station having the highest annual mean concentration for that radionuclide. For each of these three groups of data, these parameters are:

- The mean value of all concentrations including negative values and values below LLD.

- The standard error of the mean.

- The lowest and highest concentration.

- The number of positive measurements (activity which is three times greater than the standard deviation) divided by the total number of measurements.

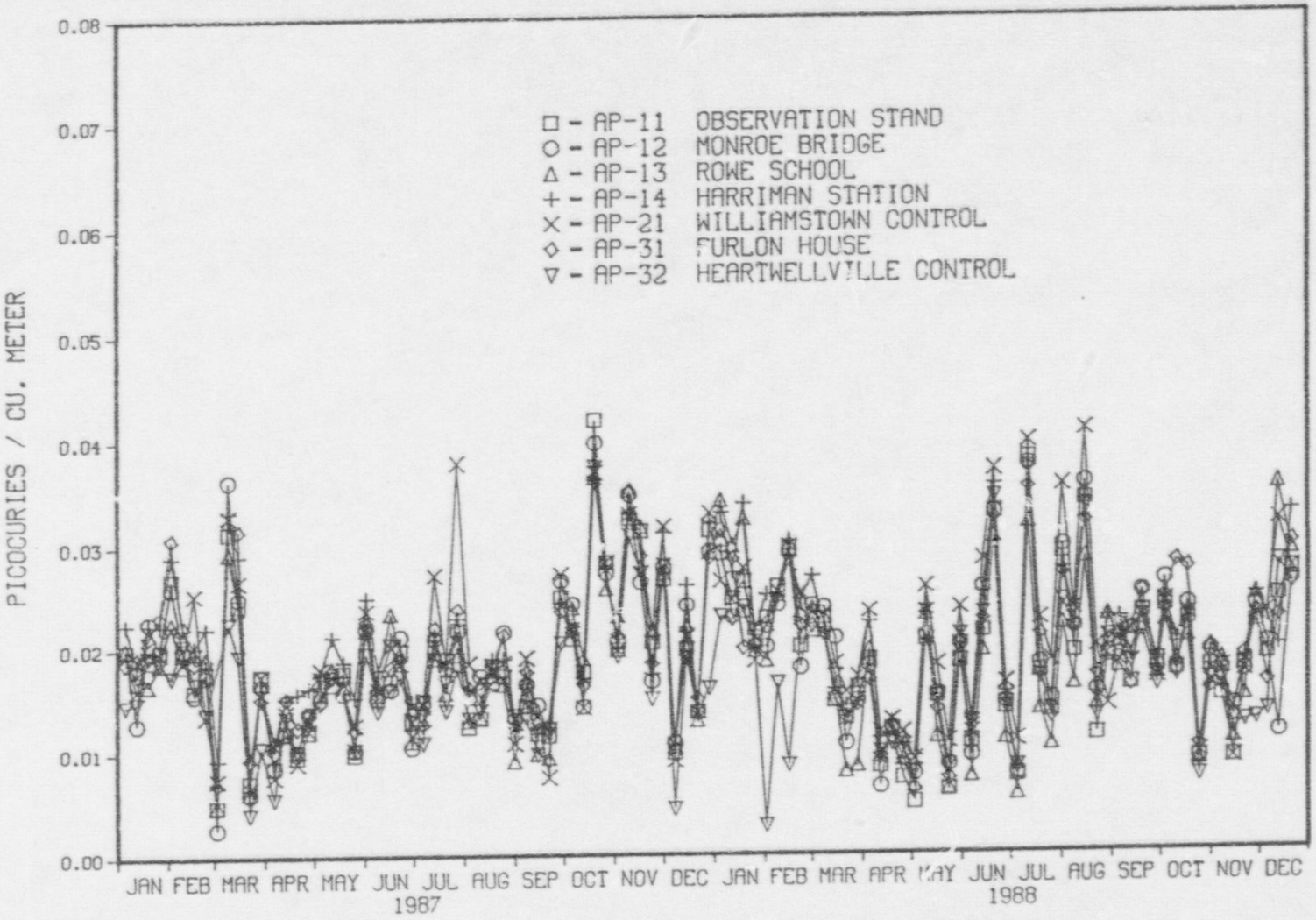
Each single radioactivity measurement datum in this report is based on a single measurement and is reported as a concentration plus or minus a one standard deviation uncertainty. The quoted uncertainty term represents only the random uncertainty associated with the radioactive decay process (counting statistics), and not the propagation of all possible uncertainties in the analytical procedure. Radioactivity is considered to be present in a sample when the concentration exceeds three times its associated standard deviation. With respect to the plots, all values less than three standard deviations (i.e., those where no radioactivity was detected) were plotted as zero.

## 3.1 Air Particulate

Air monitoring stations are established at a total of seven locations, five of which are required by the Radiological Effluent Technical Specifications. The air pumps at these locations operate continuously at a flow rate of approximately one cubic foot per minute. Airborne particulates are collected by passing the air through a glass-fiber filter. These filters are collected weekly and held for at least 100 hours before being analyzed for gross-beta activity (indicated as GR-B in tables) to allow for the decay of radon daughter products. Weekly composite air filters from each location are analyzed quarterly for gamma-emitting radionuclides.

Gross-beta analyses (Figure 3.1) show environmentally-induced fluctuations through much of the year at all sampling locations, including controls, thereby indicating that any plant contribution is negligible. One exception to this is a three-week period in February 1988 at Station AP-32 (Heartwellville Control) when the gross-beta measurements were unusually low. The first and lowest of the three weekly measurements was due apparently to a torn filter, which would allow some of the airborne particulate matter to bypass the filter. No explanation was arrived at for the other two weeks. (Station AP-32 is not required by Technical Specifications or the Off-Site Dose Calculation Manual.) Naturally occurring Be-7 was also detected in many samples.

FIGURE 3.1
GROSS BETA MEASUREMENTS OF AIR PARTICULATE FILTERS
YANKEE NUCLEAR POWER STATION, ROWE, MA



ENVIRONMENTAL RADIOLOGICAL PROGRAM SUMMARY
YANKEE NUCLEAR POWER STATION, ROWE, MA
(JANUARY - DECEMBER 1988)

MEDIUM: AIR PARTICULATE UNITS: PCI/CU. M

| RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)* | REQUIRED LLD | INDICATOR STATIONS ********** MEAN RANGE NO. DETECTED** | STATION WITH HIGHEST MEAN ********** STA. NO. | MEAN RANGE NO. DETECTED** | CONTROL STATIONS ********** MEAN RANGE NO. DETECTED** |
|---|---|---|---|---|---|
| AG-110M( 28) | | ( -3.0 ± 51.2)E -6 | 14 | ( 8.7 ± 11.4)E -5 | ( -1.2 ± 6.4)E -5 |
| ( 0) | | ( -6.4 - 4.2)E -4 | | ( -6.9 - 42.5)E -5 | ( -3.4 - 2.0)E -4 |
| | | *( 0/ 20)* | | *( 0/ 4)* | *( 0/ 8)* |
| RU-103 ( 28) | | ( 3.1 ± 50.7)E -6 | 21 | ( 1.6 ± 0.4)E -4 | ( 1.4 ± 0.7)E -4 |
| ( 0) | | ( -5.2 - 3.5)E -4 | | ( 9.5 - 23.3)E -5 | ( -9.8 - 51.5)E -5 |
| | | *( 0/ 20)* | | *( 0/ 4)* | *( 0/ 8)* |
| RU-106 ( 28) | | ( -3.8 ± 4.8)E -4 | 12 | ( 7.8 ± 11.0)E -4 | ( -3.3 ± 2.9)E -4 |
| ( 0) | | ( -5.7 - 3.3)E -3 | | ( -2.5 - 2.1)E -3 | ( -2.0 - 0.7)E -3 |
| | | *( 0/ 20)* | | *( 0/ 4)* | *( 0/ 8)* |
| CS-134 ( 28) | .05 | ( -3.7 ± 4.4)E -5 | 12 | ( 2.0 ± 1.7)E -4 | ( -1.6 ± 0.3)E -4 |
| ( 0) | | ( -2.5 - 6.7)E -4 | | ( -9.3 - 66.6)E -5 | ( -3.4 - -0.6)E -4 |
| | | *( 0/ 20)* | | *( 0/ 4)* | *( 0/ 8)* |
| CS-137 ( 28) | .06 | ( 5.2 ± 3.6)E -5 | 13 | ( 1.6 ± 0.9)E -4 | ( 2.1 ± 4.8)E -5 |
| ( 0) | | ( -2.0 - 3.6)E -4 | | ( -5.2 - 36.2)E -5 | ( -2.0 - 2.4)E -4 |
| | | *( 0/ 20)* | | *( 0/ 4)* | *( 0/ 8)* |
| BA-140 ( 28) | | ( -1.0 ± 3.3)E -4 | 13 | ( 1.2 ± 1.0)E -3 | ( 5.7 ± 15.2)E -5 |
| ( 0) | | ( -3.4 - 3.9)E -3 | | ( -7.7 - 38.7)E -4 | ( -5.4 - 5.1)E -4 |
| | | *( 0/ 20)* | | *( 0/ 4)* | *( 0/ 8)* |
| CE-141 ( 28) | | ( 8.6 ± 10.1)E -5 | 32 | ( 5.0 ± 2.3)E -4 | ( 1.9 ± 2.5)E -4 |
| ( 0) | | ( -4.7 - 14.2)E -4 | | ( -5.2 - 109.0)E -5 | ( -1.2 - 1.1)E -3 |
| | | *( 0/ 20)* | | *( 0/ 4)* | *( 0/ 8)* |
| CE-144 ( 28) | | ( 2.4 ± 17.1)E -5 | 21 | ( 1.3 ± 1.3)E -3 | ( 3.9 ± 7.3)E -4 |
| ( 0) | | ( -1.1 - 1.6)E -3 | | ( -4.9 - 50.1)E -4 | ( -2.0 - 5.0)E -3 |
| | | *( 0/ 20)* | | *( 0/ 4)* | *( 0/ 8)* |
| TH-232 ( 28) | | ( 3.2 ± 13.0)E -5 | 21 | ( 4.4 ± 4.8)E -4 | ( 3.2 ± 2.5)E -4 |
| ( 0) | | ( -1.4 - 1.1)E -3 | | ( -2.0 - 18.6)E -4 | ( -4.1 - 18.6)E -4 |
| | | *( 0/ 20)* | | *( 0/ 4)* | *( 0/ 8)* |

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT.

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3 STD DEVIATIONS) IS INDICATED WITH *( )*.

ENVIRONMENTAL RADIOLOGICAL PROGRAM SUMMARY
YANKEE NUCLEAR POWER STATION, ROWE, MA
(JANUARY - DECEMBER 1988)

MEDIUM: AIR PARTICULATE — UNITS: PCI/CU. M

| RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)* | REQUIRED LLD | INDICATOR STATIONS ********** MEAN RANGE NO. DETECTED** | STATION WITH HIGHEST MEAN ********** STA. NO. | MEAN RANGE NO. DETECTED** | CONTROL STATIONS ********** MEAN RANGE NO. DETECTED** |
|---|---|---|---|---|---|
| GR-B (364) | .01 | ( 2.0 ± 0.0)E -2 | 21 | ( 2.1 ± 0.1)E -2 | ( 2.0 ± 0.1)E -2 |
| ( 0) | | ( 4.9 - 38.0)E -3 | | ( 8.9 - 40.7)E -3 | ( 2.7 - 40.7)E -3 |
| | | *(260/260)* | | *( 52/ 52)* | *(104/104)* |
| BE-7 ( 28) | | ( 5.4 ± 0.3)E -2 | 21 | ( 6.1 ± 0.9)E -2 | ( 5.6 ± 0.6)E -2 |
| ( 0) | | ( 3.2 - 8.0)E -2 | | ( 4.1 - 8.5)E -2 | ( 3.5 - 8.5)E -2 |
| | | *( 20/ 20)* | | *( 4/ 4)* | *( 8/ 8)* |
| K-40 ( 28) | | ( 1.0 ± 0.8)E -3 | 13 | ( 2.8 ± 2.8)E -3 | ( 1.5 ± 0.7)E -3 |
| ( 0) | | ( -6.2 - 10.2)E -3 | | ( -3.0 - 10.2)E -3 | ( -1.6 - 3.5)E -3 |
| | | *( 0/ 20)* | | *( 0/ 4)* | *( 0/ 8)* |
| MN-54 ( 28) | | ( -4.5 ± 3.4)E -5 | 21 | ( 4.4 ± 14.0)E -5 | ( -8.5 ± 75.7)E -6 |
| ( 0) | | ( -4.4 - 1.6)E -4 | | ( -3.6 - 2.6)E -4 | ( -3.6 - 2.6)E -4 |
| | | *( 0/ 20)* | | *( 0/ 4)* | *( 0/ 8)* |
| CO-58 ( 28) | | ( -4.0 ± 53.0)E -6 | 31 | ( 1.0 ± 0.9)E -4 | ( -1.8 ± 6.1)E -5 |
| ( 0) | | ( -4.7 - 3.5)E -4 | | ( -9.4 - 35.1)E -5 | ( -2.5 - 1.8)E -4 |
| | | *( 0/ 20)* | | *( 0/ 4)* | 0/ 8)* |
| FE-59 ( 28) | | ( 2.6 ± 1.5)E -4 | 12 | ( 5.7 ± 4.0)E -4 | ( -1.7 ± 31.5)E -5 |
| ( 0) | | ( -1.4 - 1.7)E -3 | | ( -9.9 - 170.0)E -5 | ( -2.0 - 0.8)E -3 |
| | | *( 0/ 20)* | | *( 0/ 4)* | *( 0/ 8)* |
| CO-60 ( 28) | | ( 5.6 ± 587.5)E -7 | 13 | ( 9.3 ± 10.5)E -5 | ( -5.0 ± 5.0)E -5 |
| ( 0) | | ( -7.8 - 4.4)E -4 | | ( -1.4 - 3.7)E -4 | ( -2.1 - 2.5)E -4 |
| | | *( 0/ 20)* | | *( 0/ 4)* | *( 0/ 8)* |
| ZN-65 ( 28) | | ( 9.4 ± 92.8)E -6 | 11 | ( 2.6 ± 3.1)E -4 | ( 1.9 ± 1.4)E -4 |
| ( 0) | | ( -6.2 - 11.6)E -4 | | ( -2.1 - 11.6)E -4 | ( -4.0 - 7.7)E -4 |
| | | *( 0/ 20)* | | *( 0/ 4)* | *( 0/ 8)* |
| ZR-95 ( 28) | | ( -2.2 ± 0.7)E -4 | 13 | ( -7.3 ± 164.3)E -6 | ( -1.1 ± 0.9)E -4 |
| ( 0) | | ( -8.5 - 3.7)E -4 | | ( -4.3 - 3.7)E -4 | ( -4.7 - 2.6)E -4 |
| | | *( 0/ 20)* | | *( 0/ 4)* | *( 0/ 8)* |

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT.

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3 STD DEVIATIONS) IS INDICATED WITH *( )*.

## 3.2 Charcoal Filters

Charcoal filter cartridges are held in the air sampling filter head, downstream from the air particulate glass-fiber filters. Monitoring stations were located at a total of seven stations, five of which were required by the Technical Specifications. The air pumps at these locations operate continuously at a flow rate of approximately one cubic foot per minute.

Charcoal filters were collected and analyzed weekly for I-131 radioactivity. During 1988, no such radioactivity was detected.

ENVIRONMENTAL RADIOLOGICAL PROGRAM SUMMARY
YANKEE NUCLEAR POWER STATION, ROWE, MA
(JANUARY - DECEMBER 1988)

MEDIUM: CHARCOAL FILTER UNITS: PCI/CU. M

| RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)* | REQUIRED LLD | INDICATOR STATIONS MEAN RANGE NO. DETECTED** | STATION WITH HIGHEST MEAN STA. NO. | MEAN RANGE NO. DETECTED** | CONTROL STATIONS MEAN RANGE NO. DETECTED** |
|---|---|---|---|---|---|
| I-131 (364) | .07 | ( -4.7 ± 531.9)E -6 | 21 | ( 1.9 ± 1.2)E -3 | ( 6.4 ± 7.3)E -4 |
| ( 0) | | ( -2.4 - 2.2)E -2 | | ( -1.6 - 2.9)E -2 | ( -1.9 - 2.9)E -2 |
| | | *( 0/260)* | | *( 0/ 52)* | *( 0/104)* |

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT.

