ORNL/M-1156

Received by OSTI

OCT 08 1991

**OAK RIDGE
NATIONAL
LABORATORY**

MARTIN MARIETTA

**Environmental Surveillance Data
Report for the Third Quarter
of 1990**

P. Y. Goldberg
A. E. Osborne-Lee
M. R. Powell
M. M. Stevens
M. F. Tardiff
C. K. Valentine
D. A. Wolf

MANAGED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

This report has been reproduced directly from the best available copy.

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831; prices available from (615) 576-8401, FTS 626-8401.

Available to the public from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Rd., Springfield, VA 22161.

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

ORNL/M--1156

DE92 000422

ENVIRONMENTAL SURVEILLANCE DATA REPORT FOR
THE THIRD QUARTER OF 1990

P. Y. Goldberg
A. E. Osborne-Lee
M. R. Powell
M. M. Stevens
M. F. Tardiff
C. K. Valentine
D. A. Wolf

Date Published: July 1991

Prepared by the
Information Integration and Analysis Group
Environmental Surveillance and Protection Section
Office of Environmental and Health Protection
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831
managed by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under Contract No. DE-AC05-84OR21400

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

92

CONTENTS

	Page
LIST OF ACRONYMS	v
LIST OF FIGURES	vii
LIST OF TABLES	ix
EXECUTIVE SUMMARY	xi
1. INTRODUCTION	1
2. AIR	5
2.1 AIRBORNE EMISSIONS	5
2.2 AMBIENT AIR	12
2.3 EXTERNAL GAMMA RADIATION	23
3. WATER	27
3.1 SURFACE WATER	27
3.2 REFERENCE SURFACE WATER	44
3.3 NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM REQUIREMENTS	48
3.4 POLYCHLORINATED BIPHENYL (PCB) IN THE AQUATIC ENVIRONMENT	62
4. METEOROLOGICAL PROCESSES	65
4.1 WIND	65
5. BIOLOGICAL MONITORING	71
5.1 MILK	71

LIST OF ACRONYMS

AQCA	Air Quality Control Act
ATDD	Atmospheric Turbulence and Diffusion Division
BMP	best management practice
BOD	Biochemical oxygen demand
CAA	Clean Air Act
CWA	Clean Water Act
CYRTF	Coal Yard Runoff Treatment Facility
DCG	derived concentration guide
DOE	Department of Energy
DWL	Drinking water limit
DWS	Drinking Water Standard
EHP	Office of Environmental and Health Protection Division (ORNL)
EPA	U.S. Environmental Protection Agency
ESP	Environmental Surveillance and Protection Section (ORNL)
HEPA	high-efficiency particulate air
HFIR	High Flux Isotope Reactor
ICP	inductively coupled plasma arc emission spectrometry
MB	Melton Branch
NESHAP	National Emission Standards for Hazardous Air Pollutants
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NWT	Northwest tributary
ORGDP	Oak Ridge Gaseous Diffusion Plant
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
NRWTF	Nonradiological Wastewater Treatment Facility
PAM	perimeter air monitoring
PCB	polychlorinated biphenyl
PWTP	Process Waste Treatment Plant
QER	Quality Event Report
RAM	remote air monitoring
RCRA	Resource Conservation and Recovery Act
SARA	Superfund Amendments and Reauthorization Act
SE	standard error of the mean
SI	Système Internationale
STP	Sewage Treatment Plant
SWMU	Solid Waste Management Unit
SWSA	Solid Waste Storage Area
TDHE	Tennessee Department of Health and Environment
TOC	total organic carbon
TTO	total toxic organics
TSS	total suspended solids
WAG	waste area grouping
WOC	White Oak Creek
WOD	White Oak Dam
WOL	White Oak Lake

List of Figures

Figure	Page
1 Location map of major stacks (emission points) at ORNL	7
2 Location map of the ORR and ORNL perimeter air monitoring stations	13
3 Location map of the remote air monitoring stations	14
4 Location map of ORNL streams and sampling stations	28
5 Location map of Kingston and Gallaher sampling points	31
6 Location map of ORNL NPDES and radioactivity sampling locations .	36
7 Location map of PCB sampling points	63
8 Location map of meteorological towers at ORNL	66
9 Wind rose at 10-m level of meteorological tower A, July-August 1990	67
10 Wind rose at 30-m level of meteorological tower A, July-August 1990	67
11 Wind rose at 10-m level of meteorological tower B, July-August 1990	68
12 Wind rose at 30-m level of meteorological tower B, July-August 1990	68
13 Wind rose at 10-m level of meteorological tower C, July-August 1990	69
14 Wind rose at 30-m level of meteorological tower C, July-August 1990	69
15 Wind rose at 100-m level of meteorological tower C, July-August 1990	70
16 Location map of milk sampling stations near the Oak Ridge facilities	72

List of Tables

Table	Page
1 Airborne emissions of radionuclides from ORNL, July-September 1990	9
2 Particulate airborne emissions of long-lived radionuclides from ORNL, April-June 1990	11
3 Gross alpha activity at ambient air stations, July-September 1990	16
4 Gross beta activity at ambient air stations, July-September 1990	17
5 Estimated gross alpha activity at ambient air stations, April-June 1990	18
6 Estimated gross beta activity at ambient air stations, April-June 1990	19
7 Atmospheric I-131 concentrations at ambient air stations, July-September 1990	20
8 Atmospheric tritium concentrations at ambient air stations, July-September 1990	21
9 External gamma radiation measurements at ORNL and reservation perimeter air monitoring stations, July-September 1990	24
10 Summary of collection and analysis frequencies of surface, pond, and effluent water samples	29
11 Summary of radionuclide concentrations in water off-site ORNL, July-September 1990	32
12 Radionuclide concentrations in surface water around ORNL, July-September 1990	33
13 Radionuclide concentrations at ORNL NPDES locations, July-September 1990	37
14 Stream flows, July-September 1990	39
15 Radionuclide concentrations and releases at ORNL, July 1990	40
16 Radionuclide concentrations and releases at ORNL, August 1990	41

List of Tables (continued)

Table		Page
17	Radionuclide concentrations and releases at ORNL, September 1990	42
18	Surface Water Analyses at Reference Locations, July-September 1990	45
19	NPDES discharge point X01, July-September 1990	50
20	NPDES discharge point X02, July-September 1990	51
21	NPDES discharge point X12, July-September 1990	52
22	NPDES discharge point X13, July-September 1990	53
23	NPDES discharge point X14, July-September 1990	54
24	NPDES discharge point X15, July-September 1990	55
25	NPDES cooling towers, July-September 1990	56
26	NPDES miscellaneous outfalls, July-September 1990	56
27	NPDES discharge point category I outfalls, July-September 1990	57
28	NPDES discharge point category II outfalls, July-September 1990	57
29	NPDES discharge point category III outfalls, July-September 1990	58
30	NPDES noncompliances, July 1990	58
31	NPDES noncompliances, August 1990	59
32	NPDES noncompliances, September 1990	60
33	Concentrations of I-131 in milk and calculated doses, July-September 1990	73
34	Concentrations of total radioactive Sr in milk and calculated doses, July-September 1990	74

EXECUTIVE SUMMARY

Mark F. Tardiff

Each section of this report consists of a program description; results for the quarter; and an analysis of trends over the previous two years, depending upon the availability of data. The analyst who produced each section is identified in order to facilitate the reader in following up any questions regarding the data or the analysis approach. The reader is directed to the trend subsections for more in-depth summaries of each data section.

Airborne Emissions and Ambient Air

Emissions of tritium to the atmosphere were the highest that they have been in the previous four quarters. The Isotope Solid-State Ventilation System (3039-3) is the major airborne source of tritium. Iodines from Melton Valley (7911 Stack) showed a nominal twofold increase over the previous quarter's results. Other airborne emissions were consistent with recent monitoring results.

Ambient air sampling around Oak Ridge National Laboratory (ORNL) and the reservation showed that I-131 and H-3 continue to be at concentrations of less than 0.01% of the derived concentration guides (DCG) for these isotopes.

Surface Water

Tritium and strontium concentrations at White Oak Dam were at 6.1% and 17% of their DCGs for the quarter, respectively. All of the other radionuclides that were evaluated at the dam were at 1% or less of their DCGs. These values are slightly lower than last quarter. The concentration of total radioactive strontium at Melton Branch is lower than the previous quarter. This concentration has risen consistently for the last four quarters.

The NPDES compliance ratio for this quarter was 98.4% due to 24 noncompliances. Fourteen of the exceedences were due to measurements taken at the category outfalls. This has been a chronic problem for the ORNL. Six of the exceedences were associated with cooling tower effluents. Two violations were associated with the Coal Yard Runoff Treatment Facility, and one violation was associated with the Sewage Treatment Plant and the Nonradiological Wastewater Treatment Facility, respectively.

Biological Monitoring

Iodine in milk was detected at one of the five sampling stations during the quarter. Total radioactive strontium in milk was detected at three of the stations. The concentrations were less than 1% of the respective DCGs. The detection of iodine in milk coincides with the increase of iodine emissions in Melton Valley.

1. INTRODUCTION

The Environmental Surveillance and Protection Section within the Office of Environmental and Health Protection at the Oak Ridge National Laboratory (ORNL) is responsible for the development and implementation of an environmental program to (1) ensure compliance with all federal, state, and Department of Energy (DOE) reporting requirements to quantitatively demonstrate prevention, control, and abatement of environmental pollution; (2) monitor the adequacy of containment and effluent controls; and (3) assess impacts of releases from ORNL facilities on the environment.

The current environmental program is designed primarily to evaluate off-site impacts, to meet regulatory requirements and the DOE directives, and to provide a continuity of data on environmental media at unregulated locations. The major legislation affecting the environmental program at DOE facilities includes the Clean Water Act, the Clean Air Act, the Resource Conservation and Recovery Act, and the Superfund Amendments and Reauthorization Act. In November 1988, DOE finalized Order 5400.1, "General Environmental Protection Program" that establishes the requirements, authorities, and responsibilities for DOE operations for ensuring compliance with applicable federal, state, and local environmental protection laws and regulations. This order sets forth the requirements for both radiological and nonradiological monitoring. DOE Order 5400.5, "Radiation Protection of the Public and the Environment," specifies the guidelines for releases of radionuclides to various media. Definitive radiological monitoring requirements have been established, and additional guidance on recommended procedures and activities is provided in 10 CFR 834 (formerly Draft DOE Order 5400.6), "Radiological Effluent Monitoring and Environmental Surveillance."

Environmental monitoring, as defined by 10 CFR 834, consists of two major activities: effluent monitoring and environmental surveillance. Effluent monitoring is the collection and analysis of samples or measurements of liquid and gaseous effluents. Environmental surveillance is the collection and analysis of samples or direct measurements of air, water, soil, foodstuff, biota, and other media from DOE sites and their environs.

Monthly or quarterly summaries are presented in this report for each of the media sampled. All data are rounded to two significant digits. The summary tables generally give the number of samples collected during the period and the maximum, minimum, average, and standard error of the mean (SE) values of parameters for which determinations were made. This value is based on multiple samples collected throughout the period. It includes the random uncertainty over time and space associated with sampling, analysis, and the intrinsic variability of the media. The random uncertainty is a statement of precision (or imprecision), a measure of the reproducibility or scatter in a set of successive measurements, and an indication of the stability of the average value for the parameter. When differences in the magnitudes of the observations are small, the SE is small, and the precision is said to be high; when the differences are large, the SE is large, and the precision is low. Average values have been compared where possible to applicable guidelines,

criteria, or standards as a means of evaluating the impact of effluent releases or environmental concentrations.

In some of the tables, radionuclide concentrations are compared with derived concentration guides (DCGs) as published in DOE Order 5400.5. These concentration guides were established for drinking water and inhaled air and are guidelines for the protection of the public. DOE Order 5400.5 defines a DCG as the concentration of a radionuclide in air or water for which, under conditions of continuous exposure by one exposure pathway (i.e., drinking water, inhaling air, submersion) for year, a "reference man" would receive the most restrictive of (1) an effective dose equivalent of 100 mrem or (2) a dose equivalent of 5 rem to any tissue, including skin and lens of the eye. A "reference man" is a hypothetical human who is assumed to inhale 8400 m³ of air in a year and to drink 730 L of water in a year. When there are multiple DCGs for a given isotope, the most restrictive value is used for comparisons. When the percent of the DCG is less than 0.01, the percent is reported as "<0.01." When total radioactive Sr is measured, it is compared to the DCG for Sr-90, which is the most restrictive value.

Radioactivity measurements are reported as the net activity, or the difference between the gross activity and background activity. Because of the intrinsic uncertainties associated with making radiation measurements, it is possible to subtract a background value from a sample result and get a negative number. Results that include the negative values can be evaluated statistically without incurring the difficulties associated with performing calculations on "less than" (<) values. Radiation measurements are reported in units of becquerel (Bq). A Bq is a Systeme Internationale unit equivalent to 1 disintegration per second.

Single measurement values and multiple value summaries are tested for their difference from zero using the t statistic and a one tailed test at a confidence limit of 95%. Occasionally, the result will be declared as different from zero by the statistical test when in fact it is not. The frequency of this error is directly related to the confidence limit of the test. Since the specified confidence limit for the test is 95%, there is 5% chance of being incorrect. This is a commonly used confidence limit that represents a compromise between incorrectly determining that a value is significant and incorrectly determining that a value is not significant.