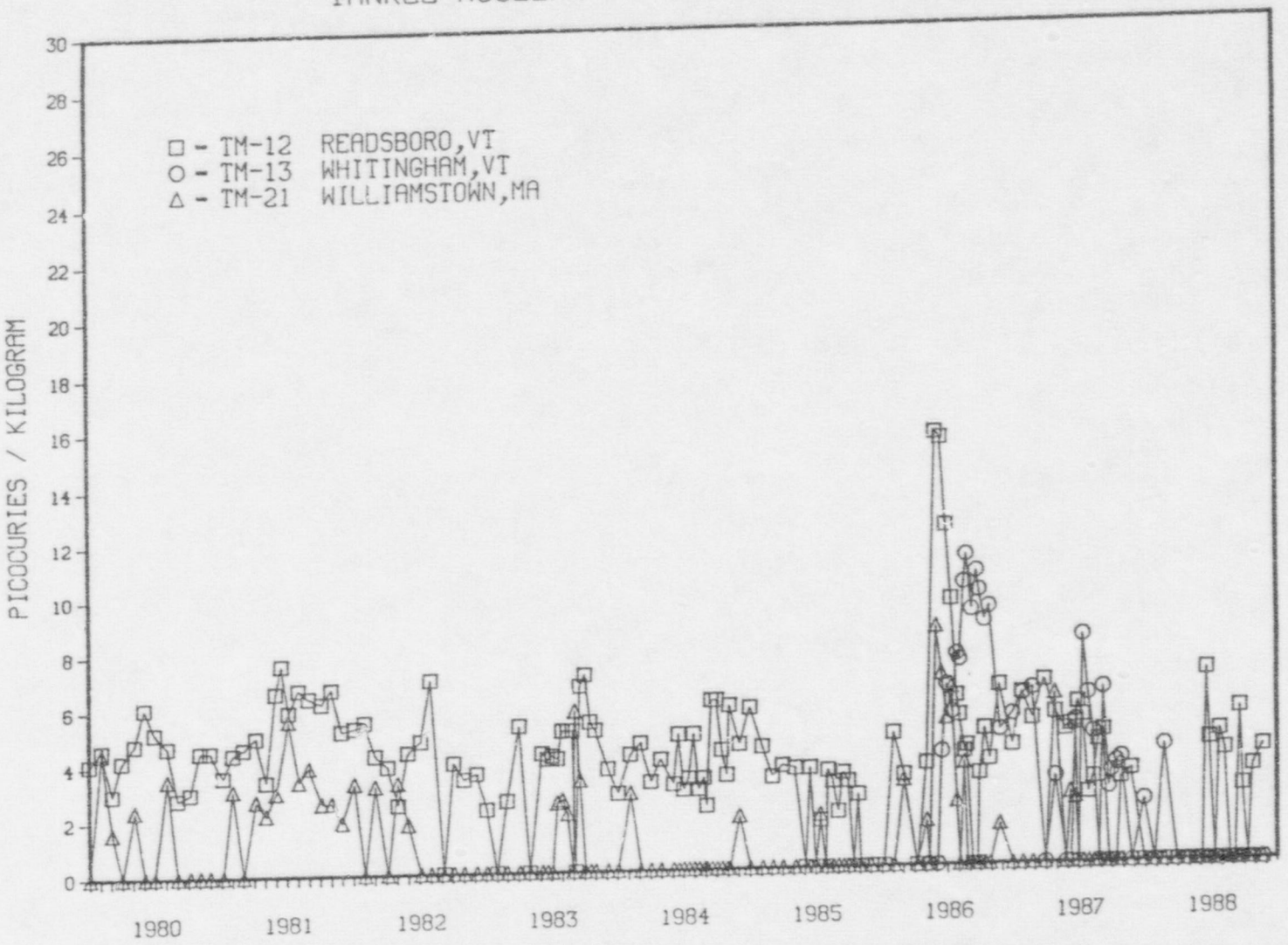
** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3 STD DEVIATIONS) IS INDICATED WITH *( )*.

## 3.3 Milk

Milk samples were collected and analyzed by the schedule shown in Table 2.1. Strontium 89 and Sr-90 analyses were also performed on quarterly composite milk samples (not required by Technical Specifications).

Detectable concentrations of Cs-137 and Sr-90 were measured in many milk samples submitted during 1988. The higher concentration in indicator station samples has been noted for many years. It has been shown in previous reports that the radioactivity in the cows' milk is a result of atmospheric nuclear weapons testing radionuclides that persist in the environment (Cs-137 and Sr-90 in particular). Differences in farming practices (amount of vegetation and type of vegetation that the cows are allowed to feed on) can cause significant variations in these radionuclides in milk. The levels of Cs-137 detected at indicator stations during 1988 is consistent with that detected in previous years. Additional Cs-137 was introduced into the environment in mid-1986 following the Chernobyl accident. A slight rise in Cs-137 levels in milk can be seen for this period in Figure 3.2.

FIGURE 3.2
CESIUM-137 IN MILK
YANKEE NUCLEAR POWER STATION, ROWE, MA



ENVIRONMENTAL RADIOLOGICAL PROGRAM SUMMARY
YANKEE NUCLEAR POWER STATION, ROWE, MA
(JANUARY - DECEMBER 1988)

MEDIUM: MILK UNITS: PCI/KG

| RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)* | REQUIRED LLD | INDICATOR STATIONS MEAN RANGE NO. DETECTED** | STATION WITH HIGHEST MEAN STA. NO. | MEAN RANGE NO. DETECTED** | CONTROL STATIONS MEAN RANGE NO. DETECTED** |
|---|---|---|---|---|---|
| SR-89 ( 12) | | ( -1.4 ± 3.8)E -1 | 13 | ( 8.0 ± 44.0)E -2 | ( -3.5 ± 1.5)E 0 |
| ( 0) | | ( -1.5 - 1.4)E 0 | | ( -9.0 - 12.3)E -1 | ( -7.1 - -0.2)E 0 |
| | | *( 0/ 8)* | | *( 0/ 4)* | *( 0/ 4)* |
| SR-90 ( 12) | | ( 3.0 ± 0.4)E 0 | 12 | ( 3.7 ± 0.5)E 0 | ( 2.3 ± 0.8)E 0 |
| ( 0) | | ( 1.5 - 4.8)E 0 | | ( 2.8 - 4.8)E 0 | ( 3.0 - 42.4)E -1 |
| | | *( 8/ 8)* | | *( 4/ 4)* | *( 3/ 4)* |
| K-40 ( 57) | | ( 1.4 ± 0.0)E 3 | 13 | ( 1.4 ± 0.0)E 3 | ( 1.3 ± 0.0)E 3 |
| ( 0) | | ( 1.1 - 1.6)E 3 | | ( 1.3 - 1.5)E 3 | ( 1.2 - 1.5)E 3 |
| | | *( 38/ 38)* | | *( 19/ 19)* | *( 19/ 19)* |
| MN-54 ( 57) | | ( 1.6 ± 2.4)E -1 | 12 | ( 4.7 ± 3.0)E -1 | ( -4.4 ± 3.7)E -1 |
| ( 0) | | ( -4.5 - 4.7)E 0 | | ( -1.4 - 4.7)E 0 | ( -5.8 - 2.2)E 0 |
| | | *( 0/ 38)* | | *( 0/ 19)* | *( 0/ 19)* |
| CO-58 ( 57) | | ( 5.2 ± 19.0)E -2 | 13 | ( 1.2 ± 2.6)E -1 | ( -2.5 ± 2.4)E -1 |
| ( 0) | | ( -2.7 - 2.0)E 0 | | ( -2.0 - 1.8)E 0 | ( -2.1 - 2.0)E 0 |
| | | *( 0/ 38)* | | *( 0/ 19)* | *( 0/ 19)* |
| FE-59 ( 57) | | ( 6.4 ± 4.5)E -1 | 12 | ( 1.1 ± 0.6)E 0 | ( -3.5 ± 6.5)E -1 |
| ( 0) | | ( -6.3 - 8.8)E 0 | | ( -3.4 - 8.8)E 0 | ( -5.6 - 5.8)E 0 |
| | | *( 0/ 38)* | | *( 0/ 19)* | *( 0/ 19)* |
| CO-60 ( 57) | | ( -4.8 ± 2.5)E -1 | 13 | ( -2.2 ± 3.5)E -1 | ( -6.8 ± 3.3)E -1 |
| ( 0) | | ( -4.9 - 2.9)E 0 | | ( -2.5 - 2.9)E 0 | ( -2.7 - 2.9)E 0 |
| | | *( 0/ 38)* | | *( 0/ 19)* | *( 0/ 19)* |
| ZN-65 ( 57) | | ( -8.9 ± 5.7)E -1 | 21 | ( 2.7 ± 6.1)E -1 | ( 2.7 ± 6.1)E -1 |
| ( 0) | | ( -7.8 - 6.4)E 0 | | ( -5.6 - 5.2)E 0 | ( -5.6 - 5.2)E 0 |
| | | *( 0/ 38)* | | *( 0/ 19)* | *( 0/ 19)* |
| ZR-95 ( 57) | | ( -7.0 ± 3.5)E -1 | 21 | ( 9.1 ± 4.7)E -1 | ( 9.1 ± 4.7)E -1 |
| ( 0) | | ( -5.0 - 3.8)E 0 | | ( -2.0 - 5.4)E 0 | ( -2.0 - 5.4)E 0 |
| | | *( 0/ 38)* | | *( 0/ 19)* | *( 0/ 19)* |

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT.

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3 STD DEVIATIONS) IS INDICATED WITH *( )*.

ENVIRONMENTAL RADIOLOGICAL PROGRAM SUMMARY
YANKEE NUCLEAR POWER STATION, ROWE, MA
(JANUARY - DECEMBER 1988)

MEDIUM: MILK UNITS: PCI/KG

| RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)* | REQUIRED LLD | INDICATOR STATIONS ********** MEAN RANGE NO. DETECTED** | STATION WITH HIGHEST MEAN ********** STA. NO. | MEAN RANGE NO. DETECTED** | CONTROL STATIONS ********** MEAN RANGE NO. DETECTED** |
|---|---|---|---|---|---|
| AG-110M( 57) | | ( 5.3 ± 305.2)E -3 | 12 | ( 3.6 ± 4.5)E -1 | ( -1.7 ± 3.2)E -1 |
| ( 0) | | ( -5.1 - 4.9)E 0 | | ( -3.3 - 4.9)E 0 | ( -3.8 - 1.6)E 0 |
| | | *( 0/ 38)* | | *( 0/ 19)* | *( 0/ 19)* |
| RU-103 ( 57) | | ( -1.2 ± 0.2)E 0 | 21 | ( -2.2 ± 3.6)E -1 | ( -2.2 ± 3.6)E -1 |
| ( 0) | | ( -3.5 - 1.1)E 0 | | ( -3.4 - 2.0)E 0 | ( -3.4 - 2.0)E 0 |
| | | *( 0/ 38)* | | *( 0/ 19)* | *( 0/ 19)* |
| RU-106 ( 57) | | ( -5.4 ± 15.7)E -1 | 21 | ( 6.1 ± 20.0)E -1 | ( 6.1 ± 20.0)E -1 |
| ( 0) | | ( -2.5 - 2.6)E 1 | | ( -2.7 - 1.2)E 1 | ( -2.7 - 1.2)E 1 |
| | | *( 0/ 38)* | | *( 0/ 19)* | *( 0/ 19)* |
| I-131 ( 57) | 1. | ( 8.4 ± 2.4)E -2 | 12 | ( 9.3 ± 3.2)E -2 | ( -1.5 ± 23.0)E -3 |
| ( 0) | | ( -1.5 - 6.1)E -1 | | ( -1.5 - 3.5)E -1 | ( -3.2 - 1.3)E -1 |
| | | *( 0/ 38)* | | *( 0/ 19)* | *( 0/ 19)* |
| CS-134 ( 57) | 15. | ( -8.1 ± 1.5)E -1 | 13 | ( -7.8 ± 2.3)E -1 | ( -1.2 ± 0.2)E 0 |
| ( 0) | | ( -3.0 - 1.0)E 0 | | ( -3.0 - 0.9)E 0 | ( -2.4 - 0.2)E 0 |
| | | *( 0/ 38)* | | *( 0/ 19)* | *( 0/ 19)* |
| CS-137 ( 57) | 18. | ( 2.6 ± 0.2)E 0 | 12 | ( 3.0 ± 0.4)E 0 | ( 8.7 ± 2.2)E -1 |
| ( 0) | | ( 1.1 - 69.3)E -1 | | ( 1.1 - 69.3)E -1 | ( -9.6 - 26.9)E -1 |
| | | *( 10/ 38)* | | *( 8/ 19)* | *( 0/ 19)* |
| BA-140 ( 57) | 15. | ( -3.1 ± 4.2)E -1 | 21 | ( -4.7 ± 39.6)E -2 | ( -4.7 ± 39.6)E -2 |
| ( 0) | | ( -5.7 - 4.3)E 0 | | ( -3.7 - 3.2)E 0 | ( -3.7 - 3.2)E 0 |
| | | *( 0/ 38)* | | *( 0/ 19)* | *( 0/ 19)* |
| CE-141 ( 57) | | ( -3.3 ± 2.9)E -1 | 21 | ( 1.5 ± 6.1)E -1 | ( 1.5 ± 6.1)E -1 |
| ( 0) | | ( -3.5 - 4.3)E 0 | | ( -5.8 - 4.3)E 0 | ( -5.8 - 4.3)E 0 |
| | | *( 0/ 38)* | | *( 0/ 19)* | *( 0/ 19)* |
| CE-144 ( 57) | | ( -2.8 ± 1.2)E 0 | 21 | ( 2.2 ± 15.1)E -1 | ( 2.2 ± 15.1)E -1 |
| ( 0) | | ( -2.2 - 1.7)E 1 | | ( -1.1 - 1.6)E 1 | ( -1.1 - 1.6)E 1 |
| | | *( 0/ 38)* | | *( 0/ 19)* | *( 0/ 19)* |

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT.

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3 STD DEVIATIONS) IS INDICATED WITH *( )*.

## 3.4 Food Crop

Kale or tomato samples were collected at harvest time at the three locations and analyzed for gamma-emitting nuclides. Other than naturally occurring K-40, no radionuclides were detected in the samples. Three maple syrup samples were collected in 1988 and are discussed in Section 3.6.

ENVIRONMENTAL RADIOLOGICAL PROGRAM SUMMARY
YANKEE NUCLEAR POWER STATION, ROWE, MA
(JANUARY - DECEMBER 1988)

MEDIUM: FOOD CROP UNITS: PCI/KG WET

| RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)* | REQUIRED LLD | INDICATOR STATIONS ********** MEAN RANGE NO. DETECTED** | STATION WITH HIGHEST MEAN ********** STA. NO | MEAN RANGE NO. DETECTED** | CONTROL STATIONS ********** MEAN RANGE NO. DETECTED** |
|---|---|---|---|---|---|
| BE-7 ( 3) | | ( -7.3 ± 48.4)E 0 | 11 | ( 4.1 ± 10.1)E 1 | ( -6.5 ± 8.3)E 1 |
| ( 0) | | ( -5.6 - 4.1)E 1 | | | |
| | | *( 0/ 2)* | | *( 0/ 1)* | *( 0/ 1)* |
| K-40 ( 3) | | ( 2.8 ± 1.0)E 3 | 11 | ( 3.7 ± 0.3)E 3 | ( 2.4 ± 0.4)E 3 |
| ( 0) | | ( 1.8 - 3.8)E 3 | | | |
| | | *( 2/ 2)* | | *( 1/ 1)* | *( 1/ 1)* |
| MN-54 ( 3) | | ( 8.2 ± 3.9)E 0 | 11 | ( 1.2 ± 1.3)E 1 | ( -1.6 ± 1.1)E 1 |
| ( 0) | | ( 4.4 - 12.1)E 0 | | | |
| | | *( 0/ 2)* | | *( 0/ 1)* | *( 0/ 1)* |
| CO-58 ( 3) | | ( -1.1 ± 0.3)E 1 | 21 | ( -2.7 ± 9.5)E 0 | ( -2.7 ± 9.5)E 0 |
| ( 0) | | ( -1.4 - -0.8)E 1 | | | |
| | | *( 0/ 2)* | | *( 0/ 1)* | *( 0/ 1)* |
| FE-59 ( 3) | | ( -2.0 ± 9.6)E 0 | 21 | ( 2.5 ± 2.4)E 1 | ( 2.5 ± 2.4)E 1 |
| ( 0) | | ( -1.1 - 0.8)E 1 | | | |
| | | *( 0/ 2)* | | *( 0/ 1)* | *( 0/ 1)* |
| CO-60 ( 3) | | ( -2.0 ± 1.2)E 1 | 21 | ( 2.6 ± 18.8)E 0 | ( 2.6 ± 18.8)E 0 |
| ( 0) | | ( -3.2 - -0.8)E 1 | | | |
| | | *( 0/ 2)* | | *( 0/ 1)* | *( 0/ 1)* |
| ZN-65 ( 3) | | ( -8.2 ± 28.3)E 0 | 11 | ( 2.0 ± 3.1)E 1 | ( 4.9 ± 26.4)E 0 |
| ( 0) | | ( -3.7 - 2.0)E 1 | | | |
| | | *( 0/ 2)* | | *( 0/ 1)* | *( 0/ 1)* |
| ZR-95 ( 3) | | ( 1.4 ± 0.9)E 1 | 13 | ( 2.3 ± 2.2)E 1 | ( 2.0 ± 1.9)E 1 |
| ( 0) | | ( 5.1 - 23.6)E 0 | | | |
| | | *( 0/ 2)* | | *( 0/ 1)* | *( 0/ 1)* |
| AG-110M( 3) | | ( 8.7 ± 17.3)E 0 | 11 | ( 2.6 ± 2.0)E 1 | ( -3.7 ± 13.4)E 0 |
| ( 0) | | ( -8.6 - 26.1)E 0 | | | |
| | | *( 0/ 2)* | | *( 0/ 1)* | *( 0/ 1)* |

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT.

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3 STD DEVIATIONS) IS INDICATED WITH *( )*.