The lower confidence limit for a single radioactivity measurement is computed by multiplying the counting standard deviation by 1.645 (t value, one-tail test at 95% confidence). If the sample result minus the lower confidence limit is equal to or less than zero, the result is said to be not significantly different from zero. If the sample result minus the lower confidence limit is greater than zero, the result is said to be significantly greater than zero.

Multiple value summaries are of two types: averages and sums. Averages are tested for a significant difference from zero using the standard error of the mean and the appropriate t value with n-1 degrees of freedom. The counting uncertainty is intrinsically incorporated in the estimate of sample variance. Consequently, the estimate of uncertainty for an average of radioactivity

measurements is propagated across the measurement uncertainty, sampling variability, and population variability. Sums are tested for a significant difference from zero using only the measurement uncertainties. The lower bound is computed by multiplying the square root of the summed counting variances by 1.645. Estimates of sampling and population variability for sums are not presently available; thus, these errors cannot be propagated.

Presentations of radioactivity data throughout the report follow the convention of flagging data which are statistically significant with an asterisk. Data that are not significantly different from zero are presented without a flag.

Chemical concentrations that are below the analytical detection limit are expressed as "less than" (<) values. In computing the average values, "less than" results are assigned the detection limit. The average value is expressed as less than the computed value when at least one of the results used for the average is less than the detection limit.

2. AIR

Martha M. Stevens and Mark F. Tardiff

Airborne emissions from Department of Energy (DOE) facilities are regulated under the provisions of the Clean Air Act (CAA), DOE orders, and the Tennessee Air Quality Control Act. The Environmental Protection Agency (EPA) has authority and responsibility for enforcing the regulations associated with the CAA. The regulatory criteria for CAA are promulgated in Title 40 Code of Federal Regulations (CFR) Parts 50-80. In particular, 40 CFR 61 establishes the National Emission Standards for Hazardous Air Pollutants (NESHAP). Authority for nonradioactive air pollutants in Tennessee has been delegated by the EPA to the state. The DOE orders are enforced at the local level through the Oak Ridge National Laboratory (ORNL) Directorate for Environmental, Safety, and Health Compliance. Airborne emissions are addressed in DOE Orders 5400.1 and 5400.5 and in Regulatory Guide 5400.6.

ORNL has monitoring requirements for radioactive emissions only. These are NESHAP standards based on calculated annual dose to off-site individuals. In addition, DOE orders require that the collective dose be calculated for the population within 80 km of the site.

The monitoring and surveillance of airborne emissions at ORNL is a two-tiered program. The first tier consists of source term emissions sampling and quantification for each stack that is an emission point for processes involving radioactive materials. These data are used in calculating the annual dose associated with operations at the facility. The second tier consists of ambient air sampling systems located within the boundary of the facility, on the reservation perimeter, and at remote locations assumed to be unaffected by facility operations. These data are used to measure the impact of ORNL operations on the surrounding area and to provide empirical data for assessing the inhalation and external pathways of exposure.

2.1 AIRBORNE EMISSIONS

2.1.1 Program Description

The major gaseous emission point sources at ORNL consist of eight stacks. They are as follows:

<u>Building</u>	<u>Description</u>
2026	High Radiation Level Analytical Laboratory
3020	Radiochemical Processing Plant
3039	Duct 1 - 3500 and 4500 Areas Cell Ventilation Systems
	Duct 2 - Central Off-gas and Scrubber System
	Duct 3 - Isotopes/Solid State Ventilation System
	Duct 4 - 3025 and 3026 Areas Cell Ventilation Systems
7025	Tritium Target Fabrication Facility
7830	Melton Valley Storage Tank Facility
7911	Melton Valley Complex (High Flux Isotope Reactor and Radiochemical Engineering Design Center)
7512	Molten Salt Reactor Facility
6010	Electron Linear Accelerator Facility

The locations of the stacks are shown in Fig. 1. Each of these point sources is provided with a variety of surveillance instrumentation, including radiation alarms, near real-time monitors, and continuous sample collectors. Only data resulting from the analysis of the continuous samples are used in this report. The other equipment does not provide data of sufficient accuracy and precision to support the quantitation of emission source terms. Data are presented for all stacks except the Electron Linear Accelerator Facility (Building 6010), where continuous sampling equipment is not presently installed.

The sampling systems generally consist of in-stack sampling probes, sample transport piping, a 47-mm-diameter particulate filter, a 47-mm-diameter by 25-mm-thick activated-charcoal canister, a silica gel tritium trap, flow measurement and totalizing instruments, a sampling pump, and return piping to the stack. The sampling system for the tritium target facility (Stack 7025) is configured with a tritium trap only. The sampling systems at Stacks 2026, 3020, and 7512 do not have tritium traps.

The sampling media are collected and evaluated weekly. The particulate filters are analyzed for gross alpha and gross beta activity. Gross alpha and gross beta measurements are made eight days after the samples are collected to reduce the contribution of short-lived natural radionuclides to the measurement. The silica gel samples are composited and analyzed biweekly for tritium. The charcoal canisters are analyzed each week by gamma spectrometry. Because of the prevalence of iodine isotopes in the point source emissions, values are reported for I-131 and I-133 each week. Data for other gamma-emitting isotopes are opportunistically captured. If an isotope is present at an activity above the analytical instrument and sample background, the value is reported. Typically there are 13 data values for gross alpha, gross beta, I-131 and I-133. In a particular quarter, some isotopes may be represented by fewer than 13 values because they were not detected in all of the sampling events. Normally there are six values for each tritium emission sampler because the weekly samples are analyzed as biweekly composites.

The particulate filters collected during a quarter are held and composited at the end of the quarter. A laboratory analysis identifies and measures the activity level of specific long-lived radionuclides present in the composite. In order to include all samples from the quarter in the analysis, results for a particular quarter are presented in the report for the following quarter.

Data are not presented in this report for noble gases or for I-125 and I-129 emissions. A program is being developed to validate the noble gas data, and analytical methods are being investigated that will address spectral interferences associated with the detection and quantitation of the iodines. Noble gas data are presented in the annual environmental report for the Oak Ridge Reservation. A summary of I-125 and I-129 emissions by month will be presented in the environmental surveillance data report for the fourth quarter.

Fig. 1. Location map of major stacks (emission points) at ORNL.

2.1.2 Procedures and Results

Emission of gross alpha, gross beta, or a specific radionuclide is calculated from the laboratory-measured activity in the sample and a conversion factor for flow. On upgraded systems in which sample flow totalizers have been installed, measured activity values are multiplied by a conversion factor that is the ratio of the total stack or duct discharge for the sampling period divided by the total sample flow during the period. For the older sampling systems at Stacks 2026, 3020, and 7512, the conversion factor consists of the average stack discharge rate divided by the average sampling rate.

All emissions data are presented in units of 10^6 Bq. Data reporting conventions are provided in the report introduction. Negative activity values are converted into negative emissions. These values represent the random uncertainty associated with quantifying emissions. Although negative emissions values can be used to infer the total measurement system uncertainty for a given isotope, the inference must be isotope-specific. Extrapolating across isotopes is not valid because the uncertainty for each isotope is unique.

Sums of weekly emission values for particular radionuclides are tested for statistical significance using the laboratory counting uncertainty associated with each measured activity. If the 95% lower bound calculated from the variance of the sum is greater than zero, then the sum is determined to be significantly different from zero. The variance used in the test is based only on the counting uncertainty; it does not include uncertainty due to the sampling process.

Table 1 presents the airborne radionuclide emissions for the third quarter, listing total emission for each isotope and the percent of the total contributed by each stack. The percent values are based on summed emissions for the quarter from each stack. In the table, percents derived from sums that were determined to be significantly different from zero are marked with an asterisk.

During this quarter, the radioactive airborne emissions from the Laboratory consisted primarily of H-3, Pb-212, I-131, I-133, and I-135. Most of the H-3 originated at Stack 3039-3, the Isotopes/Solid State Ventilation System (90%, 78×10^{12} Bq). The other large amount came from Stack 7025 at the Tritium Target Fabrication Facility (9%, 8.5×10^{12} Bq), where some release from traps occurred during shutdown procedures of the production facility.

Virtually all of the total I-131 (3.1×10^8 Bq), I-133 (3.0×10^8 Bq), and I-135 (2.3×10^8 Bq) was emitted from Stack 7911 in the Melton Valley Complex. Contributions from other stacks were all well under 1% of the total iodine emissions. The largest part of the total Pb-212 reported for the quarter came from Stack 3039-2 (6.6×10^8 Bq). Stack 3020 contributed 1.2×10^8 Bq and Stack 2026 accounted for 0.85×10^8 Bq of Pb-212. Virtually all of the reported Os-191 was released at Stack 3039-4 (3.0×10^6 Bq). A smaller amount (0.031×10^6 Bq) was released at Stack 3039-3.

Table 1. Airborne emissions of radionuclides from ORNL, July-September 1990

Radionuclide	Percent contribution by stack ^{a,b}						Total Emission (10 ⁶ Bq)
	2026	3020	3039	7025	7830	7911	7512
Au-194			100 *				0.081
Co-60			100 *				1.4
Cs-137	80 *	8.0 *	12 *				0.15
H-3			90 *	9.7 *		0.025 *	87,000,000
I-131	0.015 *	0.0048	0.031		0.15 *	100 *	0.00031
I-133	0.0065	<0.0001	0.075 *		0.16 *	100 *	<0.0001
I-135	<0.0001	0.0058	<0.0001		0.12 *	100 *	<0.0001
Os-191			100 *				3.0
Pb-212	8.8 *	12 *	73 *		0.79 *	5.6 *	0.096 *
Gross alpha	50 *	19 *	14 *		13 *	0.51	3.4 *
Gross beta	14 *	16 *	31 *		32 *	5.2 *	0.67 *

^aTotal percentages that exceed 100 are due to rounding.

^bValues marked with an asterisk represent emissions statistically determined to be significantly different from zero. Note that the variance used in the significance test is based only on the uncertainty associated with laboratory counting and does not include uncertainty due to the sampling process.

The same procedures and conventions used in calculating emissions based on the weekly samples are used for the quarterly composite sample. The only exception occurs in the determination of statistical significance. Because the emission value for a long-lived radionuclide in the composite is based on a single measured activity, the 95% lower bound is calculated from the uncertainty associated with that single measurement. For the summed weekly emissions, the 95% lower bound is calculated from the variance of the sum.

Table 2 presents the airborne emissions of long-lived radionuclides detected in the composite of particulate filters collected during the second quarter of 1990. Following the same form as Table 1, it lists total emission for each radionuclide and the percent of the total contributed by each stack. In Table 2, the percent values are calculated using only those emissions that are significantly different from zero. No test for statistical significance is applied to the uranium emissions, which are based on laboratory measurements for which no uncertainty values are available.

The largest percentages of long-lived radionuclides were contributed by Stack 2026 and by the ducts at Stack 3039. The largest emission was Cs-137, with 0.38×10^6 Bq, mostly from Stack 2026 (0.34×10^6 Bq) and Stack 3039 (0.03×10^6 Bq). The next largest, 0.087×10^6 Bq of total Sr, came from Stack 2026 (0.042×10^6 Bq), Stack 3039 (0.026×10^6 Bq), and Stack 3020 (0.015×10^6 Bq). The four ducts at Stack 3039 accounted for virtually all of the total emission of Be-7 (0.077×10^6 Bq).

2.1.3 Trends

During the third quarter, tritium emissions were significantly higher than those reported for preceding quarters. The total H-3 for this quarter was 87×10^{12} Bq, compared with 33×10^{12} Bq for second quarter and 4.1×10^{12} Bq for first quarter. Emissions from the largest source, Stack 3039-3, increased from 30×10^{12} Bq in the second quarter to 78×10^{12} Bq in this quarter. Some portion of the increase is attributed to improvements in the tritium sampling systems.

Iodine levels were, in general, higher than those reported for the last two quarters. The only significant source, Stack 7911, showed increases in all reported iodine isotopes. Emissions of I-131 at the stack more than doubled, up from 140×10^6 Bq to 310×10^6 Bq; I-133 emissions also increased, from 200×10^6 Bq to 290×10^6 Bq. The usual small sources of iodine showed only minor fluctuations in iodine levels as compared with the last several quarters.

Total emissions of Pb-212 also showed an increase this quarter, up from 600×10^6 Bq in the second quarter to 970×10^6 Bq in the third quarter. A marked increase is shown at 3039-2, with an emission of 660×10^6 Bq, compared with the more typical emission of 290×10^6 Bq of last quarter. The general increase was partially offset by a decrease at Stack 7911, from 99×10^6 Bq to 54×10^6 Bq.

Table 2. Particulate airborne emissions of long-lived radionuclides from ORNL, April-June 1990

Radionuclide	Percent contribution by stack ^a				Total Emission (10 ⁶ Bq)
	2026	3020	3039	7911	
Be-7			100		0.077
Co-60	11	34	55		0.0075
Cs-134	100				0.0016
Cs-137	89	2.9	8.4	0.23	0.38
Eu-155	100				0.0020
Pu-238	85	15			0.0017
Pu-239	79	21			0.0062
Th-228	90	9.7		0.79	0.0015
Th-230	16		71	13	0.000099
Th-232	4.7	23	56	17	0.00011
Total Sr	48	17	30	4.3	0.087
U			100		0.00011

^aTotal percentages that exceed 100 are due to rounding.
 Note: Percentages are calculated using only those emissions that are significantly different from zero.
 No significance test was applied to emission values for uranium, which are based on measurements for which no associated uncertainty is available.

Total Os-191 emission for this quarter was 3.0×10^6 Bq, down from 46×10^6 Bq in the second quarter and down from 2.2×10^9 Bq in first quarter. As usual, virtually all of the Os-191 was detected at Stack 3039-4.