ENVIRONMENTAL RADIOLOGICAL PROGRAM SUMMARY
YANKEE NUCLEAR POWER STATION, ROWE, MA
(JANUARY - DECEMBER 1988)

MEDIUM: FOOD CROP UNITS: PCI/KG WET

| RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)* | REQUIRED LLD | INDICATOR STATIONS MEAN RANGE NO. DETECTED** | STATION WITH HIGHEST MEAN STA. NO. | MEAN RANGE NO. DETECTED** | CONTROL STATIONS MEAN RANGE NO. DETECTED** |
|---|---|---|---|---|---|
| RU-103 ( 3) | | ( -2.0 ± 10.0)E 0 | 13 | ( 8.0 ± 10.6)E 0 | ( -3.6 ± 9.4)E 0 |
| ( 0) | | ( -1.2 - 0.8)E 1 | | | |
| | | *( 0/ 2)* | | *( 0/ 1)* | *( 0/ 1)* |
| RU-106 ( 3) | | ( 5.7 ± 1.5)E 1 | 13 | ( 7.2 ± 10.4)E 1 | ( -7.7 ± 9.4)E 1 |
| ( 0) | | ( 4.2 - 7.2)E 1 | | | |
| | | *( 0/ 2)* | | *( 0/ 1)* | *( 0/ 1)* |
| I-131 ( 3) | | ( -5.4 ± 17.6)E 0 | 13 | ( 1.2 ± 1.6)E 1 | ( 4.7 ± 17.1)E 0 |
| ( 0) | | ( -2.3 - 1.2)E 1 | | | |
| | | *( 0/ 2)* | | *( 0/ 1)* | *( 0/ 1)* |
| CS-134 ( 3) | 60. | ( -9.7 ± 13.5)E 0 | 13 | ( 3.8 ± 13.0)E 0 | ( -3.3 ± 1.3)E 1 |
| ( 0) | | ( -2.3 - 0.4)E 1 | | | |
| | | *( 0/ 2)* | | *( 0/ 1)* | *( 0/ 1)* |
| CS-137 ( 3) | 80. | ( -4.9 ± 5.6)E 0 | 13 | ( 6.0 ± 113.0)E -1 | ( -2.3 ± 1.0)E 1 |
| ( 0) | | ( -1.0 - 0.1)E 1 | | | |
| | | *( 0/ 2)* | | *( 0/ 1)* | *( 0/ 1)* |
| BA-140 ( 3) | | ( -2.9 ± 0.4)E 1 | 21 | ( 2.0 ± 1.6)E 1 | ( 2.0 ± 1.6)E 1 |
| ( 0) | | ( -3.2 - -2.5)E 1 | | | |
| | | *( 0/ 2)* | | *( 0/ 1)* | *( 0/ 1)* |
| CE-141 ( 3) | | ( 8.5 ± 14.6)E 0 | 11 | ( 2.3 ± 1.9)E 1 | ( 1.1 ± 1.5)E 1 |
| ( 0) | | ( -6.1 - 23.1)E 0 | | | |
| | | *( 0/ 2)* | | *( 0/ 1)* | *( 0/ 1)* |
| CE-144 ( 3) | | ( -2.4 ± 2.8)E 1 | 11 | ( 3.9 ± 69.2)E 0 | ( -4.0 ± 5.3)E 1 |
| ( 0) | | ( -5.2 - 0.4)E 1 | | | |
| | | *( 0/ 2)* | | *( 0/ 1)* | *( 0/ 1)* |
| TH-232 ( 3) | | ( -1.8 ± 1.8)E 1 | 13 | ( 1.1 ± 523.0)E -1 | ( -3.8 ± 53.4)E 0 |
| ( 0) | | ( -3.6 - 0.0)E 1 | | | |
| | | *( 0/ 2)* | | *( 0/ 1)* | *( 0/ 1)* |

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT.

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3 STD DEVIATIONS) IS INDICATED WITH *( )*.

## 3.5 Broad Leaf Vegetation

The Radiological Effluent Technical Specifications require that one sample of broad leaf vegetation be sampled at harvest time. In 1988, a sample of kale was collected from Station TV-11. The required I-131 analysis showed no detectable radioactivity.

ENVIRONMENTAL RADIOLOGICAL PROGRAM SUMMARY
YANKEE NUCLEAR POWER STATION, ROWE, MA
(JANUARY - DECEMBER 1988)

MEDIUM: BROADLEAF VEGETATION UNITS: PCI/KG WET

| RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)* | REQUIRED LLD | INDICATOR STATIONS ********** MEAN RANGE NO. DETECTED** | STATION WITH HIGHEST MEAN ********** STA. NO. | MEAN RANGE NO. DETECTED** | CONTROL STATIONS ********** MEAN RANGE NO. DETECTED** |
|---|---|---|---|---|---|
| I-131 ( 1) ( 0) | 60. | ( 2.5 ± 2.0)E 0 *( 0/ 1)* | 11 | ( 2.5 ± 2.0)E 0 *( 0/ 1)* | NO DATA |

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT.

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3 STD DEVIATIONS) IS INDICATED WITH *( )*.

## 3.6 Maple Syrup

Maple syrup grab samples (not required by Technical Specifications) were collected during April at two indicator and one control location. In addition to naturally occurring K-40 and Th-232, Cs-137 was detected in each sample. Attributed to nuclear weapons testing fallout, this Cs-137 has been detected in most samples since collection was started in 1972. The control station in 1988 had a higher Cs-137 level than detected at either of the indicator stations.

ENVIRONMENTAL RADIOLOGICAL PROGRAM SUMMARY
YANKEE NUCLEAR POWER STATION, ROWE, MA
(JANUARY - DECEMBER 1988)

MEDIUM: MAPLE SYRUP UNITS: PCI/KG

| RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)* | REQUIRED LLD | INDICATOR STATIONS MEAN RANGE NO. DETECTED** | STATION WITH HIGHEST MEAN STA. NO. | MEAN RANGE NO. DETECTED** | CONTROL STATIONS MEAN RANGE NO. DETECTED** |
|---|---|---|---|---|---|
| BE-7 ( 3) | | ( 8.6 ± 2.4)E 0 | 42 | ( 2.0 ± 1.0)E 1 | ( 2.0 ± 1.0)E 1 |
| ( 0) | | ( 6.2 - 11.0)E 0 | | | |
| | | *( 0/ 2)* | | *( 0/ 1)* | *( 0/ 1)* |
| K-40 ( 3) | | ( 1.8 ± 0.0)E 3 | 33 | ( 1.8 ± 0.0)E 3 | ( 1.6 ± 0.1)E 3 |
| ( 0) | | ( 1.7 - 1.8)E 3 | | | |
| | | *( 2/ 2)* | | *( 1/ 1)* | *( 1/ 1)* |
| MN-54 ( 3) | | ( -2.0 ± 0.0)E 0 | 42 | ( 1.4 ± 1.1)E 0 | ( 1.4 ± 1.1)E 0 |
| ( 0) | | ( -2.0 - -2.0)E 0 | | | |
| | | *( 0/ 2)* | | *( 0/ 1)* | *( 0/ 1)* |
| CO-58 ( 3) | | ( 7.7 ± 4.3)E -1 | 32 | ( 1.2 ± 1.0)E 0 | ( -5.2 ± 11.8)E -1 |
| ( 0) | | ( 3.3 - 12.0)E -1 | | | |
| | | *( 0/ 2)* | | *( 0/ 1)* | *( 0/ 1)* |
| FE-59 ( 3) | | ( 1.6 ± 1.6)E 0 | 32 | ( 3.2 ± 3.2)E 0 | ( 1.5 ± 2.7)E 0 |
| ( 0) | | ( 3.2 - 315.0)E -2 | | | |
| | | *( 0/ 2)* | | *( 0/ 1)* | *( 0/ 1)* |
| CO-60 ( 3) | | ( 5.6 ± 3.2)E -1 | 33 | ( 8.8 ± 13.1)E -1 | ( -5.1 ± 14.4)E -1 |
| ( 0) | | ( 2.3 - 8.8)E -1 | | | |
| | | *( 0/ 2)* | | *( 0/ 1)* | *( 0/ 1)* |
| ZN-65 ( 3) | | ( 1.4 ± 2.0)E 0 | 32 | ( 3.5 ± 3.1)E 0 | ( -4.2 ± 27.4)E -1 |
| ( 0) | | ( -6.3 - 34.6)E -1 | | | |
| | | *( 0/ 2)* | | *( 0/ 1)* | *( 0/ 1)* |
| ZR-95 ( 3) | | ( 9.0 ± 11.1)E -1 | 32 | ( 2.0 ± 1.8)E 0 | ( -2.6 ± 2.0)E 0 |
| ( 0) | | ( -2.1 - 20.2)E -1 | | | |
| | | *( 0/ 2)* | | *( 0/ 1)* | *( 0/ 1)* |
| AG-110M( 3) | | ( 1.7 ± 1.0)E 0 | 32 | ( 2.6 ± 2.0)E 0 | ( 7.0 ± 15.5)E -1 |
| ( 0) | | ( 7.2 - 26.4)E -1 | | | |
| | | *( 0/ 2)* | | *( 0/ 1)* | *( 0/ 1)* |

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT.

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3 STD DEVIATIONS) IS INDICATED WITH *( )*.

ENVIRONMENTAL RADIOLOGICAL PROGRAM SUMMARY
YANKEE NUCLEAR POWER STATION, ROWE, MA
(JANUARY - DECEMBER 1988)

MEDIUM: MAPLE SYRUP UNITS: PCI/KG

| RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)* | REQUIRED LLD | INDICATOR STATIONS MEAN RANGE NO. DETECTED** | STATION WITH HIGHEST MEAN STA. NO. | MEAN RANGE NO. DETECTED** | CONTROL STATIONS MEAN RANGE NO. DETECTED** |
|---|---|---|---|---|---|
| RU-103 ( 3) | | ( -3.7 ± 6.2)E -1 | 33 | ( 2.5 ± 8.7)E -1 | ( -4.9 ± 11.6)E -1 |
| ( 0) | | ( -9.8 - 2.5)E -1 | | | |
| | | *( 0/ 2)* | | *( 0/ 1)* | *( 0/ 1)* |
| RU-106 ( 3) | | ( 1.7 ± 2.9)E 0 | 32 | ( 4.6 ± 9.2)E 0 | ( 1.7 ± 10.6)E 0 |
| ( 0) | | ( -1.2 - 4.6)E 0 | | | |
| | | *( 0/ 2)* | | *( 0/ 1)* | *( 0/ 1)* |
| I-131 ( 3) | | ( 8.5 ± 0.5)E -1 | 33 | ( 9.0 ± 11.7)E -1 | ( -8.7 ± 177.0)E -2 |
| ( 0) | | ( 8.0 - 9.0)E -1 | | | |
| | | *( 0/ 2)* | | *( 0/ 1)* | *( 0/ 1)* |
| CS-134 ( 3) | | ( -9.4 ± 1.5)E -1 | 42 | ( 1.4 ± 12.1)E -1 | ( 1.4 ± 12.1)E -1 |
| ( 0) | | ( -1.1 - -0.8)E 0 | | | |
| | | *( 0/ 2)* | | *( 0/ 1)* | *( 0/ 1)* |
| CS-137 ( 3) | | ( 2.2 ± 0.8)E 1 | 42 | ( 1.2 ± 0.0)E 2 | ( 1.2 ± 0.0)E 2 |
| ( 0) | | ( 1.4 - 3.0)E 1 | | | |
| | | *( 2/ 2)* | | *( 1/ 1)* | *( 1/ 1)* |
| BA-140 ( 3) | | ( 1.2 ± 5.5)E -1 | 42 | ( 7.8 ± 12.5)E -1 | ( 7.8 ± 12.5)E -1 |
| ( 0) | | ( -4.3 - 6.7)E -1 | | | |
| | | *( 0/ 2)* | | *( 0/ 1)* | *( 0/ 1)* |
| CE-141 ( 3) | | ( -1.9 ± 0.9)E 0 | 33 | ( -1.0 ± 1.5)E 0 | ( -2.4 ± 2.0)E 0 |
| ( 0) | | ( -2.8 - -1.0)E 0 | | | |
| | | *( 0/ 2)* | | *( 0/ 1)* | *( 0/ 1)* |
| CE-144 ( 3) | | ( -4.6 ± 4.1)E 0 | 33 | ( -5.7 ± 63.8)E -1 | ( -4.4 ± 8.2)E 0 |
| ( 0) | | ( -8.7 - -0.6)E 0 | | | |
| | | *( 0/ 2)* | | *( 0/ 1)* | *( 0/ 1)* |
| TH-232 ( 3) | | ( 9.5 ± 3.9)E 0 | 33 | ( 1.3 ± 0.4)E 1 | ( 4.2 ± 4.6)E 0 |
| ( 0) | | ( 5.6 - 13.4)E 0 | | | |
| | | *( 1/ 2)* | | *( 1/ 1)* | *( 0/ 1)* |

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT.

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3 STD DEVIATIONS) IS INDICATED WITH *( )*.

## 3.7 Groundwater

Groundwater grab samples were collected from two indicator stations on a monthly basis. (Technical Specifications require a quarterly collection.) Each of these samples was analyzed for gross-beta, H-3, and gamma-emitting radionuclides.

Tritium (H-3) was detected in all of the Station WG-12 samples and none of those from Station WG-11. Since the water from WG-12 (Sherman Spring) is not used for drinking water, and since the Deerfield River into which it empties is also not used for drinking, there would be no impact on man from the low levels detected. In any case, the calculated critical organ (total body) dose to an average child who is assumed to ingest 260 kilograms per year of this water (undiluted) at the average 1988 concentration of 820 pCi/kilogram, would be approximately 0.04 mrem, using USNRC Regulatory Guide 1.109 methodology (Reference 1). The maximum monthly concentration of 1,260 pCi/kg in April of 1988 did not exceed the 30,000 pCi/kg reporting level for H-3 in water. The annual mean H-3 concentration has decreased steadily for most of the past ten years (see Figure 3.3).

Gross-beta radioactivity was detected in all groundwater samples. Caused primarily by naturally occurring radionuclides in groundwater, the gross-beta levels were similar to those of the past several years (see Figure 3.4).

No gamma-emitting radionuclides were detected in the groundwater samples.

FIGURE 3.3
TRITIUM IN SHERMAN SPRING WATER (WG-12)
(QUARTERLY AVERAGE)
YANKEE NUCLEAR POWER STATION, ROWE, MA

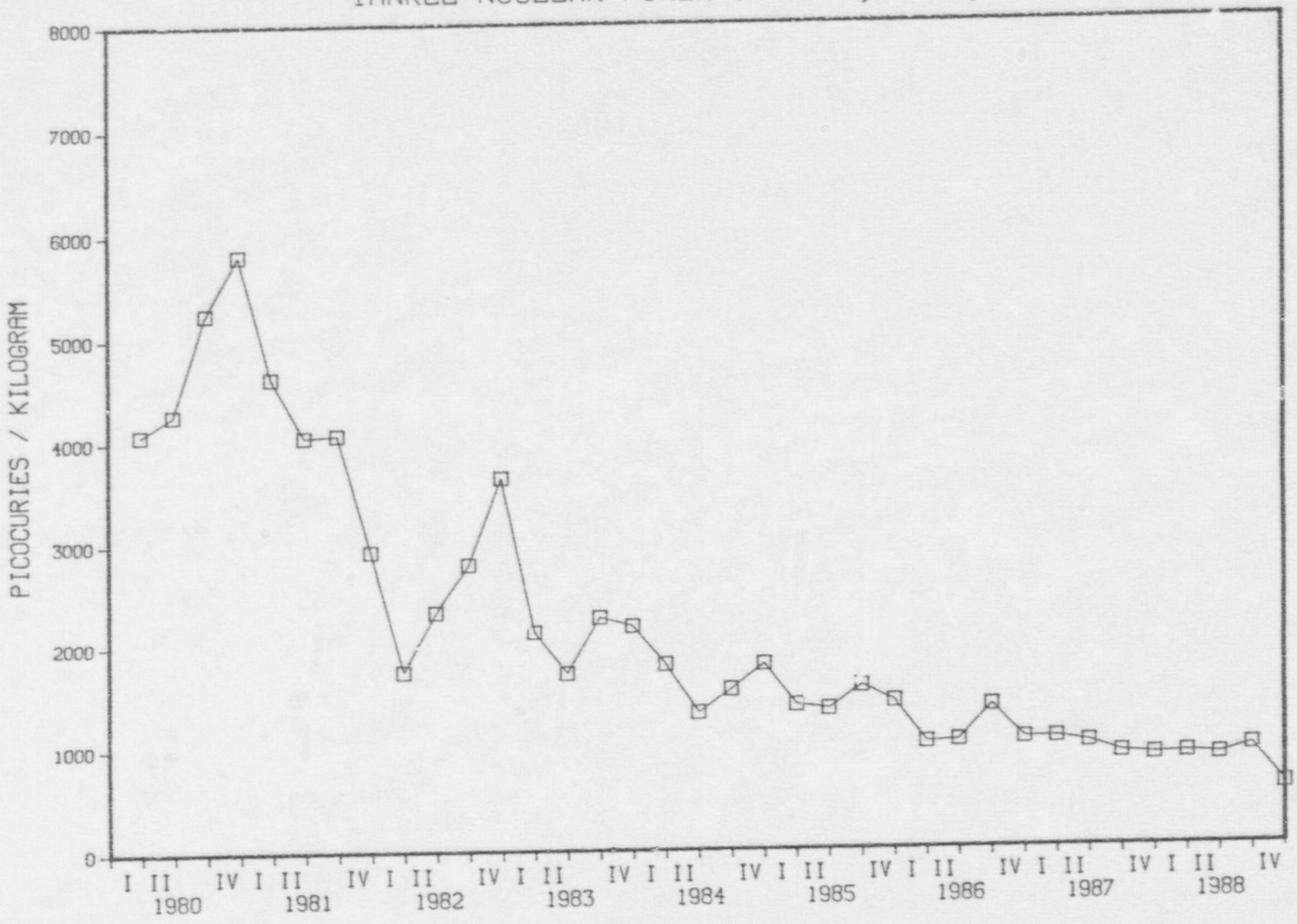
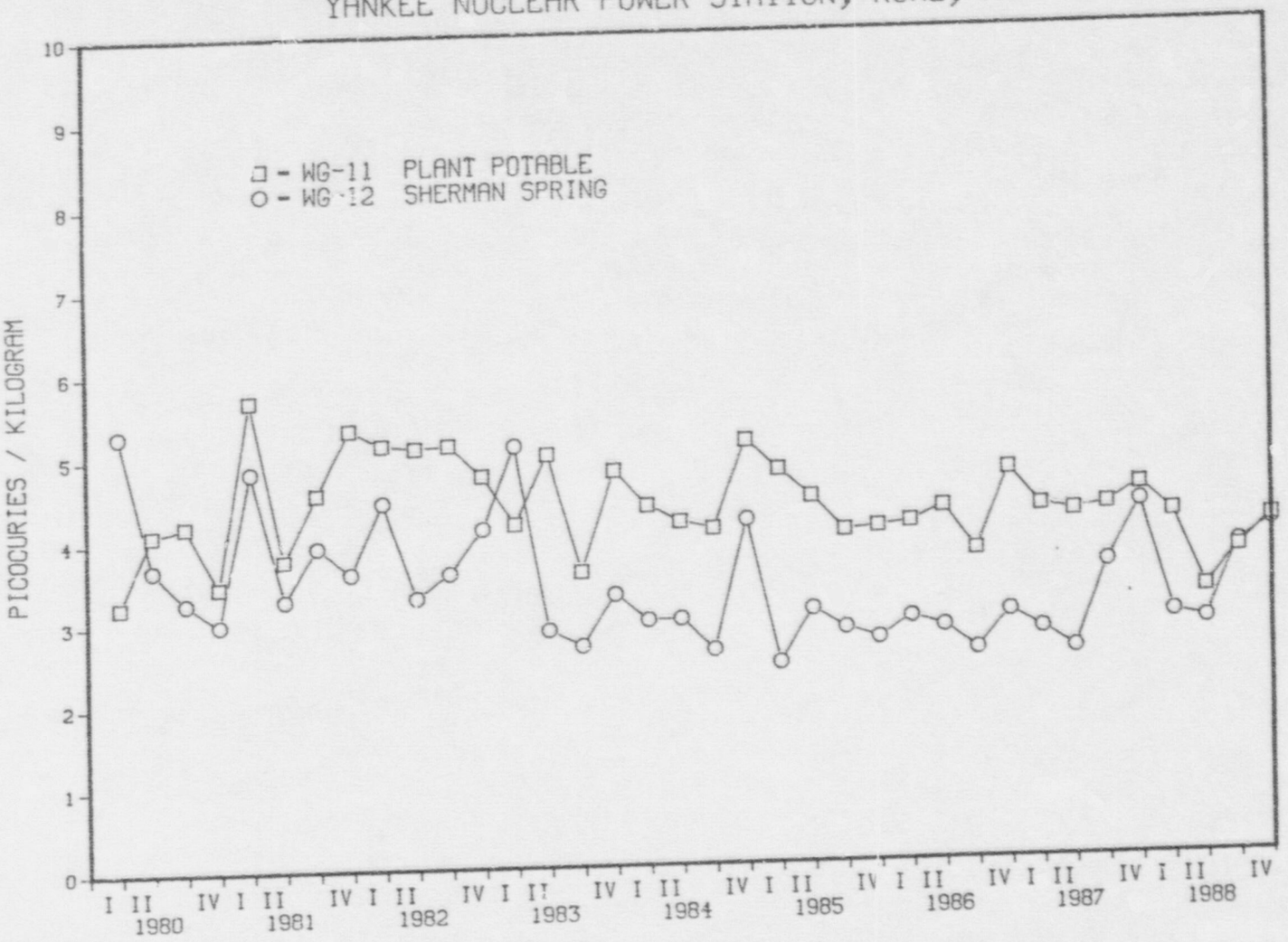


FIGURE 3.4
GROSS-BETA MEASUREMENTS OF GROUND WATER
(QUARTERLY AVERAGE)
YANKEE NUCLEAR POWER STATION, ROWE, MA



ENVIRONMENTAL RADIOLOGICAL PROGRAM SUMMARY
YANKEE NUCLEAR POWER STATION, ROWE, MA
(JANUARY - DECEMBER 1988)

MEDIUM: GROUND WATER UNITS: PCI/KG

| RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)* | REQUIRED LLD | INDICATOR STATIONS ********** MEAN RANGE NO. DETECTED** | STATION WITH HIGHEST MEAN ********** STA. NO. | MEAN RANGE NO. DETECTED** | CONTROL STATIONS ********** MEAN RANGE NO. DETECTED** |
|---|---|---|---|---|---|
| GR-B ( 24) | 4. | ( 3.6 ± .1)E 0 | 11 | ( 3.8 ± 0.2)E 0 | NO DATA |
| ( 0) | | ( 2.7 - 5.3)E 0 | | ( 3.0 - 5.3)E 0 | |
| | | *( 24/ 24)* | | *( 12/ 12)* | |
| K-40 ( 24) | | ( -5.1 ± 25.5)E -1 | 11 | ( -8.5 ± 314.1)E -2 | NO DATA |
| ( 0) | | ( -2.9 - 2.8)E 1 | | ( -2.1 - 1.4)E 1 | |
| | | *( 0/ 24)* | | *( 0/ 12)* | |
| MN-54 ( 24) | 15. | ( -3.3 ± 1.8)E -1 | 11 | ( -2.3 ± 2.9)E -1 | NO DATA |
| ( 0) | | ( -2.3 - 1.3)E 0 | | ( -2.3 - 1.3)E 0 | |
| | | *( 0/ 24)* | | *( 0/ 12)* | |
| CO-58 ( 24) | 15. | ( -2.5 ± 1.4)E -1 | 12 | ( -1.5 ± 1.9)E -1 | NO DATA |
| ( 0) | | ( -2.2 - 1.1)E 0 | | ( -1.0 - 1.1)E 0 | |
| | | *( 0/ 24)* | | *( 0/ 12)* | |
| FE-59 ( 24) | 30. | ( 1.4 ± 6.1)E -1 | 12 | ( 1.2 ± 0.9)E 0 | NO DATA |
| ( 0) | | ( -4.8 - 9.1)E 0 | | ( -1.6 - 9.1)E 0 | |
| | | *( 0/ 24)* | | *( 0/ 12)* | |
| CO-60 ( 24) | 15. | ( -6.1 ± 1.5)E -1 | 11 | ( -5.9 ± 2.1)E -1 | NO DATA |
| ( 0) | | ( -2.0 - 0.7)E 0 | | ( -1.9 - 0.6)E 0 | |
| | | *( 0/ 24)* | | *( 0/ 12)* | |
| ZN-65 ( 24) | 30. | ( -2.6 ± 5.2)E -1 | 11 | ( 3.7 ± 9.6)E -1 | NO DATA |
| ( 0) | | ( -6.5 - 5.6)E 0 | | ( -6.5 - 5.6)E 0 | |
| | | *( 0/ 24)* | | *( 0/ 12)* | |
| ZR-95 ( 24) | 15. | ( 1.1 ± 5.1)E -1 | 12 | ( 2.2 ± 6.9)E -1 | NO DATA |
| ( 0) | | ( -6.5 - 6.5)E 0 | | ( -1.8 - 6.5)E 0 | |
| | | *( 0/ 24)* | | *( 0/ 12)* | |
| AG-110M( 24) | | ( 1.6 ± 2.2)E -1 | 12 | ( 2.1 ± 2.5)E -1 | NO DATA |
| ( 0) | | ( -1.8 - 2.6)E 0 | | ( -1.0 - 1.6)E 0 | |
| | | *( 0/ 24)* | | *( 0/ 12)* | |

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT.

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3 STD DEVIATIONS) IS INDICATED WITH *( )*.

ENVIRONMENTAL RADIOLOGICAL PROGRAM SUMMARY
YANKEE NUCLEAR POWER STATION, ROWE, MA
(JANUARY - DECEMBER 1988)

MEDIUM: GROUND WATER UNITS: PCI/KG

| RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)* | REQUIRED LLD | INDICATOR STATIONS ********** MEAN RANGE NO. DETECTED** | STATION WITH HIGHEST MEAN ********** STA. NO. | MEAN RANGE NO. DETECTED** | CONTROL STATIONS ********** MEAN RANGE NO. DETECTED** |
|---|---|---|---|---|---|
| RU-103 ( 24) | | ( -8.9 ± 2.1)E -1 | 12 | ( -5.1 ± 3.3)E -1 | NO DATA |
| ( 0) | | ( -2.4 - 1.7)E 0 | | ( -2.0 - 1.7)E 0 | |
| | | *( 0/ 24)* | | *( 0/ 12)* | |
| RU-106 ( 24) | | ( -1.6 ± 1.3)E 0 | 11 | ( -9.9 ± 20.7)E -1 | NO DATA |
| ( 0) | | ( -1.1 - 1.3)E 1 | | ( -9.6 - 12.8)E 0 | |
| | | *( 0/ 24)* | | *( 0/ 12)* | |
| I-131 ( 24) | 1. | ( -9.4 ± 59.4)E -2 | 11 | ( [illegible].4 ± 10.2)E -1 | NO DATA |
| ( 0) | | ( -6.7 - 6.1)E 0 | | ( -6.[illegible] - 6.1)E 0 | |
| | | *( 0/ 24)* | | *( 0/ 12)* | |
| CS-134 ( 24) | 15. | ( -2.1 ± 2.5)E -1 | 11 | ( 3.2 ± 4.2)E -1 | NO DATA |
| ( 0) | | ( -1.9 - 3.8)E 0 | | ( -1.2 - 3.8)E 0 | |
| | | *( 0/ 24)* | | *( 0/ 12)* | |
| CS-137 ( 24) | 18. | ( -1.1 ± 2.6)E -1 | 12 | ( 1.5 ± 3.1)E -1 | NO DATA |
| ( 0) | | ( -2.5 - 2.1)E 0 | | ( -1.8 - 1.8)E 0 | |
| | | *( 0/ 24)* | | *( 0/ 12)* | |
| BA-140 ( 24) | 15. | ( -2.8 ± 3.5)E -1 | 12 | ( -1.6 ± 6.5)E -1 | NO DATA |
| ( 0) | | ( -4.7 - 3.7)E 0 | | ( -4.7 - 3.7)E 0 | |
| | | *( 0/ 24)* | | *( 0/ 12)* | |
| CE-141 ( 24) | | ( 1.0 ± 4.4)E -1 | 12 | ( 5.3 ± 7.0)E -1 | NO DATA |
| ( 0) | | ( -4.0 - 6.7)E 0 | | ( -2.6 - 6.7)E 0 | |
| | | *( 0/ 24)* | | *( 0/ 12)* | |
| CE-144 ( 24) | | ( -1.9 ± 1.3)E 0 | 12 | ( -8.6 ± 17.0)E -1 | NO DATA |
| ( 0) | | ( -1.1 - 1.1)E 1 | | ( -1.1 - 0.6)E 1 | |
| | | *( 0/ 24)* | | *( 0/ 12)* | |
| H-3 ( 24) | 2000. | ( 3.5 ± 1.1)E 2 | 12 | ( 8.2 ± 0.8)E 2 | NO DATA |
| ( 12) | | ( -2.7 - 12.6)E 2 | | ( 4.0 - 12.6)E 2 | |
| | | *( 12/ 24)* | | *( 12/ 12)* | |

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT.

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3 STD DEVIATIONS) IS INDICATED WITH *( )*.

## 3.8 River Water

Composite samplers were used at the two required sampling locations and samples from each of these were collected monthly and analyzed for gross-beta and gamma-emitting radionuclides. Quarterly composites were analyzed for H-3.

The second and third quarter composite samples showed detectable levels of H-3 at Station WR-11 (Bear Swamp Lower Reservoir). Since the Deerfield River is not used for drinking water, the low levels of H-3 found will have no impact on man. If one was to calculate, however, the critical organ (total body) dose to an average child who consumed his entire yearly intake of water (260 kilograms per year) from the Deerfield River at the above sampling location, with the average concentration of 520 pCi/kilogram over the entire year, the dose would be approximately 0.03 mrem per year, using USNRC Regulatory Guide 1.109 methodology (Reference 1). The maximum quarterly concentration of 1,030 $\pm$210 pCi/kilogram during the second quarter of 1988 did not exceed the 30,000 pCi/kilogram reporting level for H-3 in water.

Gross-beta radioactivity, primarily from naturally occurring radionuclides in river water, was detected in most samples. The mean and range were similar to those measured in previous years. The control and indicator station mean concentrations were again approximately equal in 1988. No gamma-emitting radionuclides were detected in the 1988 river water samples.

ENVIRONMENTAL RADIOLOGICAL PROGRAM SUMMARY
YANKEE NUCLEAR POWER STATION, ROWE, MA
(JANUARY - DECEMBER 1988)

MEDIUM: RIVER WATER UNITS: PCI/KG

| RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)* | REQUIRED LLD | INDICATOR STATIONS MEAN RANGE NO. DETECTED** | STATION WITH HIGHEST MEAN STA. NO. | MEAN RANGE NO. DETECTED** | CONTROL STATIONS MEAN RANGE NO. DETECTED** |
|---|---|---|---|---|---|
| GR-B ( 24) | 4. | ( 1.7 ± 0.2)E 0 | 11 | ( 1.7 ± 0.2)E 0 | ( 1.6 ± 0.1)E 0 |
| ( 0) | | ( 8.9 - 32.0)E -1 | | ( 8.9 - 32.0)E -1 | ( 1.2 - 2.0)E 0 |
| | | *( 11/ 12)* | | *( 11/ 12)* | *( 12/ 12)* |
| K-40 ( 24) | | ( -2.8 ± 4.8)E 0 | 21 | ( 1.2 ± 3.5)E 0 | ( 1.2 ± 3.5)E 0 |
| ( 0) | | ( -2.7 - 1.9)E 1 | | ( -1.8 - 2.0)E 1 | ( -1.8 - 2.0)E 1 |
| | | *( 0/ 12)* | | *( 0/ 12)* | *( 0/ 12)* |
| MN-54 ( 24) | 15. | ( -3.0 ± 1.7)E -1 | 21 | ( -7.1 ± 26.6)E -2 | ( -7.1 ± 26.6)E -2 |
| ( 0) | | ( -1.6 - 0.3)E 0 | | ( -1.0 - 1.6)E 0 | ( -1.0 - 1.6)E 0 |
| | | *( 0/ 12)* | | *( 0/ 12)* | *( 0/ 12)* |
| CO-58 ( 24) | 15. | ( -3.2 ± 3.6)E -1 | 21 | ( -6.3 ± 17.6)E -2 | ( -6.3 ± 17.6)E -2 |
| ( 0) | | ( -2.0 - 2.9)E 0 | | ( -1.0 - 0.8)E 0 | ( -1.0 - 0.8)E 0 |
| | | *( 0/ 12)* | | *( 0/ 12)* | *( 0/ 12)* |
| FE-59 ( 24) | 30. | ( 8.9 ± 7.1)E -1 | 11 | ( 8.9 ± 7.1)E -1 | ( -1.4 ± 0.7)E 0 |
| ( 0) | | ( -2.8 - 6.2)E 0 | | ( -2.8 - 6.2)E 0 | ( -5.4 - 2.7)E 0 |
| | | *( 0/ 12)* | | *( 0/ 12)* | *( 0/ 12)* |
| CO-60 ( 24) | 15. | ( -4.2 ± 4.2)E -1 | 21 | ( -3.6 ± 32.0)E -2 | ( -3.6 ± 32.0)E -2 |
| ( 0) | | ( -3.6 - 1.7)E 0 | | ( -1.2 - 2.9)E 0 | ( -1.2 - 2.9)E 0 |
| | | *( 0/ 12)* | | *( 0/ 12)* | *( 0/ 12)* |
| ZN-65 ( 24) | 30. | ( -5.5 ± 7.0)E -1 | 21 | ( -1.8 ± 3.6)E -1 | ( -1.8 ± 3.6)E -1 |
| ( 0) | | ( -5.3 - 2.1)E 0 | | ( -1.4 - 2.8)E 0 | ( -1.4 - 2.8)E 0 |
| | | *( 0/ 12)* | | *( 0/ 12)* | *( 0/ 12)* |
| ZR-95 ( 24) | 15. | ( 1.0 ± 63.5)E -2 | 11 | ( 1.0 ± 63.5)E -2 | ( -3.5 ± 4.0)E -1 |
| ( 0) | | ( -4.5 - 3.3)E 0 | | ( -4.5 - 3.3)E 0 | ( -2.5 - 1.3)E 0 |
| | | *( 0/ 12)* | | *( 0/ 12)* | *( 0/ 12)* |
| AG-110M( 24) | | ( 4.4 ± 2.7)E -1 | 11 | ( 4.4 ± 2.7)E -1 | ( -6.3 ± 42.1)E -2 |
| ( 0) | | ( -7.0 - 27.8)E -1 | | ( -7.0 - 27.8)E -1 | ( -1.7 - 3.8)E 0 |
| | | *( 0/ 12)* | | *( 0/ 12)* | *( 0/ 12)* |

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT.

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3 STD DEVIATIONS) IS INDICATED WITH *( )*.