2.2 AMBIENT AIR

2.2.1 Program Description

Most gaseous wastes from ORNL are released to the atmosphere from stacks. Radioactivity may be present in gaseous waste streams as a solid (particulates), as an adsorbable gas (e.g., iodine), or as a nonadsorbable species (noble gas). At ORNL, gaseous wastes that may contain radioactivity are processed to reduce the radioactivity to acceptable levels before the wastes are discharged to the atmosphere. As described in Sect. 2.1, airborne emissions are monitored as they leave the stacks. In addition, radioactivity in the atmosphere is continuously monitored at 18 stations placed around ORNL, the Oak Ridge Reservation (ORR), and the surrounding area. The ambient air monitoring stations are categorized into three groups according to their geographical locations:

1. The ORNL perimeter air monitoring (PAM) network consists of stations 3, 7, 9, 20, 21, and 22. These six stations, located at or near the ORNL boundary as shown in Fig. 2, provide data used to assess the impact of operations at ORNL on ambient air.
2. The ORR PAM network consists of stations 23, 33, 34, and 40-46, also shown in Fig. 2. The reservation PAM stations, located at or near the ORR boundary, provide data on effects from operations on the reservation.
3. The remote air monitoring network consists of stations 52 and 58. These stations, located within a 120-km radius of ORNL outside the ORR boundary, as shown in Fig. 3, provide reference data from areas not expected to be affected by operations on the ORR.

All ORNL stations and reservation stations 33, 34, and 40-46 have real-time monitors for five radiation parameters, including gross alpha, gross beta, iodine, gross gamma, and noble gas. The primary purpose of the monitoring system is to determine whether radiation levels on the reservation are above background levels. If radiation levels appear to be higher than normal, additional sampling can be initiated to provide quantitative measures of concentrations in the atmosphere.

Ambient air is sampled continuously at all 18 stations. Airborne radioactive particulates are collected by pumping a continuous flow of air through a paper filter. Then, at most stations, the air flows through a cartridge packed with activated charcoal to collect adsorbable gases. The filter papers are collected and analyzed biweekly for gross alpha and gross beta activity. The filter papers are analyzed four days after collection to minimize artifacts

Fig. 2. Location map of ORR and ORNL PAM stations.

Fig. 3. Location map of RAM stations.

from short-lived radionuclides and again after eight days for comparability with similar data in the airborne emissions program. (A departure from normal analysis procedures during second quarter 1990 is described in the results section.) The charcoal cartridge samples are collected concurrently with the particulate filters and analyzed within 24 h for adsorbed radioactive gases by gamma spectrometry. Iodine-131 is reported for each sample. Other radionuclides on the charcoal are opportunistically captured; they are reported only when present above instrument and sample background. The date, time, and flow value are recorded each time a sample medium is mounted or removed. The total volume of air that flowed through the sampler during the sampling period is obtained from a flow totalizer installed at each station. The concentration of radionuclides in the sampled air is calculated by dividing the total activity in the sample by the total volume of air sampled.

In addition to the biweekly analyses, the particulate filters are composited annually and analyzed for specific radionuclides of uranium, thorium, and plutonium and for total strontium. The composite provides a larger sample volume and allows more precise measurement of activity. Annual analysis is valid because the isotopes of interest are all long-lived. Results from analyses of composites prepared at the end of the fourth quarter of 1989 were summarized in the report for that quarter. The next summary of specific isotopes will appear in the report for the fourth quarter of 1990.

Monthly samples for atmospheric tritium are collected from air monitoring station 3, at the west end of ORNL, and from station 8, located east of ORNL. At these stations, atmospheric tritium in the form of water vapor is removed from the air in silica gel. In the analytical laboratory, the silica gel is heated in a distillation flask to remove the moisture, and the distillate is counted in a liquid scintillation counter. The concentration of tritium in the air is calculated by dividing the total activity in the sample by the total volume of air sampled.

2.2.2 Procedures and Results

Concentrations of gross alpha and gross beta for second and third quarters of 1990 are presented in Tables 3-6. Concentrations of atmospheric I-131 and atmospheric tritium for third quarter are summarized in Tables 7 and 8, respectively. Data reporting conventions, including negative numbers, are addressed in the report introduction.

Normally, laboratory analysis of the particulate filters for gross alpha and gross beta occurs four days after collection to allow decay of naturally occurring short-lived radionuclides. The measurements can then provide a more realistic view of the impact on ambient air from facility operations. However, in the second quarter, concomitant with a change in laboratories, analysis of the filters was performed within 24 h of collection. As a result, all measured values of gross alpha and gross beta activity were well above normal and could not be used as indicators of concentration relative to previous data. To make the data useful for other reports and for comparisons, a method to adjust the measured activities to include expected decay has been developed. The adjustment was statistically determined, based on results from time-staged analyses of samples from the same stations. The adjustment has

Table 3. Gross alpha activity at ambient air stations, July-September 1990

		Concentration (10^{-8} Bq/L)			
Station	Number of samples	Maximum	Minimum	Mean ^a	Standard error of mean
ORNL PAM Stations ^b					
3	6	21	5.0	9.3 *	2.4
7	6	13	1.5	6.9 *	1.9
9	6	13	2.9	5.8 *	1.5
20	6	16	4.4	8.3 *	1.8
21	3	6.3	2.6	4.7 *	1.1
22	6	15	5.1	11 *	1.6
Summary	33	21	1.5	7.9 *	0.80
ORR PAM Stations ^b					
23	6	15	1.2	6.3 *	2.0
33	6	16	4.0	9.2 *	1.7
34	5	14	4.6	8.9 *	1.7
40	6	14	4.7	8.0 *	1.6
41	6	10	5.3	6.9 *	0.73
42	6	22	1.6	9.6 *	3.1
43	6	11	1.2	5.0 *	1.4
44	6	17	3.1	6.9 *	2.0
45	6	15	4.2	8.9 *	1.7
46	6	21	6.7	11 *	2.2
Summary	59	22	1.2	8.1 *	0.60
RAM Stations ^c					
52	4	28	2.8	11	5.7
58	2	8.0	0.082	4.0	3.9
Summary	6	28	0.082	8.7 *	4.0
Overall Summary	98	28	0.082	8.1 *	0.50

^aMeans marked with an asterisk (*) are statistically determined to be significantly different from zero.

^bLocations of ORNL and ORR perimeter stations are shown in Fig. 2.

^cLocations of remote stations are shown in Fig. 3.

Table 4. Gross beta activity at ambient air stations, July-September 1990

Station	Number of samples	Concentration (10^{-8} Bq/L)			
		Maximum	Minimum	Mean ^a	Standard error of mean
ORNL PAM Stations ^b					
3	6	180	60	110 *	19
7	6	130	45	82 *	14
9	6	120	43	80 *	14
20	6	150	59	110 *	14
21	3	140	53	84	29
22	6	260	69	140 *	30
Summary	33	260	43	100 *	8.4
ORR PAM Stations ^b					
23	6	130	42	88 *	12
33	6	160	57	120 *	15
34	5	120	62	95 *	12
40	6	150	45	96 *	16
41	6	140	58	96 *	11
42	6	110	54	91 *	8.7
43	6	150	46	93 *	14
44	6	130	48	90 *	15
45	6	130	49	98 *	14
46	6	190	73	130 *	17
Summary	59	190	42	99 *	4.4
RAM Stations ^c					
52	4	230	89	140 *	34
58	2	130	17	73	56
Summary	6	230	17	120 *	29
Overall Summary	98	260	17	100 *	4.2

^aMeans marked with an asterisk (*) are statistically determined to be significantly different from zero.

^bLocations of ORNL and ORR perimeter stations are shown in Fig. 2.

^cLocations of remote stations are shown in Fig. 3.

Table 5. Estimated gross alpha activity at ambient air stations, April-June 1990

Station	Number of samples	Concentration (10^{-8} Bq/L)			
		Maximum	Minimum	Mean ^a	Standard error of mean
ORNL PAM Stations ^b					
3	7	9.3	0.45	3.4 *	1.1
7	7	5.9	0.70	2.4 *	0.71
9	7	4.5	0.56	2.5 *	0.46
20	7	6.9	0.59	3.1 *	0.88
21	7	3.0	0.39	1.6 *	0.39
22	7	8.8	0.91	4.4 *	1.0
Summary	42	9.3	0.39	2.9 *	0.34
ORR PAM Stations ^b					
23	7	3.8	0.41	1.9 *	0.50
33	7	6.6	1.1	3.5 *	0.88
34	7	7.6	0.58	4.0 *	1.1
40	7	8.8	1.4	4.8 *	1.2
41	7	5.2	0.89	2.4 *	0.57
42	7	6.5	1.4	3.2 *	0.65
43	6	4.6	1.1	2.8 *	0.61
44	7	4.3	0.43	2.5 *	0.55
45	7	6.5	0.47	3.3 *	0.79
46	7	9.0	0.25	3.8 *	1.2
Summary	69	9.0	0.25	3.2 *	0.27
RAM Stations ^c					
52	6	6.6	0.47	3.2 *	0.93
58	4	15	0.66	4.7	3.6
Summary	10	15	0.47	3.8 *	1.4
Overall Summary	121	15	0.25	3.2 *	0.22

^aMeans marked with an asterisk (*) are statistically determined to be significantly different from zero.

^bLocations of ORNL and ORR perimeter stations are shown in Fig. 2.

^cLocations of remote stations are shown in Fig. 3.

Table 6. Estimated gross beta activity at ambient air stations, April-June 1990

Station	Number of samples	Concentration (10 ⁻⁸ Bq/L)			
		Maximum	Minimum	Mean ^a	Standard error of mean
ORNL PAM Stations ^b					
3	7	100	27	53 *	11
7	7	100	22	52 *	11
9	7	89	22	50 *	9.1
20	7	100	21	57 *	12
21	7	130	17	46 *	14
22	7	120	28	68 *	14
Summary	42	130	17	54 *	4.8
ORR PAM Stations ^b					
23	7	110	17	43 *	12
33	7	110	24	55 *	12
34	7	99	18	57 *	12
40	7	90	29	59 *	10
41	7	93	23	50 *	9.9
42	7	100	29	56 *	12
43	6	96	27	50 *	11
44	7	100	16	47 *	11
45	7	96	28	59 *	10
46	7	130	19	63 *	16
Summary	69	130	16	54 *	3.6
RAM Stations ^c					
52	7	110	1.7	51 *	15
58	4	100	2.2	72 *	23
Summary	11	110	1.7	59 *	13
Overall Summary	122	130	1.7	55 *	2.8

^aMeans marked with an asterisk (*) are statistically determined to be significantly different from zero.

^bLocations of ORNL and ORR perimeter stations are shown in Fig. 2.

^cLocations of remote stations are shown in Fig. 3.

Table 7. Atmospheric I-131 concentrations at ambient air stations, July-September 1990

Station	Number of samples	Concentration (10^{-8} Bq/L)				Percent of DCG ^b
		Maximum	Minimum	Mean ^a	Standard error of mean	
ORNL PAM Stations ^c						
3	6	25	-5.3	3.9	4.4	<0.01
7	6	1.6	-12	-4.0	1.9	
9	6	12	-7.9	-0.076	2.9	
20	6	18	0.66	5.5 *	2.6	
21	4	2.6	-47	-11	12	
22	6	47	-46	0.37	12	
Summary	34	47	-47	-0.34	2.7	
ORR PAM Stations ^c						
23	6	25	-3.4	6.4	4.1	<0.01
34	5	31	1.6	11	5.3	
40	6	8.8	-3.4	3.5 *	1.6	
41	6	2.9	-15	-3.9	2.9	
44	6	3.8	-4.6	-0.41	1.6	
45	6	2.4	-39	-8.1	6.4	
46	6	13	-51	-6.6	9.3	
Summary	41	31	-51	-0.016	2.1	
Overall Summary	75	47	-51	-0.16	1.7	

^aMeans marked with an asterisk (*) are statistically determined to be significantly different from zero.

^bPercent of derived concentration guide (DCG) = Mean/DCG x 100. The DCG for I-131 is 1.5×10^{-2} Bq/L. This value is reported only for means that are significantly greater than zero.

^cLocations of ORNL and ORR perimeter stations are shown in Fig. 2.

Table 8. Atmospheric tritium concentrations at ambient air stations, July-September 1990

Station ^a	Number of samples	Concentration (10^{-4} Bq/L)				Percent of DCG ^c
		Maximum	Minimum	Mean ^b	Standard error of mean	
3	3	6.2	0.97	2.9	1.7	
8	3	7.6	0.84	3.4	2.1	
Overall Summary	6	7.6	0.84	3.2 *	1.2	<0.01

^aStation locations are shown in Fig. 2.

^bMeans marked with an asterisk (*) are statistically determined to be significantly different from zero.

^cPercent of DCG = $\text{Mean/DCG} \times 100$. The DCG for tritium is 3.7 Bq/L. The concentration guide assumes that 50% of the tritium is absorbed through the skin. This value is reported only for means that are significantly greater than zero.

been applied to the measured first-day values to estimate fourth-day values. The estimated second-quarter concentrations of gross alpha and gross beta are presented in Tables 5 and 6.