ENVIRONMENTAL RADIOLOGICAL PROGRAM SUMMARY
YANKEE NUCLEAR POWER STATION, ROWE, MA
(JANUARY - DECEMBER 1988)

MEDIUM: RIVER WATER UNITS: PCI/KG

| RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)* | REQUIRED LLD | INDICATOR STATIONS MEAN RANGE NO. DETECTED** | STATION WITH HIGHEST MEAN STA. NO. | MEAN RANGE NO. DETECTED** | CONTROL STATIONS MEAN RANGE NO. DETECTED** |
|---|---|---|---|---|---|
| RU-103 ( 24) | | ( -7.8 ± 2.9)E -1 | 21 | ( -6.9 ± 3.6)E -1 | ( -6.9 ± 3.6)E -1 |
| ( 0) | | ( -2.0 - 1.0)E 0 | | ( -3.5 - 1.8)E 0 | ( -3.5 - 1.8)E 0 |
| | | *( 0/ 12)* | | *( 0/ 12)* | *( 0/ 12)* |
| RU-106 ( 24) | | ( -3.6 ± 2.4)E 0 | 21 | ( -2.7 ± 2.8)E 0 | ( -2.7 ± 2.8)E 0 |
| ( 0) | | ( -1.6 - 1.6)E 1 | | ( -2.4 - 0.9)E 1 | ( -2.4 - 0.9)E 1 |
| | | *( 0/ 12)* | | *( 0/ 12)* | *( 0/ 12)* |
| I-131 ( 24) | | ( -1.3 ± 6.7)E -1 | 21 | ( 1.2 ± 10.9)E -1 | ( 1.2 ± 10.9)E -1 |
| ( 0) | | ( -5.0 - 3.0)E 0 | | ( -6.7 - 5.5)E 0 | ( -6.7 - 5.5)E 0 |
| | | *( 0/ 12)* | | *( 0/ 12)* | *( 0/ 12)* |
| CS-134 ( 24) | 15. | ( -4.7 ± 2.7)E -1 | 11 | ( -4.7 ± 2.7)E -1 | ( -1.1 ± 0.2)E 0 |
| ( 0) | | ( -2.1 - 1.1)E 0 | | ( -2.1 - 1.1)E 0 | ( -2.0 - 0.1)E 0 |
| | | *( 0/ 12)* | | *( 0/ 12)* | *( 0/ 12)* |
| CS-137 ( 24) | 18. | ( 4.7 ± 2.7)E -1 | 11 | ( 4.7 ± 2.7)E -1 | ( -5.0 ± 258.6)E -3 |
| ( 0) | | ( -5.0 - 30.2)E -1 | | ( -5.0 - 30.2)E -1 | ( -1.7 - 1.0)E 0 |
| | | *( 0/ 12)* | | *( 0/ 12)* | *( 0/ 12)* |
| BA-140 ( 24) | 15. | ( 5.7 ± 7.6)E -1 | 11 | ( 5.7 ± 7.6)E -1 | ( -7.3 ± 7.2)E -1 |
| ( 0) | | ( -2.5 - 5.3)E 0 | | ( -2.5 - 5.3)E 0 | ( -4.5 - 4.3)E 0 |
| | | *( 0/ 12)* | | *( 0/ 12)* | *( 0/ 12)* |
| CE-141 ( 24) | | ( -6.3 ± 4.6)E -1 | 21 | ( 1.2 ± 49.0)E -2 | ( 1.2 ± 49.0)E -2 |
| ( 0) | | ( -3.4 - 1.6)E 0 | | ( -2.3 - 2.9)E 0 | ( -2.3 - 2.9)E 0 |
| | | *( 0/ 12)* | | *( 0/ 12)* | *( 0/ 12)* |
| CE-144 ( 24) | | ( -7.9 ± 14.2)E -1 | 21 | ( 1.2 ± 1.4)E 0 | ( 1.2 ± 1.4)E 0 |
| ( 0) | | ( -9.4 - 5.6)E 0 | | ( -5.9 - 8.0)E 0 | ( -5.9 - 8.0)E 0 |
| | | *( 0/ 12)* | | *( 0/ 12)* | *( 0/ 12)* |
| H-3 ( 8) | 2000. | ( 5.2 ± 2.6)E 2 | 11 | ( 5.2 ± 2.6)E 2 | ( 6.8 ± 5.9)E 1 |
| ( 2) | | ( -6.8 - 103.0)E 1 | | ( -6.8 - 103.0)E 1 | ( -1.7 - 24.1)E 1 |
| | | *( 2/ 4)* | | *( 2/ 4)* | *( 0/ 4)* |

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT.

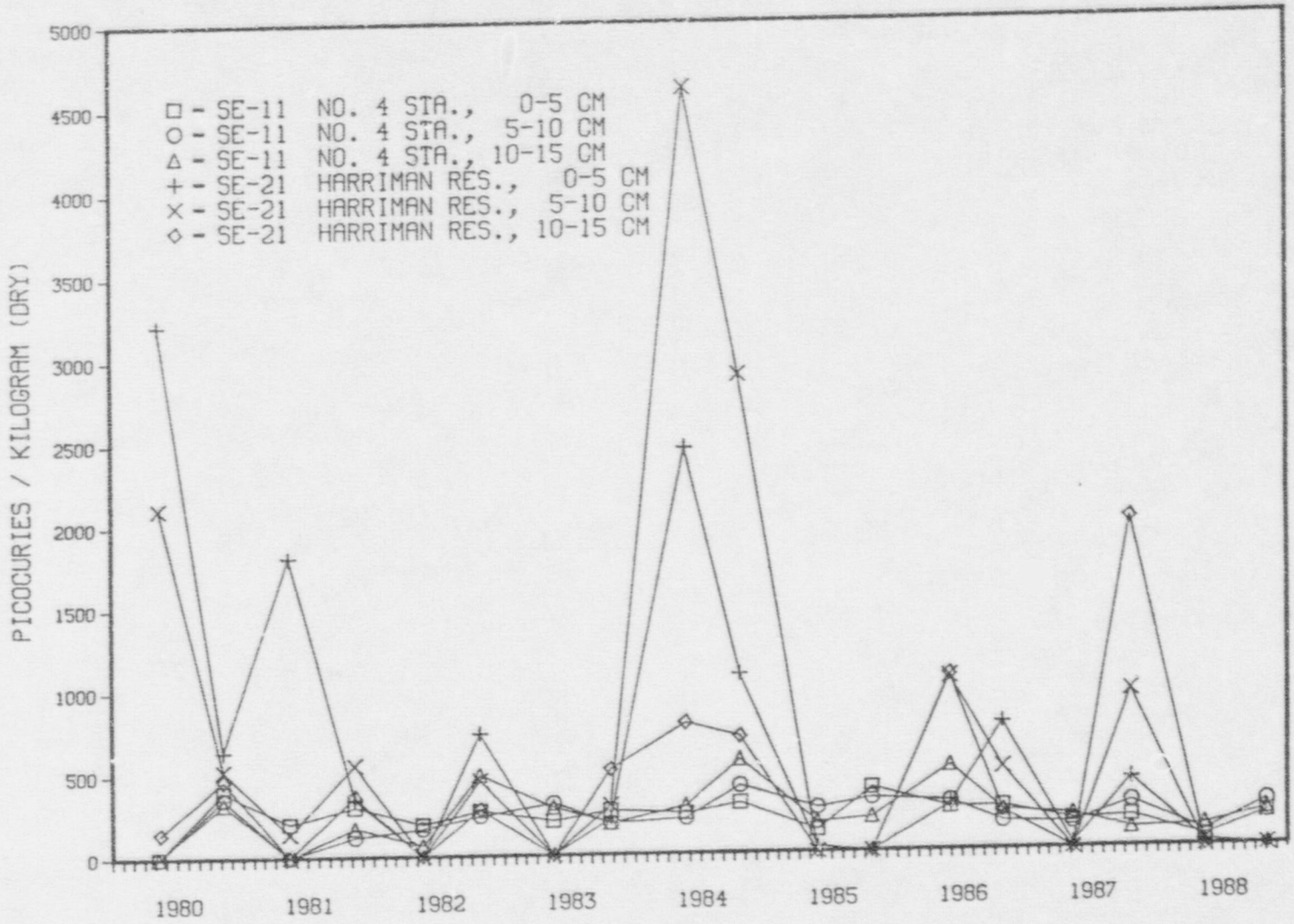
** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3 STD DEVIATIONS) IS INDICATED WITH *( )*.

## 3.9 Sediment

Sediment cores were collected semiannually from two locations. Each core was separated into three 5 cm segments, which were analyzed for gamma-emitting radionuclides. Cesium-137 was detected in most samples. The levels measured at the indicator location were consistent with what has been measured in the previous several years (see Figure 3.5) and are attributed to nuclear weapons testing fallout that has persisted in the environment.

Other than naturally occurring K-40 and Th-232, no other gamma-emitting radionuclides were detected in 1988 sediment samples.

FIGURE 3.5
CESIUM-137 IN SEDIMENT
YANKEE NUCLEAR POWER STATION, ROWE, MA



ENVIRONMENTAL RADIOLOGICAL PROGRAM SUMMARY
YANKEE NUCLEAR POWER STATION, ROWE, MA
(JANUARY - DECEMBER 1988)

MEDIUM: SEDIMENT UNITS: PCI/KG DRY

| RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)* | REQUIRED LLD | INDICATOR STATIONS ********** MEAN RANGE NO. DETECTED** | STATION WITH HIGHEST MEAN ********** STA. NO. | MEAN RANGE NO. DETECTED** | CONTROL STATIONS ********** MEAN RANGE NO. DETECTED** |
|---|---|---|---|---|---|
| BE-7 ( 12) | | ( 3.2 ± 3.4)E 1 | 21 | ( 7.4 ± 5.5)E 1 | ( 7.4 ± 5.5)E 1 |
| ( 0) | | ( -4.5 - 15.5)E 1 | | ( -1.7 - 2.2)E 2 | ( -1.7 - 2.2)E 2 |
| | | *( 0/ 6)* | | *( 0/ 6)* | *( 0/ 6)* |
| K 40 ( 12) | | ( 1.0 ± 0.1)E 4 | 21 | ( 1.2 ± 0.0)E 4 | ( 1.2 ± 0.0)E 4 |
| ( 0) | | ( 6.5 - 13.9)E 3 | | ( 1.0 - 1.4)E 4 | ( 1.0 - 1.4)E 4 |
| | | *( 6/ 6)* | | *( 6/ 6)* | *( 6/ 6)* |
| MN-54 ( 12) | | ( 8.0 ± 71.4)E -1 | 11 | ( 8.0 ± 71.4)E -1 | ( -9.7 ± 9.6)E 0 |
| ( 0) | | ( -1.7 - 3.2)E 1 | | ( -1.7 - 3.2)E 1 | ( -4.8 - 2.5)E 1 |
| | | *( 0/ 6)* | | *( 0/ 6)* | *( 0/ 6)* |
| CO-58 ( 12) | | ( -1.2 ± 0.6)E 1 | 21 | ( -9.2 ± 5.6)E 0 | ( -9.2 ± 5.6)E 0 |
| ( 0) | | ( -2.3 - 1.5)E 1 | | ( -2.6 - 0.7)E 1 | ( -2.6 - 0.7)E 1 |
| | | *( 0/ 6)* | | *( 0/ 6)* | *( 0/ 6)* |
| FE-59 ( 12) | | ( 2.4 ± 1.9)E 1 | 11 | ( 2.4 ± 1.9)E 1 | ( -4.5 ± 15.3)E 0 |
| ( 0) | | ( -5.3 - 6.8)E 1 | | ( -5.3 - 6.8)E 1 | ( -4.1 - 4.6)E 1 |
| | | *( 0/ 6)* | | *( 0/ 6)* | *( 0/ 6)* |
| CO-60 ( 12) | | ( -4.2 ± 4.2)E 0 | 21 | ( 2.6 ± 4.2)E 0 | ( 2.6 ± 4.2)E 0 |
| ( 0) | | ( -1.5 - 1.3)E 1 | | ( -1.3 - 1.2)E 1 | ( -1.3 - 1.2)E 1 |
| | | *( 0/ 6)* | | *( 0/ 6)* | *( 0/ 6)* |
| ZN-65 ( 12) | | ( 6.4 ± 10.9)E 0 | 21 | ( 1.1 ± 1.0)E 1 | ( 1.1 ± 1.0)E 1 |
| ( 0) | | ( -3.9 - 2.6)E 1 | | ( -1.9 - 4.0)E 1 | ( -1.9 - 4.0)E 1 |
| | | *( 0/ 6)* | | *( 0/ 6)* | *( 0/ 6)* |
| ZR-95 ( 12) | | ( -3.7 ± 13.0)E 0 | 21 | ( 6.6 ± 6.9)E 0 | ( 6.6 ± 6.9)E 0 |
| ( 0) | | ( -2.7 - 5.2)E 1 | | ( -1.9 - 3.0)E 1 | ( -1.9 - 3.0)E 1 |
| | | *( 0/ 6)* | | *( 0/ 6)* | *( 0/ 6)* |
| AG-110M( 12) | | ( -1.5 ± 3.1)E 0 | 11 | ( -1.5 ± 3.1)E 0 | ( -4.5 ± 4.7)E 0 |
| ( 0) | | ( -8.6 - 8.0)E 0 | | ( -8.6 - 8.0)E 0 | ( -1.3 - 1.7)E 1 |
| | | *( 0/ 6)* | | *( 0/ 6)* | *( 0/ 6)* |

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT.

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3 STD DEVIATIONS) IS INDICATED WITH *( )*.

ENVIRONMENTAL RADIOLOGICAL PROGRAM SUMMARY
YANKEE NUCLEAR POWER STATION, ROWE, MA
(JANUARY - DECEMBER 1988)

MEDIUM: SEDIMENT

UNITS: PCI/KG DRY

| RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)* | REQUIRED LLD | INDICATOR STATIONS ********** MEAN RANGE NO. DETECTED** | STATION WITH HIGHEST MEAN ********** STA. NO. | MEAN RANGE NO. DETECTED** | CONTROL STATIONS ********** MEAN RANGE NO. DETECTED** |
|---|---|---|---|---|---|
| RU-103 ( 12) | | ( 6.8 ± 7.2)E 0 | 11 | ( 6.8 ± 7.2)E 0 | ( -3.5 ± 5.6)E 0 |
| ( 0) | | ( -1.9 - 2.2)E 1 | | ( -1.9 - 2.2)E 1 | ( -2.6 - 1.3)E 1 |
| | | *( 0/ 6)* | | *( 0/ 6)* | *( 0/ 6)* |
| RU-106 ( 12) | | ( 2.8 ± 4.1)E 1 | 11 | ( 2.8 ± 4.1)E 1 | ( -3.7 ± 18.7)E 0 |
| ( 0) | | ( -1.2 - 1.5)E 2 | | ( -1.2 - 1.5)E 2 | ( -4.7 - 6.5)E 1 |
| | | *( 0/ 6)* | | *( 0/ 6)* | *( 0/ 6)* |
| I-131 ( 12) | | ( -1.7 ± 1.2)E 2 | 21 | ( 2.8 ± 10.1)E 1 | ( 2.8 ± 10.1)E 1 |
| ( 0) | | ( -6.6 - 1.1)E 2 | | ( -2.7 - 4.1)E 2 | ( -2.7 - 4.1)E 2 |
| | | *( 0/ 6)* | | *( 0/ 6)* | *( 0/ 6)* |
| CS-134 ( 12) | 150. | ( 6.2 ± 4.2)E 0 | 11 | ( 6.2 ± 4.2)E 0 | ( -2.6 ± 3.5)E 0 |
| ( 0) | | ( -7.4 - 18.3)E 0 | | ( -7.4 - 18.3)E 0 | ( -1.1 - 1.3)E 1 |
| | | *( 0/ 6)* | | *( 0/ 6)* | *( 0/ 6)* |
| CS-137 ( 12) | 180. | ( 1.6 ± 0.3)E 2 | 11 | ( 1.6 ± 0.3)E 2 | ( 1.4 ± 5.7)E 0 |
| ( 6) | | ( 6.1 - 27.3)E 1 | | ( 6.1 - 27.3)E 1 | ( -1.5 - 2.7)E 1 |
| | | *( 6/ 6)* | | *( 6/ 6)* | *( 1/ 6)* |
| BA-140 ( 12) | | ( -2.2 ± 1.6)E 1 | 11 | ( -2.2 ± 1.6)E 1 | ( -4.8 ± 2.2)E 1 |
| ( 0) | | ( -6.1 - 4.3)E 1 | | ( -6.1 - 4.3)E 1 | ( -1.2 - 0.0)E 2 |
| | | *( 0/ 6)* | | *( 0/ 6)* | *( 0/ 6)* |
| CE-141 ( 12) | | ( 1.6 ± 2.0)E 1 | 11 | ( 1.6 ± 2.0)E 1 | ( 1.5 ± 0.5)E 1 |
| ( 0) | | ( -2.3 - 10.0)E 1 | | ( -2.3 - 10.0)E 1 | ( -5.7 - 292.0)E -1 |
| | | *( 0/ 6)* | | *( 0/ 6)* | *( 0/ 6)* |
| CE-144 ( 12) | | ( 7.9 ± 22.9)E 0 | 11 | ( 7.9 ± 22.9)E 0 | ( -7.9 ± 22.8)E 0 |
| ( 0) | | ( -7.6 - 7.2)E 1 | | ( -7.6 - 7.2)E 1 | ( -5.2 - 9.9)E 1 |
| | | *( 0/ 6)* | | *( 0/ 6)* | *( 0/ 6)* |
| TH-232 ( 12) | | ( 6.2 ± 0.8)E 2 | 11 | ( 6.2 ± 0.8)E 2 | ( 3.9 ± 0.2)E 2 |
| ( 0) | | ( 3.9 - 8.3)E 2 | | ( 3.9 - 8.3)E 2 | ( 3.2 - 4.8)E 2 |
| | | *( 6/ 6)* | | *( 6/ 6)* | *( 6/ 6)* |

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT.

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3 STD DEVIATIONS) IS INDICATED WITH *( )*.

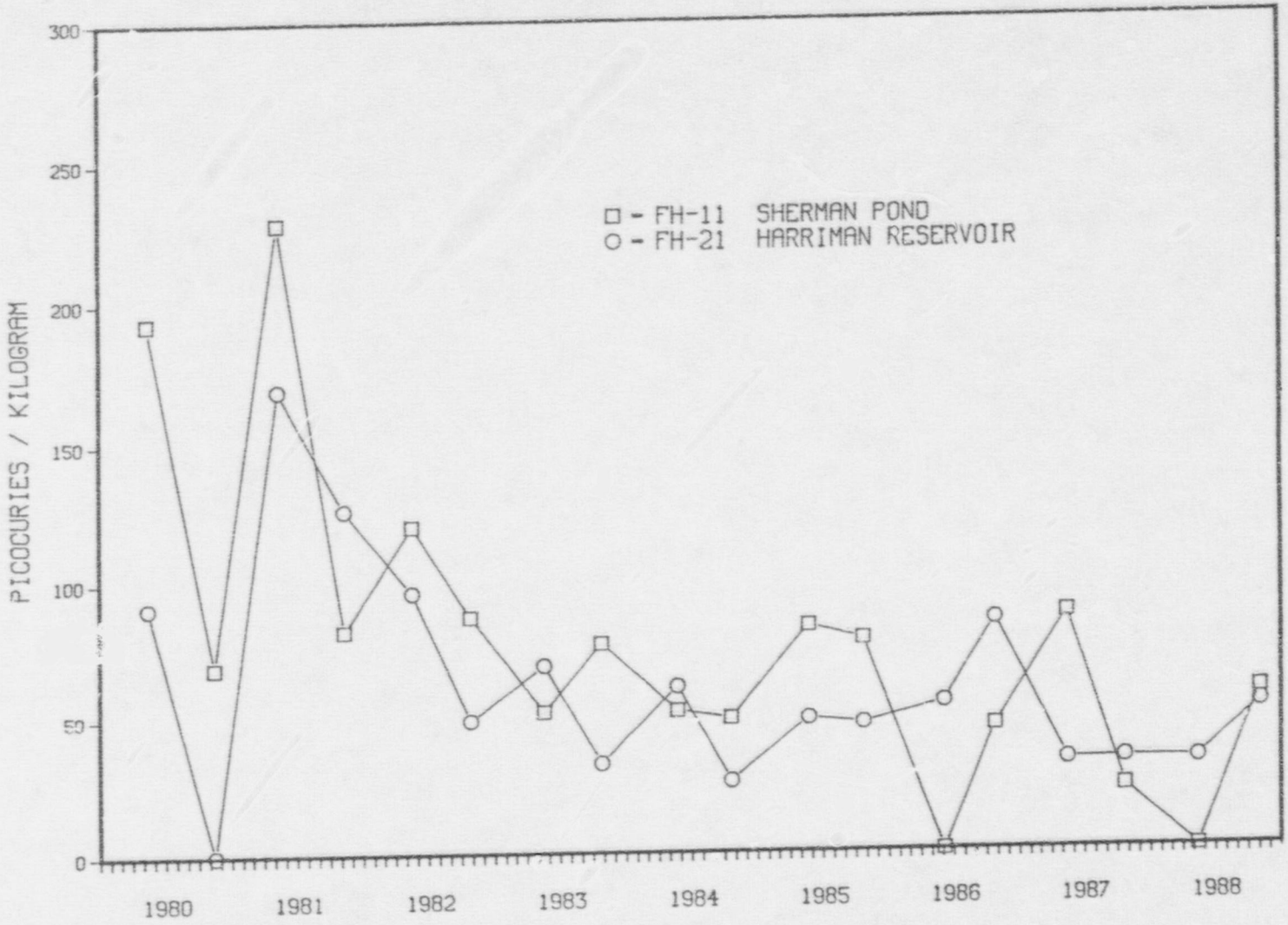
## 3.10 Fish

Fish samples were collected semiannually from two locations. Each was analyzed for gamma-emitting radionuclides.

Cesium-137 was detected in all control samples and one of the indicators. Over the past several years, the levels have been comparable between Station FH-11 and Station FH-21 fish, as can be seen in Figure 3.6. These levels are consistent with well-documented environmental levels and are attributed to nuclear weapons testing fallout.

Other than Cs-137 and naturally occurring K-40, no gamma-emitting radionuclides were detected in 1988 fish samples.

FIGURE 3.6
CESIUM-137 IN FISH
YANKEE NUCLEAR POWER STATION, ROWE, MA



ENVIRONMENTAL RADIOLOGICAL PROGRAM SUMMARY
YANKEE NUCLEAR POWER STATION, ROWE, MA
(JANUARY - DECEMBER 1988)

MEDIUM: FISH UNITS: PCI/KG WET

| RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)* | REQUIRED LLD | INDICATOR STATIONS ********** MEAN RANGE NO. DETECTED** | STATION WITH HIGHEST MEAN ********** STA. NO. | MEAN RANGE NO. DETECTED** | CONTROL STATIONS ********** MEAN RANGE NO. DETECTED** |
|---|---|---|---|---|---|
| BE-7 ( 4) | | ( -9.2 ± 90.0)E 0 | 11 | ( -9.2 ± 90.0)E 0 | ( -4.8 ± 0.7)E 1 |
| ( 0) | | ( -9.9 - 8.1)E 1 | | ( -9.9 - 8.1)E 1 | ( -5.5 - -4.1)E 1 |
| | | *( 0/ 2)* | | *( 0/ 2)* | *( / 2)* |
| K-40 ( 4) | | ( 2.9 ± 0.2)E 3 | 11 | ( 2.9 ± 0.2)E 3 | ( 2.7 ± 0.2)E 3 |
| ( 0) | | ( 2.6 - 3.1)E 3 | | ( 2.6 - 3.1)E 3 | ( 2.5 - 3.0)E 3 |
| | | *( 2/ 2)* | | *( 2/ 2)* | *( 2/ 2)* |
| MN-54 ( 4) | 130. | ( 6.1 ± 3.5)E 0 | 11 | ( 6.1 ± 3.5)E 0 | ( 8.5 ± 7.5)E -2 |
| ( 0) | | ( 2.7 - 9.6)E 0 | | ( 2.7 - 9.6)E 0 | ( -6.7 - 6.9)E 0 |
| | | *( 0/ 2)* | | *( 0/ 2)* | *( 0/ 2)* |
| CO-58 ( 4) | 130. | ( 3.5 ± 1.2)E 0 | 11 | ( 3.5 ± 1.2)E 0 | ( 8.2 ± 104.8)E -1 |
| ( 0) | | ( 2.3 - 4.7)E 0 | | ( 2.3 - 4.7)E 0 | ( -9.6 - 11.3)E 0 |
| | | *( 0/ 2)* | | *( 0/ 2)* | *( 0/ 2)* |
| FE-59 ( 4) | 260. | ( -4.0 ± 4.8)E 0 | 11 | ( -4.0 ± 4.8)E 0 | ( -2.1 ± 3.8)E 1 |
| ( 0) | | ( -8.9 - 0.8)E 0 | | ( -8.9 - 0.8)E 0 | ( -5.9 - 1.7)E 1 |
| | | *( 0/ 2)* | | *( 0/ 2)* | *( 0/ 2)* |
| CO-60 ( 4) | 130. | ( -1.6 ± 0.2)E 1 | 21 | ( -6.1 ± 5.2)E 0 | ( -6.1 ± 5.2)E 0 |
| ( 0) | | ( -1.8 - -1.5)E 1 | | ( -1.1 - -0.1)E 1 | ( -1.1 - -0.1)E 1 |
| | | *( 0/ 2)* | | *( 0/ 2)* | *( 0/ 2)* |
| ZN-65 ( 4) | 260. | ( -2.1 ± 1.3)E 1 | 11 | ( -2.1 ± 1.3)E 1 | ( -3.3 ± 3.5)E 1 |
| ( 0) | | ( -3.4 - -0.8)E 1 | | ( -3.4 - -0.8)E 1 | ( -6.8 - 0.2)E 1 |
| | | *( 0/ 2)* | | *( 0/ 2)* | *( 0/ 2)* |
| ZR-95 ( 4) | | ( -1.2 ± 0.3)E 1 | 21 | ( -7.5 ± 0.5)E 0 | ( -7.5 ± 0.5)E 0 |
| ( 0) | | ( -1.5 - -0.9)E 1 | | ( -8.0 - -7.0)E 0 | ( -8.0 - -7.0)E 0 |
| | | *( 0/ 2)* | | *( 0/ 2)* | *( 0/ 2)* |
| AG-110M( 4) | | ( 2.7 ± 11.3)E 0 | 11 | ( 2.7 ± 11.3)E 0 | ( -6.5 ± 13.6)E 0 |
| ( 0) | | ( -8.6 - 14.0)E 0 | | ( -8.6 - 14.0)E 0 | ( -2.0 - 0.7)E 1 |
| | | *( 0/ 2)* | | *( 0/ 2)* | *( 0/ 2)* |

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT.

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3 STD DEVIATIONS) IS INDICATED WITH *( )*.

ENVIRONMENTAL RADIOLOGICAL PROGRAM SUMMARY
YANKEE NUCLEAR POWER STATION, ROWE, MA
(JANUARY - DECEMBER 1988)

MEDIUM: FISH UNITS: PCI/KG WET

| RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)* | REQUIRED LLD | INDICATOR STATIONS MEAN RANGE NO. DETECTED** | STATION WITH HIGHEST MEAN STA. NO. | MEAN RANGE NO. DETECTED** | CONTROL STATIONS MEAN RANGE NO. DETECTED** |
|---|---|---|---|---|---|
| RU-103 ( 4) | | ( 8.2 ± 35.3)E -1 | 11 | ( 8.2 ± 35.3)E -1 | ( -2.0 ± 1.0)E 1 |
| ( 0) | | ( -2.7 - 4.3)E 0 | | ( -2.7 - 4.3)E 0 | ( -3.0 - -1.0)E 1 |
| | | *( 0/ 2)* | | *( 0/ 2)* | *( 0/ 2)* |
| RU-106 ( 4) | | ( 3.9 ± 3.2)E 1 | 11 | ( 3.9 ± 3.2)E 1 | ( -4.5 ± 1.1)E 1 |
| ( 0) | | ( 7.4 - 70.8)E 0 | | ( 7.4 - 70.8)E 0 | ( -5.7 - -3.4)E 1 |
| | | *( 0/ 2)* | | *( 0/ 2)* | *( 0/ 2)* |
| I-131 ( 4) | | ( 3.4 ± 6.4)E 1 | 11 | ( 3.4 ± 6.4)E 1 | ( -5.9 ± 35.2)E 0 |
| ( 0) | | ( -2.9 - 9.8)E 1 | | ( -2.9 - 9.8)E 1 | ( -4.1 - 2.9)E 1 |
| | | *( 0/ 2)* | | *( 0/ 2)* | *( 0/ 2)* |
| CS-134 ( 4) | 130. | ( -1.5 ± 20.2)E -1 | 11 | ( -1.5 ± 20.2)E -1 | ( -7.6 ± 2.3)E 0 |
| ( 0) | | ( -2.2 - 1.9)E 0 | | ( -2.2 - 1.9)E 0 | ( -9.9 - -5.4)E 0 |
| | | *( 0/ 2)* | | *( 0/ 2)* | *( 0/ 2)* |
| CS-137 ( 4) | 150. | ( 4.6 ± 1.2)E 1 | 11 | ( 4.6 ± 1.2)E 1 | ( 4.3 ± 1.0)E 1 |
| ( 0) | | ( 3.3 - 5.8)E 1 | | ( 3.3 - 5.8)E 1 | ( 3.3 - 5.3)E 1 |
| | | *( 1/ 2)* | | *( 1/ 2)* | *( 2/ 2)* |
| BA-140 ( 4) | | ( 6.9 ± 50.3)E 0 | 21 | ( 9.8 ± 1.8)E 0 | ( 9.8 ± 1.8)E 0 |
| ( 0) | | ( -4.3 - 5.7)E 1 | | ( 8.0 - 11.6)E 0 | ( 8.0 - 11.6)E 0 |
| | | *( 0/ 2)* | | *( 0/ 2)* | *( 0/ 2)* |
| CE-141 ( 4) | | ( 1.1 ± 1.6)E 1 | 11 | ( 1.1 ± 1.6)E 1 | ( 6.8 ± 6.0)E 0 |
| ( 0) | | ( 4.9 - 27.3)E 0 | | ( -4.9 - 27.3)E 0 | ( 8.0 - 129.0)E -1 |
| | | *( 0/ 2)* | | *( 0/ 2)* | *( 0/ 2)* |
| CE-144 ( 4) | | ( -1.4 ± 1.0)E 1 | 21 | ( 3.5 ± 3.7)E 1 | ( 3.5 ± 3.7)E 1 |
| ( 0) | | ( -2.3 - -0.4)E 1 | | ( -2.0 - 71.9)E 0 | ( -2.0 - 71.9)E 0 |
| | | *( 0/ 2)* | | *( 0/ 2)* | *( 0/ 2)* |
| TH-232 ( 4) | | ( 4.8 ± 23.3)E 0 | 21 | ( 1.1 ± 1.2)E 1 | ( 1.1 ± 1.2)E 1 |
| ( 0) | | ( -1.9 - 2.8)E 1 | | ( -5.5 - 226.0)E -1 | ( -5.5 - 226.0)E 1 |
| | | *( 0/ 2)* | | *( 0/ 2)* | *( 0/ 2)* |

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT.

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3 STD DEVIATIONS) IS INDICATED WITH *( )*.

## 3.11 Direct Radiation

Direct gamma radiation exposure was determined from the use of thermoluminescent dosimeters (TLDs). Specifically, Panasonic UD-801AS1 and UD-814AS1 calcium sulfate dosimeters were used, with a total of five elements in place at each monitoring location. A total of thirty-eight stations is required by the Radiological Effluent Technical Specifications. TLDs from twenty-two must be read out quarterly, while those from the remaining sixteen incident response (outer ring) stations need only be de-dosed (annealed) quarterly, unless a gaseous release LCO was exceeded during the period. During 1988, all TLDs were routinely readout on a quarterly schedule. Table 3.1 provides a summary of the results. Figures 3.7 to 3.12 show the TLD results graphically.

Distinct annual cycles can be seen in the TLD data from each category of monitoring station (see Figures 3.7 to 3.12). The lowest point of the cycle occurs during the winter months. This is due primarily to the attenuating effect of the snow cover during those months. The effect is not as noticeable with the fenceline TLDs, since the plant contribution to radiation levels at these sites tends to obscure seasonal fluctuations in the environment. The fenceline where TLDs are situated is located well within the site boundary.

The natural background radiation level at each site varies for many reasons. The one that best explains the consistent differences between sites is the radioactive composition of the underlying and nearby soil and rock. Conspicuous deviations from any of these trends would indicate some abnormal condition, possibly a power plant contribution to the radiation levels. No such abnormalities were detected off-site during 1988, as can be seen in Figures 3.7 to 3.12.

As can be seen in Figure 3.11, elevated exposure rates were noted at several on-site locations during the first quarter of 1981. This was believed not to have been caused by plant activities, and was discussed in Reference 4.

Missing TLDs: Approximately halfway through the second quarter, the TLD at Station GM-12 was discovered to be missing, apparently due to theft. The TLD was replaced shortly afterward. The measurement in Table 3.1 is based on the accumulated exposure at that station for the last half of the quarter.