Summary data for gross alpha activity detected at stations in the three air monitoring networks in the third quarter are presented in Table 3. Estimated average concentration values from all stations were statistically determined to be significantly different from zero. In the ORNL network, the maximum concentration (21×10^{-8} Bq/L) occurred at station 3, at the west end of the plant. The maximum concentration reported in the ORR network (22×10^{-8} Bq/L) occurred at station 42, near the Oak Ridge Gaseous Diffusion Plant (ORGDP). The highest average concentration over all three networks was reported at ORNL station 22 and ORR station 46, both with an average of 11×10^{-8} Bq/L. As usual, there was no statistical difference in average alpha activity among the ORNL, ORR, and remote networks.

Summary data for gross beta activity in the third quarter are given in Table 4. All average concentration values are marked as significantly different from zero except for the averages computed for ORNL station 21 from only three samples and for remote station 58 from only two samples. In the ORNL network, the maximum gross beta concentration, 260×10^{-8} Bq/L, occurred at station 22. The maximum concentration reported in the ORR network, 190×10^{-8} Bq/L, occurred at station 46. The highest average concentrations over all three networks were reported from ORNL station 22, with 140×10^{-8} Bq/L, and from ORR station 46, with 130×10^{-8} Bq/L. There was no statistical difference in average beta activity among the three networks in the third quarter.

The maximum values associated with ORNL station 22 are probably the result of the sampler intake being too close to the ground. This configuration captures a disproportionately high amount of naturally occurring radioisotopes from the soil surface. The station was designed and installed prior to modern day technical specifications, such as those found in the draft 5400 series DOE orders. The location does not provide useful information about facility operations because it is located near the Dosimetry Applications Research facility, which has been shut down. Its location is also a poor choice for reservation perimeter monitoring because it does not intercept a major wind rose direction from the operating facilities. Pending DOE approval, station 22 will be removed from operation.

A summary of atmospheric I-131 concentrations in the third quarter is presented in Table 7. Average concentration values for I-131 at only two stations were determined to be significantly different from zero; both average values are reported as less than 0.01% of the DCG.

Concentrations of atmospheric tritium for the period are summarized in Table 8. The means for each of the two stations were not significantly greater than zero. The pooled mean is significantly greater than zero due to the increased number of samples and the smaller associated t value. The airborne concentration represented by the pooled mean is less than 0.01% of the DCG for tritium.

2.2.3 Trends

Compared with summary results from the last six quarters, concentrations of gross alpha showed some increase in third quarter 1990. Average network concentrations of gross alpha for this quarter were about 8×10^{-8} Bq/L; in previous quarters, they have ranged from 3×10^{-8} to 4.5×10^{-8} Bq/L. The apparent increase in the gross alpha results is believed to be an artifact of sampling system improvements. These nominally elevated values should persist through subsequent quarters. In similar comparisons, concentrations of gross beta, I-131, and tritium showed little difference or were slightly lower. All average concentrations fell within expected ranges.

2.3 EXTERNAL GAMMA RADIATION

Anita E. Osborne-Lee

2.3.1 Program Description

External gamma radiation measurements (exposure rates) are recorded on a near real-time data acquisition system at ORNL and reservation perimeter air monitoring stations. The location of these PAMs are shown in Fig. 2. The readings are averaged at 10-min intervals and stored in a database on the host computer. From these data, hourly averages are computed and also stored in a database. Readings are marked as invalid by the system if less than 75% of data is available for the computation of the average, as well as if the data are out of a predefined range. If a station has been marked off poll, there will be no readings returned to the data acquisition system for inclusion into the databases.

2.3.2 Procedure and Results

The valid hourly averages for the quarter are queried from the data acquisition system database and processed by a statistical program to produce the maximum, minimum, and average hourly measurements. The equivalent dose rate is calculated using the average reading for each station during the quarter. Table 9 summarizes these measurements for the third quarter of 1990.

The high hourly average at station 36 was on July 14, 1990, at 4 a.m. There were two other anomolous averages during that same time frame. One was at 3 a.m.; the other was on July 13 at 11 p.m. The theory is that the anomolous occurence around the station caused all three averages to be well above normal.

2.3.3 Trends

Typical external gamma exposure rates for cities in the United States are usually between 1.5 and 4.2 nC/kg/h (nanocoulomb per kilogram per hour) according to the recent issues of EPA Environmental Radiation Data. The median value for cities in the contiguous United States for the first three quarters of 1989 was 2.4 nC/kg/h. The last value given for Knoxville (July - September 1989) was 2.4 nC/kg/h. All of the values given in Table 9 are close

Table 9. External gamma radiation measurements at ORNL and reservation perimeter air monitoring stations, July-September 1990

Location	Number of Samples ^b	Exposure rate(nC/kg/h) ^a				Equivalent Dose (uSv/h)
		Max	Min	Av	Standard error ^c	
ORNL PAM Stations ^d						
04	2157	36	23	28	0.049	1.1
07	11	1.6	1.4	1.5	0.014	0.057
20	2124	3.2	2.1	2.2	0.0026	0.087
Network summary	4292	36	1.4	15	0.20	0.58
ORR PAM Stations ^e						
08	788	3.1	1.7	1.9	0.0045	0.074
31	1090	2.9	1.9	2.0	0.0024	0.079
33	1975	3.0	1.5	1.8	0.0032	0.071
34	1928	5.5	1.9	2.0	0.0032	0.079
36	1066	23	1.7	1.9	0.032	0.074
40	1280	3.5	2.0	2.2	0.0038	0.086
41	1948	1.7	1.4	1.4	0.00062	0.055
42	58	2.1	1.8	1.9	0.0087	0.074
43	1981	3.3	1.7	1.9	0.0029	0.075
44	1973	3.0	1.5	1.7	0.0025	0.067
45	1734	3.4	1.7	1.9	0.0030	0.072
46	1641	3.8	2.2	2.3	0.0025	0.091
Network summary	17462	23	1.4	1.9	0.0029	0.074

^aNanocoulomb per kilogram per hour

^bReal-time readings were collected at all stations at 10-min intervals. The number of samples indicate the total number of valid hourly averages during the quarter.

^cStandard deviation of the mean.

^dSee Fig. 2.

^eSee Fig. 3.

to the range of background values as given above. Readings at station 4 have been historically higher than the norm because of its location near the Process Waste Treatment Plant (PWTP).

3.0 WATER

The Oak Ridge National Laboratory (ORNL) site is located in the 17 km² White Oak Creek (WOC) watershed, with the exception of two small effluent points in the 7600 area that discharge directly into Melton Hill Lake. A sketch of the watershed and sampling station locations is shown in Fig. 4. The major tributary to WOC is Melton Branch (MB). Upper WOC drains Bethel Valley in the vicinity of ORNL; receiving inputs from Fifth Creek, First Creek, and Northwest Tributary (NWT) prior to crossing the gap in Haw Ridge and flowing Southwest to White Oak Lake (WOL). Melton Branch drains Melton Valley and joins WOC less than a mile from WOL. The present final point of control for the watershed is at White Oak Dam (WOD), which is the structure that forms WOL. The lake is about two-thirds of a mile long and less than a tenth of mile wide. The purpose of the lake is to serve as a settling basin and catchment in the event of contaminant releases from the ORNL facility. The receiving water for the watershed is Watts Bar Lake of the Clinch River.

Water quality in these streams is affected primarily by effluent discharges, surface runoff, subsurface storm flow, and groundwater transport of contaminants from historically disposed wastes. The average flow for the watershed is 14 CFS (9 MGD), of which 1 CFS (0.67 MGD) is attributed to the major National Pollutant Discharge Elimination System (NPDES) effluent points, and 3 CFS (2 MGD) is attributed to cooling towers and blowdown. The base flow during drought is estimated to 1.75 CFS (1.14 MGD).

Surveillance of the water environment consists of the collection of surface water, effluent and sediment samples required under the NPDES Permit, and groundwater from Waste Area Groupings 1, 5, 7, and 6. Samples are analyzed for radionuclides and nonradioactive chemicals.

3.1 SURFACE WATER

Dennis A. Wolf

3.1.1 Program Description

Water samples are collected for radiological analyses at off-site and on-site locations, at background or reference locations, in streams on the ORNL site, and from all process discharge point sources. A summary of locations, parameters analyzed, and frequencies of sample collection and analysis for all radiological samples is provided in Table 10. In addition, analyses for uranium isotopes U-234, U-235, U-238, Pu-238, and Pu-239 were performed on the September samples from Melton Hill Dam (MHD), WOC headwaters, and WOD.

Changes in the sampling program were implemented during the last quarter. X09A (HFIR Ponds and TRU Ponds), X06A (190 Ponds, 1500 Area and 2000 Area), 3518 and 3544 effluents were redirected to the Nonradioactive Wastewater Treatment Facility (NRWTF). The results section contains data summaries of samples collected from each location. Data reporting conventions are discussed in the report introduction.

Fig. 4. Location map of ORNL streams and sampling stations.

Table 10. Summary of collection and analysis frequencies of surface, pond, and effluent water samples

Station	Collection frequency	Sample type	Parameters	Analysis frequency
7500 Bridge, MB1 WOC, MB2	Weekly	Flow proportional	Gamma scan, total Sr ^a , H-3	Monthly
First Creek, Fifth Creek, Raccoon Creek	Weekly	Grab	Gamma scan, total Sr ^a	Monthly
Gallaher	Weekly	Time proportional	H-3, gamma scan, gross alpha, gross beta, total U, total Sr ^a , Pu-238, Pu-239	Quarterly
Kingston	Weekly	Grab	H-3, gamma scan, gross alpha, gross beta, total U, total Sr ^a , Pu-238, Pu-239	Quarterly
Melton Hill Dam	Weekly	Flow proportional	Gamma scan, gross alpha ^b , gross beta ^c	Monthly
NRWTF	Weekly	Flow proportional	H-3, gamma scan, gross alpha, gross beta, total Sr ^a	Monthly
NWT	Weekly	Flow proportional	Gamma scan, total Sr ^a	Monthly
STP	Weekly	Flow proportional	Gamma scan, gross beta, total Sr ^a	Monthly
WOC Headwaters	Weekly	Flow proportional	Gamma scan, gross alpha ^b , gross beta ^c	Monthly
WOD	Weekly	Flow proportional	Gamma scan, gross alpha, gross beta	Weekly
"	"	"	H-3, total Sr ^a	Monthly

^aTotal radioactive Sr (Sr-89 + Sr-90).

^bIf gross alpha >1 Bq/L, analyze for Am-241, Cm-244, Pu-238, Pu-239, Th-228, Th-230, Th-233, U-234, U-235, and U-238.

^cIf gross beta >30 Bq/L, analyze for total radioactive Sr.

3.1.2 Procedure and Results

Treated water samples are collected weekly at the Kingston and Gallaher potable water treatments plants (Fig. 5) and are analyzed quarterly. Table 11 contains the concentrations measured at these stations during this quarter. At Gallaher, gross beta, Pu-239, and total radioactive Sr were significantly greater than zero; gross beta and total radioactive Sr were no greater than 8.1% of the Sr-90 Environmental Protection Agency (EPA) drinking water standard. The Pu-239 concentration is less than 0.1% of the gross alpha drinking water standard. At Kingston, total radioactive Sr, gross alpha, and gross beta were significantly greater than zero but less than 6% of the drinking water standards. No test of significance was possible for the single total uranium measurement (concentration not determined from counting) at each site, but the concentrations at Gallaher and Kingston are less than 0.2% of the gross alpha standard.

Derived concentration guides (DCG) are estimates of the rate of exposure to a given radioisotope via one exposure pathway that would result in an effective dose equivalent of 100 mrem (1 mSv) per year to "reference man," as defined by the International Commission of Radiation Protection Publication 23. These values have been published in draft 10 CFR 834 and are used here as a means of standardized comparison for effluent points with different isotope signatures. The calculation of percent DCG does not imply that effluent points or ambient water sampling stations at ORNL are sources of drinking water.

The sum of DCG percentages for each of the effluent points and ambient water stations is less than 100%. In the event a sum ever exceeds 100%, an analysis of the best available technology to reduce the signature would be conducted as specified in 10 CFR 834.

Melton Hill Dam and WOC headwaters, two locations above ORNL discharge points, serve as references for other water sampling locations at the ORNL site. Water samples are collected there and from six streams: WOC, MB, First Creek, Fifth Creek, Northwest Tributary, and Raccoon Creek (Fig. 4). Summary statistics for each radionuclide at each surface water sampling location are given in Table 12.

Gross alpha, U-234, and U-238 concentrations at Melton Hill Dam were significantly greater than zero (0.35 Bq/L, 0.015 Bq/L, and 0.0060 Bq/L, respectively). Plutonium-239, U-234, U-235, and U-238 concentrations at WOC headwaters were significantly greater than zero (0.011 Bq/L, 0.060 Bq/L, 0.010 Bq/L, and 0.016 Bq/L, respectively). For those isotopes with DCGs, the concentrations are less than 1% of the DCG.

Average total radioactive Sr concentration at First Creek (16 Bq/L) was 42% of the DCG for Sr-90. Otherwise, all average concentrations at First Creek, Fifth Creek, Northwest Tributary, Raccoon Creek, MB2, and 7500 bridge were no greater than 5.8% of the respective DCGs.

Locations that are sampled for nonradioactive chemicals under the requirements of the NPDES Permit (see Section 3.2) are also sampled for radionuclides (Fig. 6). Parameters are analyzed, and the frequency of analysis are given in

Fig. 5. Location map of Kingston and Gallaher sampling points.

Table 11. Summary of radionuclide concentrations in water
off-site ORNL, July-September 1990.

Radionuclide	Concentration ^a (Bq/L)	Drinking Water Standard ^b (DWS) (Bq/L)	Percentage of DWS ^c
<i>Gallagher^d</i>			
Co-60	0.018	<i>e</i>	<i>e</i>
Cs-137	-0.0010	<i>e</i>	<i>e</i>
Gross alpha	0.011	0.56	<i>e</i>
Gross beta	0.084*	1.5	5.7
Pu-238	0.00033	<i>e</i>	<i>e</i>
Pu-239	0.000095*	<i>e</i>	<i>e</i>
Total Sr ^f	0.024*	0.30	8.1
Total U ^g	0.00055	<i>e</i>	<i>e</i>
H-3	2.9	740	<i>e</i>
<i>Kingston^d</i>			
Co-60	-0.0010	<i>e</i>	<i>e</i>
Cs-137	0.0010	<i>e</i>	<i>e</i>
Gross alpha	0.012*	0.56	2.2
Gross beta	0.086*	1.5	5.8
Pu-238	-0.00012	<i>e</i>	<i>e</i>
Pu-239	-0.000077	<i>e</i>	<i>e</i>
Total Sr ^f	0.010*	0.30	3.4
Total U ^g	0.00014	<i>e</i>	<i>e</i>
H-3	1.9	740	<i>e</i>

^aConcentrations significantly greater than zero are identified by an *.

^bNational Primary Drinking Water Standard. From 40 CFR 141, as amended.
Values for gross beta and total Sr are based upon the Sr-90 limit.

^cConcentration as a percentage of the DWS.

^dSee Fig. 5.

^eNot applicable.

^fTotal radioactive Sr (Sr-89 + Sr-90).

^gNo test for significance is possible.

Table 12. Radionuclide concentrations in surface waters around ORNL,^a July-September 1990.

Radionuclide	Number of Samples	Concentration (Bq/L)				Derived Concentration Guide (DCG) ^d	Percentage of DCG ^e
		Max	Min	Av ^b	Standard error ^c		
Melton Hill Dam							
Co-60	3	1.2	-0.70	0.10	0.57	190	f
Cs-137	3	1.3	-1.3	0.40	0.85	110	f
Gross alpha	3	0.49	0.13	0.35*	0.11	f	f
Gross beta	3	0.70	-0.20	0.13	0.28	f	f
Pu-238	1	-0.0050	-0.0050	-0.0050	f	1.5	f
Pu-239	1	0.0010	0.0010	0.0010	f	1.1	f
Total Sr ^g	1	0.080	0.080	0.080	f	37	f
U-234	1	0.015	0.015	0.015*	f	19	0.079
U-235	1	0.0030	0.0030	0.0030	f	22	f
U-238	1	0.0060	0.0060	0.0060*	f	22	0.027
White Oak Creek Headwaters							
Co-60	3	0.30	-2.2	-0.73	0.75	190	f
Cs-137	3	1.4	-0.60	0.33	0.58	110	f
Gross alpha	3	0.30	-0.39	-0.0033	0.20	f	f
Gross beta	3	1.2	-0.40	0.13	0.53	f	f
Pu-238	1	0.020	0.020	0.020	f	1.5	f
Pu-239	1	0.011	0.011	0.011*	f	1.1	1.0
Total Sr ^g	1	-0.040	-0.040	-0.040	f	37	f
U-234	1	0.060	0.060	0.060*	f	19	0.32
U-235	1	0.010	0.010	0.010*	f	22	0.045
U-238	1	0.016	0.016	0.016*	f	22	0.073
7500 Bridge							
Co-60	3	-0.10	-1.4	-0.57	0.42	190	f
Cs-137	3	5.8	2.4	4.6*	1.1	110	4.2
Total Sr ^g	3	2.4	2.0	2.1*	0.13	37	5.8
H-3	3	150	87	120*	19	74,000	0.17
First Creek							
Co-60	3	1.9	0.10	0.80	0.56	190	f
Cs-137	3	0.20	-0.20	0.033	0.12	110	f
Total Sr ^g	3	17	14	16*	0.88	37	42

Table 12. (continued)

Radionuclide	Number of Samples	Concentration (Bq/L)				Derived Concentration Guide (DCG) ^d	Percentage of DCG ^e
		Max	Min	Av ^b	Standard error ^c		
Fifth Creek							
Co-60	3	3.1	-0.70	0.93	1.1	190	f
Cs-137	3	0.10	-0.90	-0.30	0.31	110	f
Total Sr ^g	3	1.8	1.4	1.6*	0.12	37	4.4
Melton Branch 2							
Co-60	3	1.2	-2.9	-0.67	1.2	190	f
Cs-137	3	-0.80	-1.0	-0.90	0.058	110	f
Total Sr ^g	3	0.16	0.010	0.067	0.047	37	f
H-3	3	170	90	120*	24	74,000	0.17
Northwest Tributary							
Co-60	3	0.80	0.30	0.50*	0.15	190	0.26
Cs-137	3	0.90	-0.60	0.067	0.44	110	f
Total Sr ^g	3	1.7	0.72	1.2*	0.28	37	3.3
Raccoon Creek							
Co-60	3	1.6	0.30	1.1	0.39	190	f
Cs-137	3	0.60	-0.40	0.20	0.31	110	f
Total Sr ^g	3	2.5	1.3	1.9*	0.35	37	5.0

^aLocations are shown in Fig. 4.

^bMean concentrations significantly greater than zero are identified by an *.

^cStandard error of the mean.

^dDCG ingestion of water. From Department of Energy (DOE) Order 5400.5.

^eMean concentration as a percentage of the DCG, calculated only when a DCG exists and mean concentration is significantly greater than zero.

^fNot applicable.

^gTotal radioactive Sr (Sr-89 + Sr-90).

Table 10. Table 13 contains a summary of the concentrations for each of these locations during this quarter. The average concentration is expressed as a percentage of the DCG (when one exists) in the last column of this table.

No parameter average concentration at the NPDES points exceeded 48% of its DCG. Average total radioactive Sr (18 Bq/L) and H-3 (24,000 Bq/L) at MBI are 48% and 32% of the respective DCGs. Average Cs-137 (30 Bq/L) at NRWTF is 27% of the DCG and total radioactive Sr (6.4 Bq/L) at WOD is 17% of the DCG. All other concentrations were no greater than 10% of the DCGs.

The discharge of radioactive contaminants from ORNL is affected by the stream flows. Flows in MB (as measured at station MBI), WOC (as measured at the confluence of MB and at WOD), and the Clinch River (as measured at Melton Hill Dam) are given in Table 14. Clinch River flows are regulated by a series of Tennessee Valley Authority dams, one of which is Melton Hill Dam. The flow in MB is usually less than one-third that in WOC. The ratio of WOC flow measured at WOD to Clinch River flow is also reported in Table 14. The ratios given were calculated daily and averaged for the month. This ratio gives an indication of the dilution factor that is expected for potential contaminants entering the Clinch River from WOC. The ratio for the quarter ranged from 380 to 530.

Discharges of radioactivity into WOC at the Sewage Treatment Plant (STP), at the confluence of WOC and MB, at WOD, and into MB were calculated from concentration and flow. A single flow-proportional sample was obtained weekly at each of WOD, WOC, MBI, and STP stations. A flow weighted composite is made and analyzed monthly. The discharge for the period is calculated as the product of the flow-weighted concentration and the total flow for the sampling period (Tables 15-17). In addition, weekly flow-proportional samples were obtained at WOD and analyzed for radionuclides other than H-3 and total Sr, at weekly intervals. The average concentration during the calendar month was calculated as a weighted sum of all concentrations obtained for sampling periods overlapping the calendar month. The weights were proportional to the calendar period total flow attributable to the sampling periods. This average concentration was multiplied by the calendar month total flow to arrive at the discharge.

Each average flow-weighted concentration was compared with an existing DCG. Cobalt-60 and Cs-137 concentrations did not exceed 4.0% of the DCGs during this quarter. At MBI, total radioactive Sr concentrations ranged from 43% to 51% of the DCG for Sr-90. Tritium concentrations there were fairly constant, ranging from 31% to 34% of the DCG. Total radioactive Sr and H-3 concentrations ranged, respectively, from 6.8% to 18% and 0.49% to 4.9% of the DCG at the other locations where they were measured.

3.1.3 Trends

Radionuclide concentrations obtained during this quarter were compared with historical concentrations to assess trends. For the off-site stations Gallaher and Kingston, the concentrations have been fairly stable historically. The significant concentrations observed during this quarter are all lower than the two-year maxima.

Fig. 6. Location map of ORNL NPDES and radioactivity sampling locations.

Table 13. Radionuclide concentrations at ORNL NPDES locations,^a July-September 1990.

Radionuclide	Number of Samples	Concentration (Bq/L)				Derived Concentration Guide (DCG) ^d	Percentage of DCG ^e
		Max	Min	Av ^b	Standard error ^c		
Sewage Treatment Plant (X01)							
Co-60	3	1.4	-1.1	0.23	0.73	190	f
Cs-137	3	0.60	-1.4	-0.23	0.60	110	f
Gross beta	3	10	6.7	8.4*	0.95	f	f
Total Sr ⁹⁰	3	4.2	3.0	3.7*	0.37	37	10
Nonradioactive Wastewater Treatment Plant (X12)							
Co-60	3	1.9	-1.4	0.80	1.1	190	f
Cs-137	3	31	29	30*	0.58	110	27
Gross alpha	3	0.66	0.37	0.49*	0.086	f	f
Gross beta	3	32	15	23*	4.9	f	f
Total Sr ⁹⁰	3	1.2	0.77	1.0*	0.13	37	2.8
H-3	3	990	820	920*	51	74,000	1.2
Melton Branch 1 (X13)							
Co-60	3	1.5	-0.20	0.77	0.50	190	f
Cs-137	3	1.8	-0.60	0.43	0.71	110	f
Total Sr ⁹⁰	3	19	16	18*	0.88	37	48
H-3	3	25,000	23,000	24,000*	670	74,000	32
White Oak Creek (X14)							
Co-60	3	1.5	-1.7	-0.17	0.93	190	f
Cs-137	3	4.4	2.3	3.3*	0.61	110	3.0
Total Sr ⁹⁰	3	5.4	2.5	4.0*	0.84	37	11
H-3	3	3,000	360	1,700	760	74,000	f

Table 13. (continued)

Radionuclide	Number of Samples	Concentration (Bq/L)				Derived Concentration Guide (DCG) ^d	Percentage of DCG ^e
		Max	Min	Av ^b	Standard error ^c		
White Oak Dam (X15)							
Co-60	13	0.48	-0.10	0.16*	0.048	190	0.084
Cs-137	13	1.8	0.29	0.98*	0.14	110	0.89
Gross alpha	13	1.1	0.090	0.30*	0.073	f	f
Gross beta	13	21	7.9	14*	1.1	f	f
Pu-238	1	-0.0030	-0.0030	-0.0030	f	1.5	f
Pu-239	1	-0.0030	-0.0030	-0.0030	f	1.1	f
Total Sr ^g	3	6.7	6.0	6.4*	0.20	37	17
H-3	3	5,100	3,600	4,500*	470	74,000	6.1
U-234	1	0.19	0.19	0.19*	f	19	1.0
U-235	1	0.064	0.064	0.064*	f	22	0.29
U-238	1	0.034	0.034	0.034*	f	22	0.15

^aLocations are shown in Fig. 6.

^bMean concentrations significantly greater than zero are identified by an *.

^cStandard error of the mean.

^dDCG for ingestion of water. From DOE Order 5400.5.

^eMean concentration as a percentage of the DCG, calculated only when a DCG exists and mean concentration is significantly greater than zero.

^fNot applicable.

^gTotal radioactive Sr (Sr-89 + Sr-90).

Table 14. Stream^a flows, July-September 1990.

Month	Flow (10 ⁹ L)				
	Melton Branch 1	White Oak Creek ^b	White Oak Dam ^c	Clinch River	Average Ratio ^d
July	0.18	0.81	0.94	340	460
August	0.16	0.95	1.1	330	380
September	0.073	0.49	0.54	280	530

^aSee Fig. 4.^bWOC at confluence of MB.^cWOC at WOD.^dFlow ratios Clinch River: WOC at WOD are calculated daily and averaged for the month.

Table 15. Radionuclide concentrations and releases at ORNL^a, July 1990.

Radionuclide	Flow (10 ⁶ L)	Discharge ^b (10 ¹⁰ Bq)	Concentration ^c (Bq/L)	Concentration Guide (DCG) ^d (Bq/L)	Percentage of DCG ^e
<i>Melton Branch 1 (06/27-07/25)</i>					
Co-60	170	g	-0.20	190	g
Cs-137	170	0.031	1.8*	110	1.6
Total Sr ^f	170	0.28	16*	37	43
H-3	170	400	23,000*	74,000	31
<i>Sewage Treatment Plant (06/29-07/31)</i>					
Co-60	31	0.0044	1.4*	190	0.74
Cs-137	31	g	0.60	110	g
Gross beta	31	0.026	8.4*	g	g
Total Sr ^f	31	0.013	4.0*	37	11
<i>White Oak Creek (06/27-07/25)</i>					
Co-60	770	g	1.5	190	g
Cs-137	770	0.34	4.4*	110	4.0
Total Sr ^f	770	0.41	5.4*	37	15
H-3	770	230	3,000*	74,000	4.1
<i>White Oak Dam^h (07/01-08/01)</i>					
Co-60	940	0.021	0.22*	190	0.12
Cs-137	940	0.11	1.2*	110	1.1
Gross alpha	940	0.028	0.29*	g	g
Gross beta	940	1.6	17*	g	g
<i>White Oak Dam (06/27-07/25)</i>					
Total Sr ^f	890	0.54	6.0*	37	16
H-3	890	440	4,900*	74,000	6.6

^aLocations are shown in Fig. 4.