FIGURE 3.7
EXPOSURE RATE AT INDICATOR TLDS, GM 01-07
YANKEE NUCLEAR POWER STATION, ROWE, MA

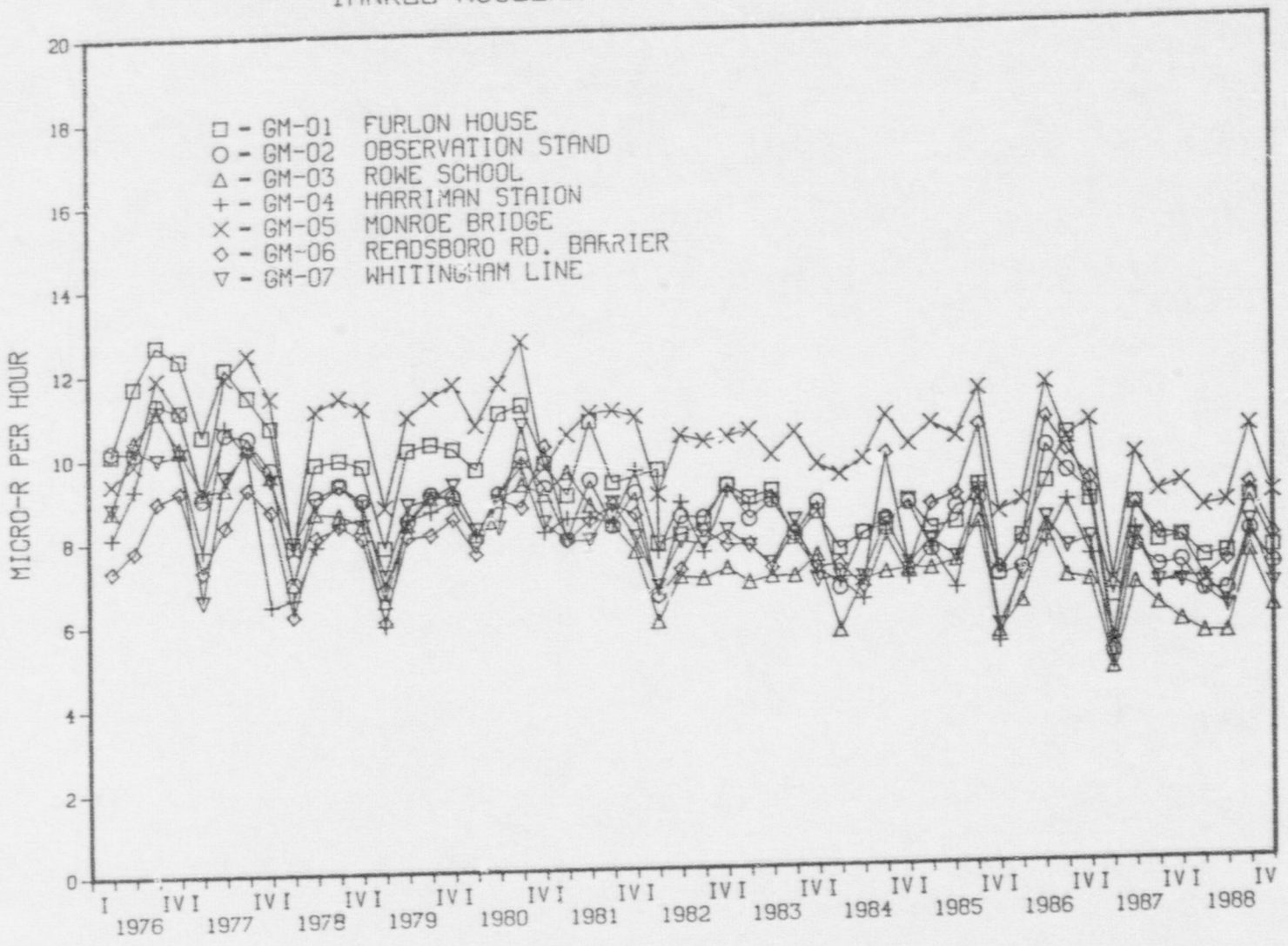


FIGURE 3.8
EXPOSURE RATE AT INDICATOR TLDS, GM 08-12,40
YANKEE NUCLEAR POWER STATION, ROWE, MA

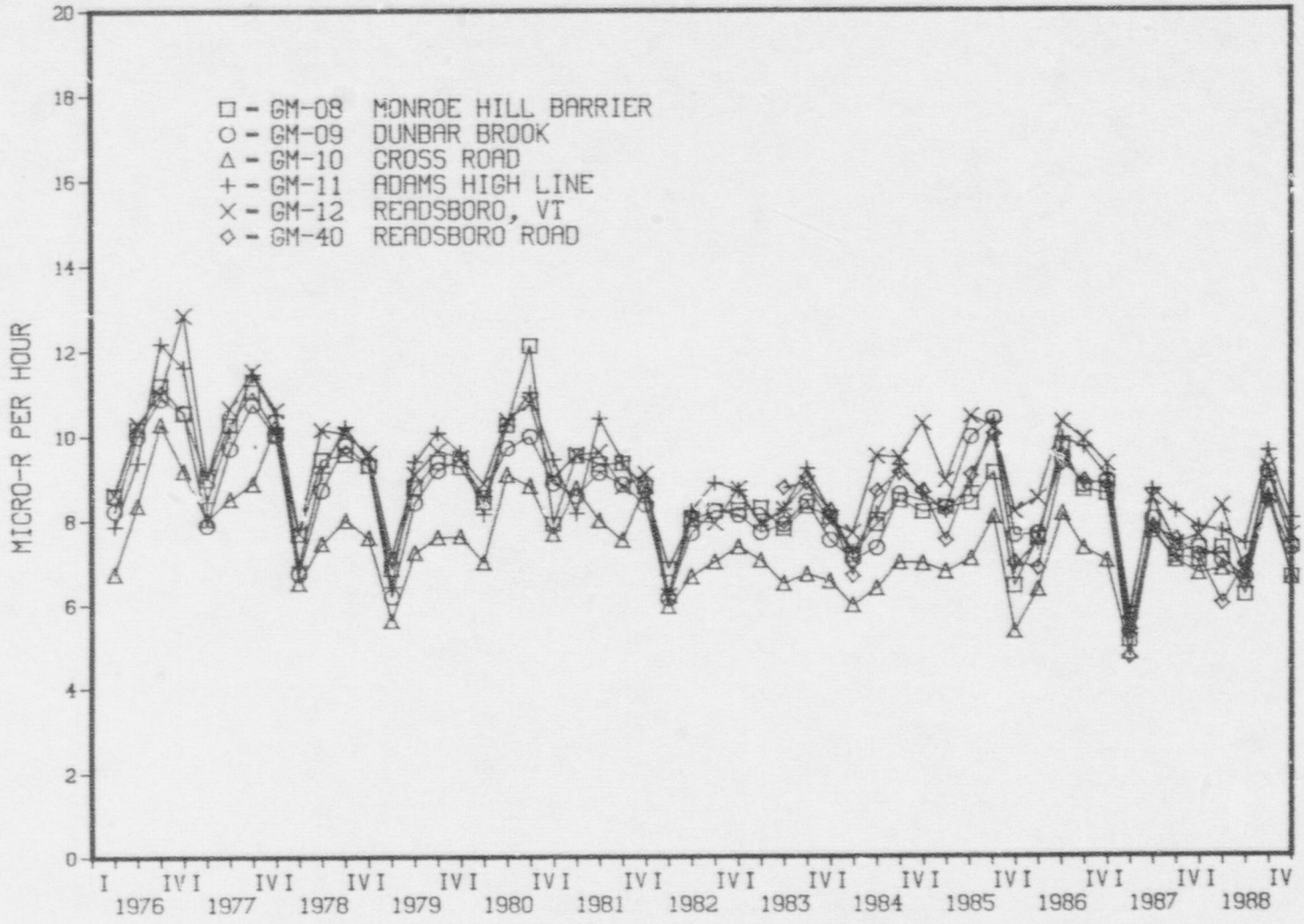


FIGURE 3.9
EXPOSURE RATE AT OUTER RING TLDS, GM 24-31
YANKEE NUCLEAR POWER STATION, ROWE, MA

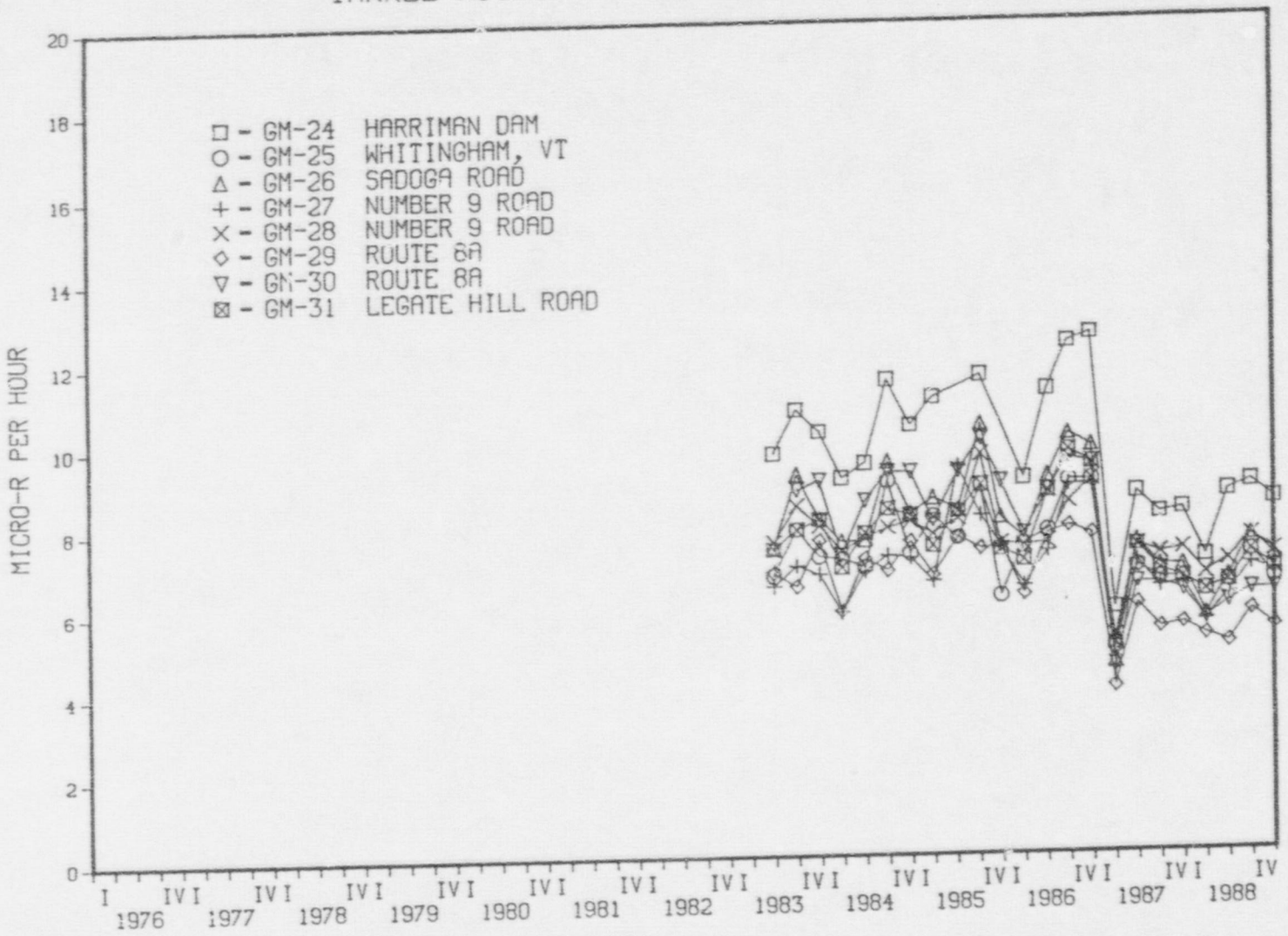


FIGURE 3.10
EXPOSURE RATE AT OUTER RING TLDS, GM 32-39
YANKEE NUCLEAR POWER STATION, ROWE, MA

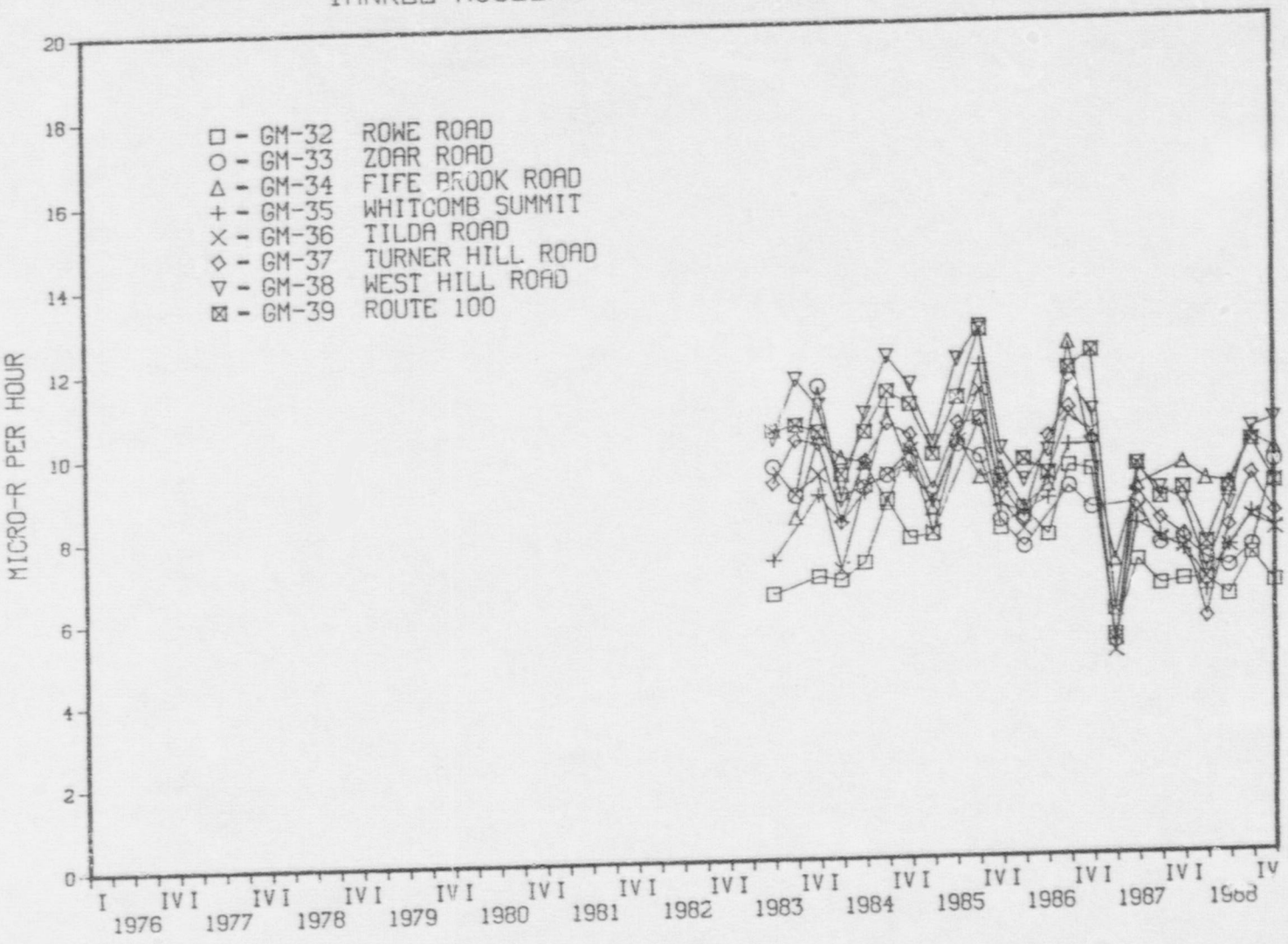


FIGURE 3.11
EXPOSURE RATE AT FENCELINE TLDS, GM 13-21
YANKEE NUCLEAR POWER STATION, ROWE, MA

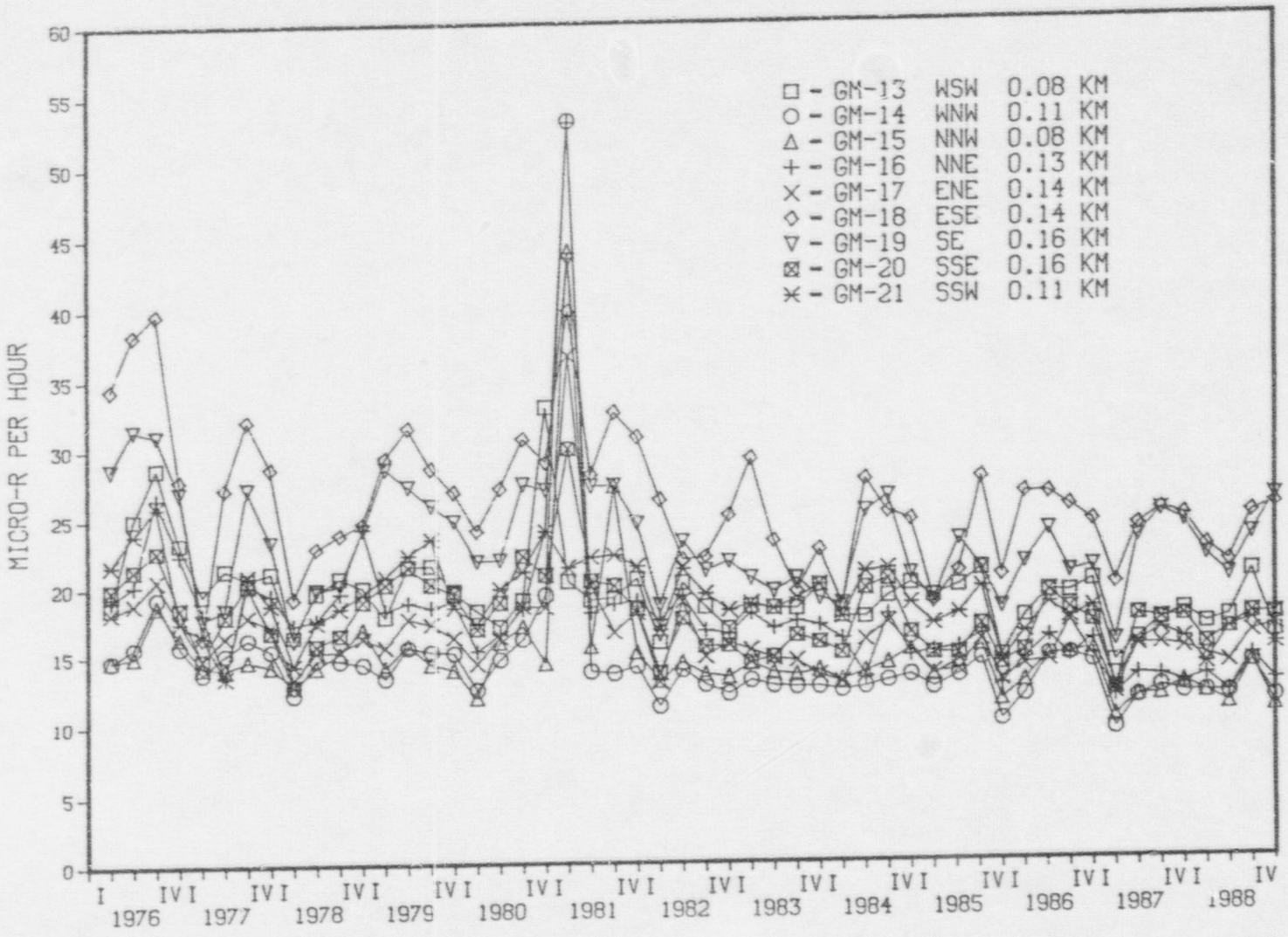
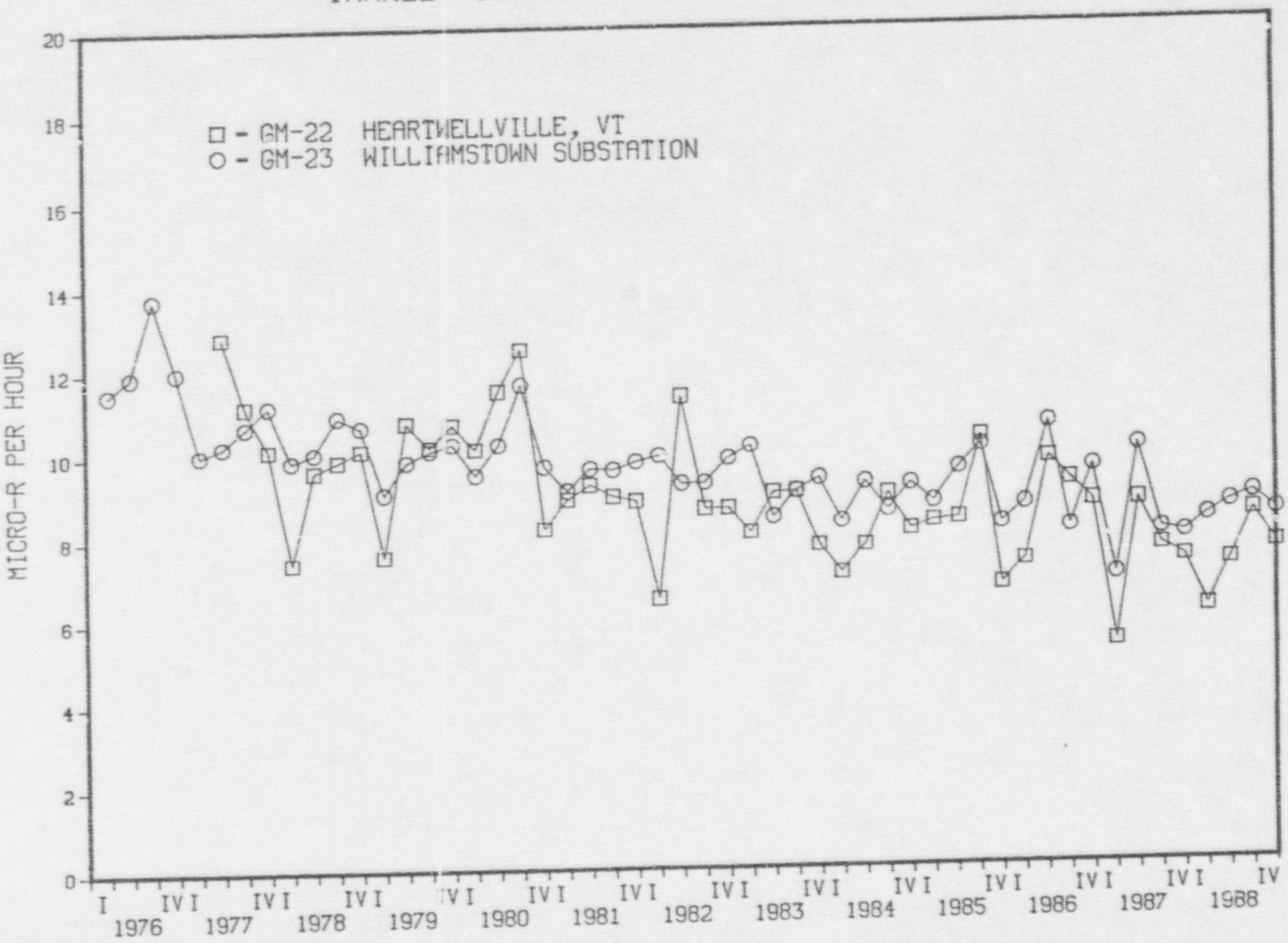