^bDischarges are calculated from flow and concentration and are listed when concentrations are significantly greater than zero.

^cConcentrations significantly greater than zero are identified by an *

^dDCG for ingestion of water from DOE Order 5400.5

^eMean concentration as a percentage of the DCG

^fTotal radioactive Sr (Sr-89 + Sr-90).

^gNot applicable.

^hConcentration is a flow-weighted average of the weekly samples. Discharge is the total for the month.

Table 16. Radionuclide concentrations and releases at ORNL,^a August 1990.

Radionuclide	Flow (10 ⁶ L)	Discharge ^b (10 ¹⁰ Bq)	Concentration ^c (Bq/L)	Concentration Guide (DCG) ^d (Bq/L)	Percentage of DCG ^e
<i>Melton Branch 1 (07/25-08/29)</i>					
Co-60	160	0.024	1.5*	190	0.79
Cs-137	160	g	-0.60	110	g
Total Sr ^f	160	0.30	19*	37	51
H-3	160	400	25,000*	74,000	34
<i>Sewage Treatment Plant (07/31-08/29)</i>					
Co-60	27	g	-1.1	190	g
Cs-137	27	g	0.10	110	g
Gross beta	27	0.027	10*	g	g
Total Sr ^f	27	0.011	4.2*	37	11
<i>White Oak Creek (07/25-08/29)</i>					
Co-60	1,000	g	-0.30	190	g
Cs-137	1,000	0.23	2.3*	110	2.1
Total Sr ^f	1,000	0.41	4.1*	37	11
H-3	1,000	170	1,700*	74,000	2.3
<i>White Oak Dam^h (08/01-09/01)</i>					
Co-60	1,100	0.014	0.12*	190	0.065
Cs-137	1,100	0.16	1.5*	110	1.3
Gross alpha	1,100	0.063	0.57*	g	g
Gross beta	1,100	1.7	16*	g	g
<i>White Oak Dam (07/25-08/29)</i>					
Total Sr ^f	1,100	0.77	6.7*	37	18
H-3	1,100	580	5,100*	74,000	6.9

^aLocations are shown in Fig. 4.

^bDischarges are calculated from flow and concentration and are listed when concentrations are significantly greater than zero.

^cConcentrations significantly greater than zero are identified by an *

^dDCG for ingestion of water from DOE Order 5400.5

^eMean concentration as a percentage of the DCG

^fTotal radioactive Sr (Sr-89 + Sr-90).

^gNot applicable.

^hConcentration is a flow-weighted average of the weekly samples.
Discharge is the total for the month.

Table 17. Radionuclide concentrations and releases at ORNL,^a September 1990

Radionuclide	Flow (10 ⁶ L)	Discharge ^b (10 ¹⁰ Bq)	Concentration ^c (Bq/L)	Concentration Guide (DCG) ^d (Bq/L)	Percentage of DCG ^e
<i>Melton Branch 1 (08/29-09/26)</i>					
Co-60	70	g	1.0	190	g
Cs-137	70	g	0.10	110	g
Total Sr ^f	70	0.13	18*	37	49
H-3	70	160	23,000*	74,000	31
<i>Sewage Treatment Plant (08/29-09/26)</i>					
Co-60	23	g	0.40	190	g
Cs-137	23	g	-1.4	110	g
Gross beta	23	0.015	6.7*	g	g
Total Sr ^f	23	0.0068	3.0*	37	8.1
<i>White Oak Creek (08/29-09/26)</i>					
Co-60	480	g	-1.7	190	g
Cs-137	480	0.15	3.1*	110	2.8
Total Sr ^f	480	0.12	2.5*	37	6.8
H-3	480	17	360*	74,000	0.49
<i>White Oak Dam^h (09/01-10/01)</i>					
Co-60	540	0.012	0.22*	190	0.12
Cs-137	540	0.029	0.54*	110	0.49
Gross alpha	540	0.013	0.23*	g	g
Gross beta	540	0.67	13*	g	g
Pu-238	540	g	-0.0030	1.5	g
Pu-239	540	g	-0.0030	1.1	g
U-234	540	0.0024	0.19*	19	1.0
U-235	540	0.00082	0.064*	22	0.29
U-238	540	0.00044	0.034*	22	0.15

Table 17 (continued)

Radionuclide	Flow (10 ⁶ L)	Discharge ^b (10 ¹⁰ Bq)	Concentration ^c (Bq/L)	Concentration Guide (DCG) ^d (Bq/L)	Percentage of DCG ^e
<i>White Oak Dam (08/29-09/26)</i>					
Total Sr ^f	530	0.34	6.4*	37	17
H-3	530	190	3,600*	74,000	4.9

^aLocations are shown in Fig. 4.

^bDischarges are calculated from flow and concentration and are listed when concentrations are significantly greater than zero.

^cConcentrations significantly greater than zero are identified by an *

^dDCG for ingestion of water from DOE Order 5400.5

^eMean concentration as a percentage of the DCG

^fTotal radioactive Sr (Sr-89 + Sr-90).

^gNot applicable.

^hConcentration is a flow-weighted average of the weekly samples.
Discharge is the total for the month.

All radionuclide concentrations reported this quarter for MBI, WOC, and WOD are lower than past two-year maxima.

Total radioactive Sr concentrations at MBI appear to have been increasing slightly over the past two years; however, concentrations were fairly constant during this quarter. There is evidence of seasonality in total radioactive Sr at these three stations, with a tendency for higher values in the winter and spring and lower values in the summer and fall.

Tritium concentrations at MBI appear to be decreasing with time; whereas, the levels at WOC and WOD have been fairly constant since the fall of 1989. Prior to then there was a clear seasonal trend at WOD with higher values in the winter and spring and lower values in the summer and fall.

Cobalt-60 and Cs-137 concentrations appear to be reasonably stable over time at MBI, WOC, and WOD.

Total radioactive Sr concentrations in First Creek have decreased since 1988 (27 Bq/L average concentration in 1988 to around 11 Bq/L in 1990) and exhibit a seasonal pattern with higher concentrations in the fall relative to the spring.

3.2 REFERENCE SURFACE WATERS

Michael R. Powell

3.2.1 Program Description

Monthly surface water samples are collected at two sampling locations for the purpose of determining background contamination levels before the influence of ORNL. One sampling location is MHD above ORNL's discharge point into the Clinch River (Fig. 4). The other sample location is WOC headwaters, above the point where ORNL discharges to WOC (Fig. 4). Analyses were performed to detect classical, inorganic, and organic pollutants in the water. Classical pollutants are those indicated by conductivity, temperature, turbidity, pH, total dissolved solids, suspended solids, and oil and grease. Inorganic parameters are those indicated by metal and anion analysis. The presence of organic pollutants are based on the total organic carbon (TOC) analysis. If significant amounts of TOC are detected, a more complete organic analysis is performed.

The inorganics, oil and grease, and dissolved solids were collected flow-proportionally by a sampling station at each location. All other samples are grab samples taken once per month.

3.2.2 Results

The results for the inorganic, organic, and classical pollutants are found in Table 18. The column "percent DWL" is included to show the average concentration as a percentage of the National Primary or Secondary Drinking Water regulation level, where available. There were no high levels of organic

Table 18. Surface Water Analyses at Reference Locations
July-September 1990

Parameter	Number of Samples	Concentration (mg/L)				Percent ^a DWL
		Max	Min	Av	Standard Error	
Melton Hill Dam ^b						
Aluminum-total	3	1.2	0.097	0.47	0.37	
Antimony-total	3	<0.050	<0.050	<0.050	0	
Arsenic-total	5	<0.050	<0.010	<0.034	0.0098	<68
Barium-total	3	0.037	0.028	0.031	0.0028	3.1
Beryllium-total	3	<0.0003	<0.0002	<0.0002	0.000033	
Boron-total	3	<0.080	<0.080	<0.080	0	
Cadmium-total	3	<0.0050	<0.0050	<0.0050	0	<50
Calcium-total	3	41	36	38	1.5	
Chromium-total	3	0.0073	0.0042	0.0055	0.00094	10
Cobalt-total	3	<0.0040	<0.0040	<0.0040	0	
Copper-total	3	<0.0070	<0.0050	<0.0063	0.00067	<0.63
Dissolved solids-total	3	170	150	160	3.2	
Fluoride-total	3	<1.0	<1.0	<1.0	0	
Iron-total	3	0.63	0.074	0.28	0.17	94
Lead-total	3	<0.050	<0.050	<0.050	0	<100
Lithium-total	3	<15	<15	<15	0	
Magnesium-total	3	11	9.4	9.9	0.53	
Manganese-total	5	0.13	0.020	0.049	0.021	98
Molybdenum-total	3	<0.040	<0.040	<0.040	0	
Nickel-total	3	<0.0050	<0.0040	<0.0043	0.00033	
Nitrate	3	<5.0	<5.0	<5.0	0	<50
Oil and grease	3	<2.0	<2.0	<2.0	0	
Organic carbon-total	3	5.8	1.6	3.0	1.4	
Phosphorus-total	3	<0.30	<0.30	<0.30	0	
Selenium-total	5	<0.050	<0.0020	<0.031	0.011	<314
Silicon-total	3	4.7	2.5	3.2	0.73	
Silver-total	3	<0.0050	<0.0050	<0.0050	0	<10
Sodium-total	3	<5.0	<5.0	<5.0	0	
Strontium-total	3	0.097	0.086	0.091	0.0033	
Sulfate (as SO4)	3	30	21	24	2.8	9.7
Suspended solids-total	3	15	<5.0	<8.3	3.3	
Tin-total	3	<0.050	<0.050	<0.050	0	
Titanium-total	3	<0.020	<0.020	<0.020	0	
Vanadium-total	3	<0.0020	<0.0020	<0.0020	0	
Zinc-total	3	0.016	0.0075	0.010	0.0028	0.20
Zirconium-total	3	<0.020	<0.020	<0.020	0	

Table 18. (continued)

Parameter	Number of Samples	Concentration (mg/L)				Percent ^a DWL
		Max	Min	Av	Standard Error	
Conductivity, mS/cm	3	1.1	0.37	0.66	0.22	
Oxygen-dissolved	3	10	7.4	8.7	0.90	
Temperature, °C	3	22	19	20	0.92	
Turbidity, JTU	3	68	4.0	28	20	
pH, standard units	3	8.6	7.4	8.0	0.35	
<i>White Oak Creek^b</i>						
Aluminum-total	3	1.0	0.25	0.69	0.23	
Antimony-total	3	<0.050	<0.050	<0.050	0	
Arsenic-total	5	<0.050	<0.010	<0.034	0.0098	<68
Barium-total	3	0.081	0.067	0.075	0.0041	7.4
Beryllium-total	3	<0.0003	<0.0002	<0.0002	0.000033	
Boron-total	3	<0.080	<0.080	<0.080	0	
Cadmium-total	3	<0.0050	<0.0050	<0.0050	0	<50
Calcium-total	3	30	25	28	1.5	
Chromium-total	3	0.0080	0.0053	0.0063	0.00087	12
Cobalt-total	3	<0.0040	<0.0040	<0.0040	0	
Copper-total	3	<0.0070	<0.0050	<0.0063	0.00067	<0.63
Dissolved solids-total	3	140	96	110	13	
Fluoride-total	3	<1.0	<1.0	<1.0	0	
Iron-total	3	0.67	0.26	0.51	0.13	170
Lead-total	3	<0.050	<0.050	<0.050	0	<100
Lithium-total	3	<15	<15	<15	0	
Magnesium-total	3	14	11	13	1.0	
Manganese-total	5	0.099	0.016	0.037	0.016	74
Molybdenum-total	3	<0.040	<0.040	<0.040	0	
Nickel-total	3	<0.0050	<0.0040	<0.0043	0.00033	
Nitrate	3	<5.0	<5.0	<5.0	0	<50
Oil and grease	3	<2.0	<2.0	<2.0	0	
Organic carbon-total	3	1.4	1.0	1.2	0.12	
Phosphorus-total	3	<0.30	<0.30	<0.30	0	
Selenium-total	5	<0.050	<0.0020	<0.031	0.011	<314
Silicon-total	3	4.5	3.7	4.0	0.27	
Silver-total	3	<0.0050	<0.0050	<0.0050	0	<10
Sodium-total	3	<5.0	<5.0	<5.0	0	
Strontium-total	3	0.033	0.028	0.031	0.0015	
Sulfate (as SO ₄)	3	<5.0	<5.0	<5.0	0	<2.0
Suspended solids-total	3	33	9.0	18	7.7	

Table 18. (continued)

Parameter	Number of Samples	Concentration (mg/L)			Standard Percent ^a	
		Max	Min	Av	Error	DWL
Tin-total	3	<0.050	<0.050	<0.050	0	
Titanium-total	3	<0.020	<0.020	<0.020	0	
Vanadium-total	3	0.0023	<0.0020	<0.0021	0.00010	
Zinc-total	3	0.016	<0.0050	<0.011	0.0032	<0.22
Zirconium-total	3	<0.020	<0.020	<0.020	0	
Conductivity, mS/cm	3	0.27	0	0.16	0.081	
Oxygen-dissolved	3	11	7.3	8.7	1.2	
Temperature, °C	3	17	15	16	0.69	
Turbidity, JTU	3	22	8.0	13	4.7	
pH, standard units	3	7.6	6.8	7.1	0.24	

^aAverage concentration as a percentage of National Primary or Secondary Drinking Water Regulation level.

^bSee Fig 4.

compounds detected by the TOC analysis at either location, as indicated by the average value of 2.1 mg/L. Most inorganic compounds were also below the National Primary and Secondary Drinking Water regulation levels. Exceptions to this were iron and selenium. The concentration of iron at these reference locations has been consistently high for all sampling periods. The average concentration of iron at MHD was 94% of the National Secondary Drinking Water Limit, and at WOC this figure was 170%. Similarly, selenium was 314% at MHD and WOC. Iron values are well within the limit of detection of the inductively coupled plasma spectroscopy (ICP) method used for metals analysis. This is not true for the selenium concentrations. In addition, arsenic and manganese have the same high ICP detection limit problem. In order to obtain precise information on the concentrations of these metals additional analyses were conducted by higher sensitivity atomic absorption (AA) methods. Analysis of the data from these AA determinations indicates concentrations of these metals are much lower than can be detected by the currently used ICP methods. The results from these AA determinations are included in the data summary of these metals in Table 18. Future analyses of these metals will be conducted by the more sensitive AA methods.

Many of the inorganic analytical results show a wide range of detection limits. This results from a dilution that must be made to some of the water samples. When a given sample contains an element in a concentration that is higher than the ICP equipment can accurately measure, this compound can cause a spectral interference with other elements. The sample must then be diluted to bring the interfering element into a range that the equipment can accurately measure. The resulting analytical values from the ICP process must be adjusted by the dilutions factor. This dilution factor must also be applied to the detection limit value for each element.

3.2.3 Trends

Current trends in the concentration of pollutants found at these reference locations are assessed by comparing the average values for the quarter to the historic concentrations of these pollutants at the same locations for the last two years. In the current quarter, magnesium and organic carbon values have exceeded the two-year average at MHD. The values for these two parameters are only slightly greater than past average values. The average values for the calcium, magnesium, strontium, organic carbon, and dissolved solids have exceeded the highest two-year average value at the WOC reference location. However, values for these parameters are only slightly higher than the highest average value for the past two years.

3.3 NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM REQUIREMENTS

Pamela Y. Goldberg and Charles K. Valentine, Jr.

3.3.1 Program Description and Results

ORNL's current NPDES Permit requires that point-source outfalls be sampled prior to their discharge into receiving waters or before mixing with any other wastewater stream. There are ambient sampling points that are located in the streams as reference points or for additional information. Effluent discharge from the Vehicle Cleaning Facility (VC7002) was discontinued on March 8, 1990, pending resolution of the investigation.

Quarterly summary statistics for the third quarter of 1990 are given for each sampling location in Tables 19 through 29. The maximum and minimum values for methylene chloride at the NRWTF (X12) reflects a prefix of JB, which represents the fact that methylene chloride was estimated and found in the blank. The maximum value for tetrachloroethene at X12 reflects a prefix of B, which represents the fact that tetrachloroethene was found in the blank. The continuous pH monitoring system failed on July 9; operations data (1-min averages) were obtained.

Data collected for the NPDES Permit are also summarized monthly for reporting to DOE and the state of Tennessee. These summaries are submitted to DOE in the monthly discharge monitoring reports and are available upon request. Noncompliances are provided in Tables 30 through 32. A brief summary of the noncompliances follows.

3.3.2 Noncompliances

3.3.2.1 July 1990

The oil-and-grease exceedences at the Coal Yard Runoff Treatment Facility (CYRTF) on July 1, 1990 was attributed to failure of a treatment system component: a gearbox oil seal failed, which allowed a small amount of oil to drip into the CYRTF effluent. The problem was discovered and corrected the following day.

The high downstream pH measurement at the NRWTF on July 3, 1990, was conducted at a time when the effluent pH was well below 8.6 standard units. Therefore, the instream pH of 8.6 is attributed to ambient conditions, and the NRWTF downstream pH measurement is not considered an NPDES limit exceedence but must be reported as such for the current permit.

The water sample that indicated a high chromium concentration at the 3117 cooling tower on July 12, 1990, was collected from the tower basin. Interviews with tower operators indicated that no blowdown has been discharged from this tower for several years. Therefore, this is not an NPDES limit exceedence.

3.3.2.2 August 1990

The metals exceedences at the cooling towers on August 6, 1990, have been attributed to stripping of tower components (e.g., galvanized and copper piping) by the chlorinated water used to make up tower water solutions. An ORNL Quality Event Report was filed earlier in 1990 on this type of occurrence, and Plant and Equipment Division personnel have implemented corrective measures as a result. However, additional attention will be focused on this area as a result of the latest exceedences.

The total suspended solids (TSS) exceedences on August 24, 1990, were attributed to storm water runoff from three ORNL areas: a gravel road near Building 6011 (outfall 116), the hillside near the NRWTF access road (outfall 203), and street drains near Building 4508 (outfall 209). Based on

Table 19. NPDES discharge point X01,^a July-September 1990

Parameter	Number of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Ammonia (as N)	39	0.35	0.013	0.068	0.011
Biochemical oxygen demand	39	<5.0	<5.0	<5.0	0
Bromodichloromethane	4	<0.0050	-0.00080	-0.0030	0.0012
Chlorine-total residual	39	0.65	<0.010	<0.23	0.021
Copper-total	6	0.0093	0.0059	0.0077	0.00054
Cyanide-total	3	<0.0020	<0.0020	<0.0020	0
Downstream pH, standard units	13	8.3	6.6	NA ^c	NA
Fecal coliform, col/100 mL ^d	39	100	<1.0	<4.1	2.5
Flow, Mgd	62	0.36	0.092	0.24	0.0054
Mercury-total	5	<0.00005	<0.00005	<0.00005	0
Oil and grease	39	8.0	<2.0	<2.2	0.15
Oxygen-dissolved	62	11	6.0	7.8	0.12
pH, standard units	13	8.1	7.0	NA	NA
Recoverable phenolics-total	5	<0.050	<0.0010	<0.013	0.0095
Silver-total	6	0.026	<0.0050	<0.0085	0.0035
Suspended solids-total	39	17	<5.0	<5.5	0.34
Trichloroethene	4	<0.0050	<0.0010	<0.0040	0.0010
Zinc-total	6	0.056	0.037	0.049	0.0028

^aSee Fig. 6.^bStandard error of the mean.^cNA = not applicable.^dGeometric mean.

Table 20. NPDES discharge point X02,^a July-September 1990

Parameter	Number of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Arsenic-total	16	0.096	<0.050	<0.059	0.0034
Cadmium-total	16	<0.0050	<0.0050	<0.0050	0
Chromium-total	16	0.020	0.0077	0.012	0.00074
Copper-total	16	0.021	0.0066	0.013	0.0012
Downstream pH, standard units	62	8.4	6.6	NA ^c	NA
Flow, Mgd	62	0.081	0	0.020	0.0022
Iron-total	16	1.0	0.068	0.32	0.072
Lead-total	16	<0.050	<0.050	<0.050	0
Manganese-total	16	0.12	0.014	0.043	0.0085
Nickel-total	16	0.028	<0.0040	<0.0070	0.0015
pH, standard units	62	8.7	6.6	NA	NA
Oil and grease	13	88	<2.0	<8.8	6.6
Selenium-total	16	0.086	0.048	0.055	0.0025
Silver-total	16	0.044	<0.0050	<0.0080	0.0024
Sulfate (as SO ₄)	3	2200	1900	2100	88
Suspended solids-total	13	29	<5.0	<10	2.2
Temperature, °C	62	30	18	26	0.32
Zinc-total	16	0.18	0.017	0.040	0.0099

^aSee Fig. 6.^bStandard error of the mean.^cNA = not applicable.

Table 21. NPDES discharge point X12,^a July-September 1990

Parameter	Number of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
1,1-Dichloroethane	14	<0.0050	<0.0010	<0.0047	0.00029
Arsenic-total	17	<0.050	<0.050	<0.050	0
Benzene	14	<0.0050	<0.0010	<0.0047	0.00029
Biochemical oxygen demand	13	<5.0	<5.0	<5.0	0
Bromodichloromethane	14	<0.0050	<0.0010	<0.0047	0.00029
Cadmium-total	17	<0.0050	<0.0050	<0.0050	0
Chlorobenzene	14	<0.0050	<0.0010	<0.0047	0.00029
Chloroform	14	<0.0050	-0.0020	-0.0037	0.00041
Chromium-total	17	0.0080	<0.0040	<0.0051	0.00031
Copper-total	17	0.0091	<0.0050	<0.0063	0.00029
Cyanide-total	13	0.0030	<0.0020	<0.0021	0.000077
Downstream pH, standard units	62	8.6	7.1	NA ^c	NA
Flow, Mgd	62	0.64	0.28	0.47	0.0088
Fluoride-total	13	1.1	1.0	1.0	0.0077
Iron-total	17	0.071	<0.020	<0.044	0.0036
Lead-total	17	<0.050	<0.050	<0.050	0
Mercury-total	16	<0.00005	<0.00005	<0.00005	0
Methylene chloride ^d	14	JB0.0050	JB0.00050	-0.0038	0.00052
Nickel-total	17	0.0051	<0.0040	<0.0045	0.00013
Nitrate	13	<5.0	<5.0	<5.0	0
Oil and grease	13	4.0	<2.0	<2.2	0.17
pH, standard units	^e	8.8	6.4	NA	NA
Phosphorus-total	13	0.60	<0.30	<0.42	0.032
Recoverable phenolics-total	13	<0.0010	<0.0010	<0.0010	0
Selenium-total	17	<0.050	<0.050	<0.050	0
Silver-total	17	0.015	<0.0050	<0.0056	0.00059
Sulfate (as SO ₄)	13	220	80	140	9.6
Suspended solids-total	13	<5.0	<5.0	<5.0	0
Temperature, °C	62	30	21	25	0.21
Tetrachloroethene ^f	14	B0.0060	<0.0010	<0.0048	0.00030
Total toxic organics	13	0.067	<0.010	<0.017	0.0050
Trichloroethene	14	<0.0050	<0.0010	<0.0047	0.00029
Zinc-total	17	0.061	0.011	0.024	0.0032

^aSee Fig. 6.^bStandard error of the mean.^cNA = not applicable.^dJB means that the maximum and minimum values of methylene chloride was estimated and found in the blank.^epH monitoring is continuous.^fB means that the maximum value of tetrachloroethene was found in the blank.

Table 22. NPDES discharge point X13,^a July-September 1990

Parameter	Number of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Aluminum-total	5	5.3	0.071	1.3	0.99
Ammonia (as N)	3	0.050	0.040	0.043	0.0033
Arsenic-total	5	<0.050	<0.050	<0.050	0
Biochemical oxygen demand	3	<5.0	<5.0	<5.0	0
Cadmium-total	6	<0.0050	<0.0020	<0.0035	0.00067
Chlorine-total residual	13	<0.010	<0.010	<0.010	0
Chloroform	3	<0.0050	-0.0010	-0.0037	0.0013
Chromium-total	5	0.016	<0.0040	<0.0082	0.0021
Conductivity, mS/cm	3	2.2	1.8	1.9	0.13
Copper-total	5	0.015	<0.0050	<0.0082	0.0017
Dissolved solids-total	3	330	230	260	36
Flow, Mgd	62	7.6	0.37	1.1	0.17
Fluoride-total	3	1.2	1.0	1.1	0.067
Iron-total	5	3.9	0.16	1.1	0.70
Lead-total	6	<0.050	<0.0040	<0.027	0.010
Manganese-total	5	0.38	0.061	0.19	0.057
Mercury-total	5	<0.00005	<0.00005	<0.00005	0
Nickel-total	5	<0.0050	<0.0040	<0.0044	0.00024
Nitrate	3	<5.0	<5.0	<5.0	0
Oil and grease	13	44	<2.0	<6.0	3.3
Organic carbon-total	3	3.7	2.5	2.9	0.38
Oxygen-dissolved	13	12	5.2	7.6	0.50
PCB-total	3	<0.0020	<0.0020	<0.0020	0
pH, standard units	3	7.9	7.2	NA ^c	NA
Phosphorus-total	6	0.80	<0.30	<0.56	0.092
Recoverable phenolics-total	3	<0.0010	<0.0010	<0.0010	0
Silver-total	6	<0.0050	<0.0050	<0.0050	0
Sulfate (as SO ₄)	3	71	22	40	15
Suspended solids-total	3	74	<5.0	<28	23
Temperature, °C	16	26	17	23	0.59
Trichloroethene	3	<0.0050	<0.0050	<0.0050	0
Turbidity, JTU ^d	3	98	40	60	19
Zinc-total	5	0.059	0.012	0.028	0.0090

^aSee Fig. 6.^bStandard error of the mean.^cNA = not applicable.^dMeasured in Jackson Turbidity Units.