FIGURE 3.12
EXPOSURE RATE AT CONTROL TLDS, GM 22-23
YANKEE NUCLEAR POWER STATION, ROWE, MA



Environmental Radiological Program Summary
Yankee Nuclear Power Station, Rowe, Massachusetts
January - December 1988

Medium: Direct Radiation Measurements (TLD) Units: Micro-R per Hour

| Indicator Stations | Outer-Ring Stations | Restricted Area Fence | Control Stations |
|---|---|---|---|
| Mean | Mean | Mean | Mean |
| Range | Range | Range | Range |
| (No. Meas.)* | (No. Meas.)* | (No. Meas.)* | (No. Meas.)* |
| 7.4 ± 1.1 | 7.3 ± 1.3 | 16.5 ± 4.2 | 7.9 ± 0.9 |
| 5.4 - 10.3 | 5.0 - 10.4 | 10.8 - 25.9 | 6.1 - 8.8 |
| (52) | (64) | (36) | (8) |

* All measurements based on the mean of five readings per station (quarterly readout).



2918R

Table 3.1

Summary of Direct Radiation Measurements - 1988
Yankee Nuclear Power Station
(Micro-R Per Hour)

| Station | Distance (km) | Direction | First Quarter | Second Quarter | Third Quarter | Fourth Quarter | Yearly Mean |
|---|---|---|---|---|---|---|---|
| GM-1 | 0.8 | SW | 7.2 | 7.3 | 8.6 | 7.4 | 7.6 |
| GM-2 | 0.5 | NW | 6.4 | 6.4 | 7.8 | 7.0 | 6.9 |
| GM-3 | 4.2 | SE | 5.4 | 5.4 | 7.3 | 6.0 | 6.0 |
| GM-4 | 3.2 | N | 6.7 | 6.1 | 7.7 | 7.0 | 6.9 |
| GM-5 | 1.1 | SW | 8.4 | 8.5 | 10.3 | 8.7 | 9.0 |
| GM-6 | 1.3 | N | 6.7 | 7.1 | 8.9 | 7.7 | 7.6 |
| GM-7 | 3.5 | NE | 6.4 | 6.0 | 8.0 | 6.5 | 6.7 |
| GM-8 | 1.8 | S | 7.3 | 6.2 | 8.7 | 6.6 | 7.2 |
| GM-9 | 3.2 | SW | 7.0 | 6.6 | 9.1 | 7.3 | 7.5 |
| GM-10 | 3.5 | E | 6.8 | 6.5 | 8.5 | 6.6 | 7.1 |
| GM-11 | 2.1 | WNW | 7.7 | 7.4 | 9.6 | 8.0 | 8.2 |
| GM-12 | 5.5 | NNW | 8.3 | 6.7 | 9.2 | 7.6 | 8.4 |
| GM-13 | 0.08 | WSW | 16.8 | 17.3 | 20.5 | 16.1 | 17.7 |
| GM-14 | 0.11 | WNW | 11.8 | 11.7 | 13.9 | 11.4 | 12.2 |
| GM-15 | 0.08 | NNW | 11.8 | 11.0 | 13.9 | 10.8 | 11.9 |
| GM-16 | 0.13 | NNE | 13.0 | 11.8 | 14.4 | 12.6 | 13.0 |
| GM-17 | 0.14 | ENE | 14.4 | 13.9 | 16.1 | 16.6 | 15.3 |
| GM-18 | 0.14 | ESE | 22.4 | 21.2 | 24.8 | 25.4 | 23.5 |
| GM-19 | 0.16 | SE | 21.7 | 20.2 | 23.2 | 25.9 | 22.8 |
| GM-20 | 0.16 | SSE | 15.3 | 16.4 | 17.5 | 17.4 | 16.7 |
| GM-21 | 0.11 | SSW | 13.8 | 16.4 | 17.0 | 15.2 | 15.6 |
| GM-22 | 12.6 | NNW | 6.1 | 7.2 | 8.4 | 7.6 | 7.3 |
| GM-23 | 22.2 | W | 8.3 | 8.6 | 8.8 | 8.4 | 8.5 |
| GM-24 | 7.3 | N | 7.1 | 8.7 | 8.9 | 8.5 | 8.3 |
| GM-25 | 7.7 | NNE | 6.3 | 6.5 | 7.2 | 6.6 | 6.7 |
| GM-26 | 7.6 | NE | 5.7 | 6.6 | 7.6 | 7.1 | 6.8 |
| GM-27 | 7.6 | ENE | 5.6 | 6.2 | 6.9 | 6.7 | 6.4 |
| GM-28 | 6.0 | E | 6.7 | 7.0 | 7.6 | 7.2 | 7.1 |
| GM-29 | 8.2 | ESE | 5.2 | 5.0 | 5.8 | 5.4 | 5.4 |
| GM-30 | 9.4 | SE | 5.6 | 6.0 | 6.3 | 6.3 | 6.1 |
| GM-31 | 7.6 | SSE | 6.3 | 6.5 | 7.2 | 6.8 | 6.7 |
| GM-32 | 7.9 | S | 6.6 | 6.2 | 7.2 | 6.5 | 6.6 |
| GM-33 | 6.9 | SSW | 7.1 | 6.9 | 7.4 | 9.4 | 7.7 |
| GM-34 | 6.4 | SW | 9.0 | 8.9 | 10.0 | 9.7 | 9.4 |
| GM-35 | 8.6 | WSW | 6.3 | 7.4 | 8.2 | 7.9 | 7.5 |
| GM-36 | 6.6 | W | 6.6 | 7.4 | 8.1 | 7.8 | 7.5 |
| GM-37 | 6.7 | WNW | 5.7 | 7.9 | 9.1 | 8.2 | 7.7 |
| GM-38 | 6.6 | NW | 6.8 | 8.4 | 10.2 | 10.4 | 8.9 |
| GM-39 | 6.8 | NNW | 7.5 | 8.8 | 9.9 | 8.9 | 8.8 |
| GM-40 | 0.5 | W | 6.0 | 6.9 | 8.4 | 7.2 | 7.1 |

## 4.0 QUALITY ASSURANCE PROGRAM

Three separate Quality Assurance programs were performed during 1988 to demonstrate the validity of laboratory analyses by the Yankee Atomic Environmental Laboratory (YAEL).

YAEL participates in the EPA Interlaboratory Comparison (cross-check) program for those species and matrices routinely analyzed by the laboratory. This provides an independent check of accuracy and precision of the laboratory analysis. When the results of the cross-check analysis fall outside of the control limit, an investigation is made to determine the cause of the problem, and corrective measures are taken, as appropriate.

YAEL maintains an intralaboratory quality control program to assure the validity and reliability of the data. This program includes quality control of laboratory equipment, use of reference standards for calibration, and analysis of blank and spiked samples. The records of the quality control program are reviewed by the responsible cognizant individual, and corrective measures are taken whenever applicable.

A blind duplicate program is maintained in which paired samples from five nuclear plants, including Yankee Atomic, are prepared from homogenous media and sent to the laboratory for analysis. The results from this blind duplicate program are used to check for precision in laboratory analyses.

### Intralaboratory and EPA Interlaboratory Results

The Quality Assurance Program implemented at the analytical laboratory indicated good precision and accuracy in reported values. Table 4.1 shows the results of accuracy and precision for laboratory analyses in 1988 for intralaboratory analyses and EPA interlaboratory cross-check analyses. For accuracy, 65.0 and 86.5 percent of the results were within 5 and 10 percent of the known values, respectively, with 96.6 percent of all results falling within the laboratory criteria of 15 percent. For precision, 84.7 and 96.7 percent of the results were within 5 and 10 percent of the mean, respectively, with 99.8 percent of all results meeting the laboratory criteria of 15 percent.

Table 4.1

Intralaboratory and EPA Interlaboratory Results - 1988

| | | Accuracy | |
|---|---|---|---|
| Total Number of Measurements | 0 to 5% | 0 to 10% | 0 to 15%* |
| 654 | 425 | 566 | 632 |
| | (65.0%) | (86.5%) | (96.6%) |
| | | Precision | |
| Total Number of Measurements | 0 to 5% | 0 to 10% | 0 to 15%* |
| 633 | 536 | 612 | 632 |
| | (84.7%) | (96.7%) | (99.8%) |

* This category also contains those samples having a verified zero concentration which were analyzed and found not to contain the i e of interest.

The results of the EPA Interlaboratory Comparison Program, when considered apart from the remainder of the Quality Assurance program, were satisfactory with respect to accuracy and precision in 1988. Two hundred and nineteen analyses were performed on air particulate filters, milk, food, urine, and water. Based upon this sample analysis total, 217 analyses (i.e., 99.1 percent) met the EPA's definition of mean value criteria. The sample analyses that did not meet the criteria were a Sr-90 analysis on a milk sample and a Ra-226 analysis on a water sample. Two of the three milk samples were remilked and analyzed for Sr-90 before the EPA results had been received. The new Sr-90 mean value, using the above results, fell within the EPA control limits. With respect to the Ra-226 results, no new radium analyses have been performed since the receipt of these results, and the Beta-Gamma Coincidence System for Ra-226/Ra-228 is scheduled for recalibration. (Details of this may be found in References 2 and 3.)

The above EPA Interlaboratory Comparison Program results are provided in compliance with Technical Specification 4.12.3.

Blind Duplicate Program

A total of 51 paired samples were submitted by the five participating plants for analysis during 1988. The data base used for the duplicate analysis consisted of paired measurements of 26 gamma-emitting nuclides, H-3, Sr-89, Sr-90, low level I-131, gross beta, Ra-226, and Ra-228. A dual level criteria for agreement was established. If the paired measurements fall within ± 15 percent of their average value, then agreement between the measurements has been met. If the value falls outside of the ± 15 percent, then a two standard deviation range (95 percent confidence level) is established for each of the analyses. If the ranges overlap, agreement is obtained.

One thousand three hundred and seventeen paired duplicate measurements were analyzed for 1988. A total of 99.5 percent of all measurements fell within the established criteria discussed above. The six measurements that did not meet the criteria were measurements of Zn-65 in groundwater, Mo-99 in

milk, TeI-132 in groundwater, Zr-95 in cranberries, Ba-140 in milk, and Sb-124 in milk. In all of the above cases, the radionuclide in question was not detected in the sample and a three standard deviation acceptance criteria was met. The six duplicate measurements represent 0.5 percent of all the blind duplicate paired measurements made during 1988. No trend was evident with respect to repeated failings of measurements for the above radionuclides.

## 5.0 LAND USE CENSUS

Specification 3/4.12.2 of the Radiological Effluent Technical specifications requires that a land use census be conducted after June 1 and before October 1 of each year. The census is used to identify the location of the nearest milk animal, the nearest residence, and the nearest garden of greater than 500 square feet producing fresh leafy vegetables in each of the sixteen meteorological sectors within a distance of five miles. The 1988 census was completed within the above dates. The distance and direction from the plant for each of the above locations are shown in Table 5.1.

The land use census for this reporting period identified two milk animal locations which yielded a calculated dose commitment (via the same exposure pathway) at least 20 percent greater than at a location from which samples are currently being obtained in accordance with Technical Specification 3.12.1. Specifically, these milk animal locations were found at WNW, 1.9 km and NE, 3.7 km. Neither location, however, would be able to provide samples of sufficient size over an extended period due to the small number of milking cows owned. Consequently, the two existing locations, TM-12 and TM-13, were kept as official sampling locations in compliance with Technical Specification 3.12.2.b.

No garden locations were identified that yielded a calculated dose or dose commitment at least 20 percent greater than that at the existing food crop sampling locations. Consequently, the food crop sampling locations were not changed in 1988 as a result of the Land Use Census.

Following the census, Technical Specification 3.12.2.a requires the identification in the Semi-Annual Effluent Release Report of any location(s) identified in the census which yields at least a 20 percent greater dose or dose commitment than the values currently being calculated in Technical Specification 4.11.2.3. No such locations were identified.

Table 5.1

1988 Land Use Census Results
Yankee Nuclear Power Station

| Sector | Nearest Residence (km) | Nearest Milk Animal (km) | Nearest Garden (km) |
|---|---|---|---|
| N | 2.4 | 6.1 | 3.5 |
| NNE | 4.7 | - | 4.7 |
| NE | 3.7 | 3.7 | 3.7 |
| ENE | 3.1 | 8.4 | 7.4 |
| E | 3.1 | - | 3.1 |
| ESE | 3.4 | - | 3.4 |
| SE | 2.3 | - | 2.3 |
| SSE | 2.1 | - | 2.9 |
| S | 2.3 | - | 2.3 |
| SSW | - | - | - |
| SW | 1.3 | - | 1.3 |
| WSW | 1.3 | - | 1.3 |
| W | 1.9 | - | 2.7 |
| WNW | 1.9 | 1.9 | 1.9 |
| NW | 0.45 | - | 4.6 |
| NNW | 2.9 | - | 3.9 |

## 6.0 SUMMARY

During 1988, samples collected as part of the radiological environmental monitoring program at Yankee Atomic showed detectable levels of man-made radionuclides in cow milk, groundwater, river water, sediment, finfish, and maple syrup. The H-3 detected in groundwater (Station WG-12, Sherman Spring) and river water (Station WR-11, Bear Swamp Lower Reservoir) was the only radionuclide possibly related to plant operations. Since water from the spring or the Deerfield River is not consumed by man, there would be no impact on man from the low levels detected. The dose to an imaginary child who consumed large quantities of the above water was calculated, however, to set an upper bound to the possible consequences of the measured environmental levels of H-3. In both cases (river and groundwater), the dose was negligible when compared to natural background radiation and its yearly fluctuations.

The other man-made radionuclides were due either to residual fallout from nuclear weapons tests conducted in the 1970s and 1980, or fallout from the Chernobyl nuclear plant accident in April and May of 1986. In summary, there was no observable radiological impact on the environment from plant operations.

## 7.0 REFERENCES


1. USNRC Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR50, Appendix I," 1977.

2. Yankee Environmental Radiation Measurement Laboratory Semiannual Quality Assurance Status Report, January-June 1988, Yankee Atomic Electric Company.

3. Yankee Atomic Environmental Laboratory Semiannual Quality Assurance Status Report, July-December 1988, Yankee Atomic Electric Company.

4. Yankee Atomic Electric Company, Annual Radiological Environmental Operating Report, January-December 1986.

YANKEE ATOMIC ELECTRIC COMPANY

Telephone (508) 779-6711
TWX 710-380-7619

580 Main Street, Bolton, Massachusetts 01740-1398

April 28, 1989
BYR 89-79

United States Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

Reference: (a) License No. DPR-3 (Docket No. 50-29)

Subject: Annual Radiological Environmental Operating Report

Dear Sir:

Enclosed herewith please find the Annual Radiological Environmental Monitoring Report for the Yankee Nuclear Power Station. This report contains a summary and analysis of the radiological environmental data collected for the year 1988 and is submitted as required by Technical Specification 6.9.5(a).

We trust that you will find this submittal satisfactory; however, if you have any questions, please contact us.

Very truly yours,

YANKEE ATOMIC ELECTRIC COMPANY

George Papanic, Jr.
Senior Project Engineer - Licensing

GP/gbc

Enclosure

cc: USNRC Region I
USNRC Resident Inspector, YNPS

IE45
1/1