Table 23. NPDES discharge point X14,^a July-September 1990

Parameter	Number of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Aluminum-total	5	1.3	<0.050	<0.36	0.24
Ammonia (as N)	3	0.70	0.040	0.26	0.22
Arsenic-total	5	<0.050	<0.050	<0.050	0
Biochemical oxygen demand	3	<5.0	<5.0	<5.0	0
Cadmium-total	6	<0.0050	<0.0020	<0.0035	0.00067
Chlorine-total residual	13	<0.010	<0.010	<0.010	0
Chloroform	3	<0.0050	-0.0030	-0.0043	0.00067
Chromium-total	5	0.010	<0.0040	<0.0068	0.0011
Conductivity, mS/cm	3	1.8	1.2	1.5	0.18
Copper-total	5	<0.0070	<0.0050	<0.0063	0.00042
Dissolved solids-total	3	270	230	250	13
Flow, Mgd	62	31	3.1	6.3	0.56
Fluoride-total	3	1.0	1.0	1.0	0
Iron-total	5	1.0	0.075	0.31	0.17
Lead-total	6	<0.050	<0.0040	<0.028	0.0098
Manganese-total	5	0.046	0.012	0.029	0.0061
Mercury-total	5	<0.00005	<0.00005	<0.00005	0
Nickel-total	5	<0.0050	<0.0040	<0.0044	0.00024
Nitrate	3	<5.0	<5.0	<5.0	0
Oil and grease	13	29	<2.0	<4.1	2.1
Organic carbon-total	3	4.2	2.1	2.8	0.70
Oxygen-dissolved	13	11	6.8	8.7	0.29
PCB-total	3	<0.0020	<0.0020	<0.0020	0
pH, standard units	3	8.2	7.1	NA ^c	NA
Phosphorus-total	6	0.90	0.21	0.40	0.10
Recoverable phenolics-total	3	<0.0010	<0.0010	<0.0010	0
Silver-total	6	<0.0050	<0.0050	<0.0050	0
Sulfate (as SO ₄)	3	51	36	46	4.8
Suspended solids-total	3	15	<5.0	<8.3	3.3
Temperature, °C	16	26	17	23	0.60
Trichloroethene	3	<0.0050	<0.0050	<0.0050	0
Turbidity, JTU ^d	3	320	22	140	93
Zinc-total	5	0.029	0.019	0.025	0.0019

^aSee Fig. 6.^bStandard error of the mean.^cNA = not applicable.^dMeasured in Jackson Turbidity Units.

Table 24. NPDES discharge point X15,^a July-September 1990

Parameter	Number of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Aluminum-total	5	0.70	<0.050	<0.40	0.11
Ammonia (as N)	3	0.15	0.020	0.090	0.038
Arsenic-total	5	<0.050	0.0020	0.032	0.011
Biochemical oxygen demand	3	<5.0	<5.0	<5.0	0
Cadmium-total	6	<0.0050	<0.0020	<0.0035	0.00067
Chlorine-total residual	13	<0.010	<0.010	<0.010	0
Chloroform	3	<0.0050	~0.0010	~0.0037	0.0013
Chromium-total	5	0.016	<0.0040	<0.011	0.0020
Conductivity, mS/cm	3	1.9	1.6	1.7	0.088
Copper-total	5	<0.0070	<0.0050	<0.0062	0.00049
Dissolved solids-total	3	230	210	220	7.2
Flow, Mgd	62	38	3.2	7.1	0.69
Fluoride-total	3	1.0	1.0	1.0	0
Iron-total	5	0.79	0.075	0.45	0.13
Lead-total	6	<0.050	<0.0040	<0.027	0.010
Manganese-total	7	0.13	0.052	0.085	0.010
Mercury-total	5	<0.00005	<0.00005	<0.00005	0
Nickel-total	5	<0.0050	<0.0040	<0.0044	0.00024
Nitrate	3	<5.0	<5.0	<5.0	0
Oil and grease	13	180	<2.0	<24	13
Organic carbon-total	3	3.0	2.5	2.8	0.15
Oxygen-dissolved	13	8.0	5.3	6.4	0.23
PCB-total	3	<0.0020	<0.0020	<0.0020	0
pH, standard units	3	7.8	7.2	NA ^c	NA
Phosphorus-total	6	1.0	<0.30	<0.44	0.11
Silver-total	6	<0.0050	<0.0050	<0.0050	0
Sulfate (as SO ₄)	3	41	38	40	0.88
Suspended solids-total	3	8.0	<5.0	<6.0	1.0
Temperature, °C	16	29	16	25	0.88
Trichloroethene	3	<0.0050	<0.0050	<0.0050	0
Turbidity, JTU ^d	3	320	75	160	79
Zinc-total	5	0.019	0.0089	0.014	0.0021

^aSee Fig. 6.^bStandard error of the mean.^cNA = not applicable.^dMeasured in Jackson Turbidity Units.

Table 25. NPDES cooling towers,^a July-September 1990

Parameter	Number of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Chlorine-total residual	21	1.7	<0.010	<0.23	0.11
Chromium-total	27	1.5	0.0052	0.11	0.063
Copper-total	27	11	<0.0070	<0.45	0.41
Downstream pH, standard units	18	8.2	7.4	NA ^c	NA
Flow, Mgd	26	0.19	0.0010	0.035	0.013
pH, standard units	27	8.9	7.4	NA	NA
Temperature, °C	27	34	19	26	0.65
Zinc-total	27	3.7	0.023	0.37	0.13

^aORNL.^bStandard error of the mean.^cNA = not applicable.

Table 26. NPDES miscellaneous outfalls, July-September 1990

Parameter	Concentration (mg/L)	
	EF7002 ^a	SP2519 ^b
Flow, Mgd	NO DISCHARGE	0.00011
pH, standard units	NO DISCHARGE	8.2
Temperature, °C	NO DISCHARGE	31

^aVehicle and Equipment Maintenance Facility, Building 7002.^bCentral Steam Plant, Building 2519.

Table 27. NPDES discharge point category I outfalls,^a July-September 1990

Parameter	Number of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
pH, standard units	6	8.2	7.0	NA ^c	NA
Suspended solids-total	5	420	3.0	96	81
Temperature, °C	6	27	24	25	0.39

^aORNL.^bStandard error of the mean.^cNA = not applicable.Table 28. NPDES discharge point category II outfalls,^a July-September 1990

Parameter	Number of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Downstream pH, standard units	46	8.3	7.2	NA ^c	NA
Flow, Mg/day	46	0.17	0.00017	0.016	0.0047
Gross beta	46	29	-0.070	1.6 ^d	0.79
Oil and grease	46	29	<2.0	<3.5	0.72
pH, standard units	50	8.3	7.1	NA	NA
Suspended solids-total	51	310	<1.0	<33	9.3
Temperature, °C	50	40	21	25	0.58

^aORNL.^bStandard error of the mean.^cNA = not applicable.^dAverage is statistically significantly different than zero.

Table 29. NPDES discharge point category III outfalls,^a July-September 1990

Parameter	Number of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Flow, Mgd	12	0.086	0.00072	0.023	0.0084
pH, standard units	13	8.4	7.8	NA ^c	NA

^aORNL.^bStandard error of the mean.^cNA = not applicable.

Table 30. NPDES noncompliances, July 1990

Permit Location	Limit Violated	Limit			Value
Cooling Tower 3117	Chromium	1.0	mg/L	daily max	1.5
CYRTF	Oil and grease	15	mg/L	monthly max	19.2
	Oil and grease	20	mg/L	daily max	88
NRWTF	Downstream pH	8.5		daily max	8.6

Table 31. NPDES noncompliances, August 1990

Permit Location	Limit Violated (daily max)	Limit (mg/l) (daily max)	Value
Category I Outfall 116	Total suspended solids	50	419
Category II Outfall 203	Total suspended solids	50	96
Category II Outfall 209	Total suspended solids	50	54
Cooling Tower CS2000	Chlorine	0.2	1.5
Cooling Tower CS3525-E	Chlorine	0.2	1.7
Cooling Tower CS7710	Copper	1.0	11
	Zinc	1.0	3.7
Sewage Treatment Plant	Chlorine	0.5	0.65

Table 32. NPDES noncompliances, September 1990

Permit Location	Limit Violated	Limit		Value
Category II Outfall 203	Total suspended solids	30	mg/L quarterly avg	52
Category II Outfall 209	Total suspended solids	30	mg/L quarterly avg	34
Category II Outfall 223	Total suspended solids	50	mg/L daily max	264
Category II Outfall 232	Oil and grease	15	mg/L daily max	21
Category II Outfall 242	Total suspended solids	50	mg/L daily max	155
	Total suspended solids	30	mg/L quarterly avg	82
Category II Outfall 248	Total suspended solids	50	mg/L daily max	312
Category II Outfall 261	Total suspended solids	50	mg/L daily max	164
Category II Outfall 266	Total suspended solids	50	mg/L daily max	71
Category II Outfall 268	Total suspended solids	50	mg/L daily max	189
Category II Outfall 291	Oil and grease	15	mg/L daily max	29
Cooling Tower CS4510	Chlorine	0.2	mg/L daily max	0.76

inspections of the three areas, no obvious signs of erosion or suspended solids buildup have been noted. However, outfall 203 includes a partially collapsed drain pipe that is targeted for repair under an ORNL Engineering project to improve end-of-pipe access and/or condition at several ORNL outfalls.

The chlorine exceedence on August 29, 1990, was attributed to a temporary excursion in the chlorine level in the STP effluent. Interviews with STP supervisory personnel found no evidence of upset or unusual operating conditions that would account for the exceedence.

3.3.2.3 September 1990

3.3.2.3.1 Inappropriate and/or Unpermitted Discharges

On September 19, ORNL personnel inspecting a subcontractor construction site in the ORNL 6000 Area noted muddy water being pumped to a storm drain outfall in the course of dewatering an excavation. ORNL's Best Management Practice (BMP) for dewatering excavations includes pumping muddy water to a grassy or wooded area or through straw bales and/or silt fences to facilitate removal of suspended sediment from the water. In this particular case, adequate BMPs were not being practiced. The construction subcontractor was required to cease operation until proper BMPs were implemented.

On September 19, ORNL personnel noted a situation where accumulated water was being manually pumped from a steam valve pit into a storm drain outfall during maintenance activities in the valve pit. The ORNL NPDES Permit allows discharge of heated water including cooling water and steam condensate as long as temperature criteria are not violated in the receiving stream. Because the pumping was of short duration, no temperature readings were conducted of the discharge or in the receiving stream. However, because the volume of water being pumped was reported to be fairly high for a short time, the in-stream temperature criteria may have been exceeded. No discernable effects were seen on the receiving stream or on stream inhabitants. The event was of short duration; therefore, no corrective actions were developed. By November 15, 1990, Environmental Compliance (EC) Section personnel issued an ORNL memorandum reaffirming that discharges to storm drains, including significant quantities of heated water, are not acceptable under the conditions of the NPDES Permit.

3.3.2.3.2 Exceedences of NPDES Permit limits

Between September 28 and October 5, analytical results were received for storm water samples collected from numerous storm drain outfalls during September 1990. The results indicated NPDES exceedences of TSS or oil and grease (O&G) at eight outfalls, which were inspected on October 8. The exceedences are attributed to storm water conveyance of residual dirt, dust, grease, and oil from ORNL streets and parking lots. Upon inspection, four of the outfalls showed no apparent sources of TSS or O&G. The other four, Outfalls 223, 242, 248 and 266, were noted to include catch basins and/or drainage ditches that would appear to benefit from cleanout to remove accumulated solids. The locations of these outfalls were forwarded to appropriate ORNL personnel along with requests for cleanout on October 8, 1990.

ORNL staff noted exceedence of the NPDES quarterly average limit of 30 mg/L TSS at three Category II outfalls in the third quarter of 1990. Quarterly monitoring is required for Category II outfalls, which include parking lot storm drains, roof drains, condensate, once-through cooling water, and cooling tower blowdown. However, several ORNL Category II outfalls were monitored more frequently during the third quarter of 1990, to obtain data necessary for preparing ORNL's NPDES Permit renewal application. As a result of the additional measurements, TSS averages were calculated and the quarterly average limit was exceeded at Outfalls 203, 209, and 242, even though no new individual exceedences occurred. These three outfalls are storm water runoff drains from areas including streets and parking areas. The calculations were made on September 30, 1990.

The chlorine concentration in cooling tower blowdown at Cooling Tower CS4510 exceeded the NPDES chlorine limit of 0.2 mg/L on September 20, 1990. Monitoring results were received by ORNL EC personnel on October 5, 1990, and CS4510 operators were interviewed. The chlorine exceedence was attributed to chlorine dosing of the CS4521 cooling tower to control Legionella bacteria buildup around September 20. The CS4521 tower is piped in series with the CS4510 tower, and some of the chlorine apparently carried over into CS4510. Additional chlorine measurements were made on October 5, and the chlorine concentration was within the NPDES limit. CS4510 operators are investigating the installation of chlorine sensors that would disallow opening of cooling tower blowdown valves if the chlorine concentration in the tower exceeded a preset limit. The feasibility of installing chlorine sensors in the CS4510 blowdown system will be completed by November 30, 1990.

3.4 POLYCHLORINATED BIPHENYL (PCB) IN THE AQUATIC ENVIRONMENT

Michael R. Powell

3.4.1 Program Description

Water samples were collected from various locations along WOC, MB, NWT and the Clinch River to determine PCB concentrations in these areas (Fig. 7). A total of twelve sites were sampled; eight on WOC (including one at WOD), one on MB, one on NWT and two on the Clinch River. Two samples per site were taken for water during July through September, 1990. This was done to comply with the Clean Water Act and is an integral part of ORNL's NPDES activities. Water samples are being analyzed quarterly for aroclors 1016, 1221, 1232, 1242, 1248, 1254 and 1260. Sediment samples are being analyzed for the same aroclors semiannually. The EPA acute criteria for the protection of fish and aquatic life is 2.0 ug/L for PCB.

Water samples were taken by the manual grab method and placed in amber glass containers. The samples were cooled to 4°C; the water samples can be held for a maximum of seven days before extraction. The samples were analyzed by a gas chromatographic procedure and measured by electron capture detector. This provides a method to determine individual aroclors, as well as total PCB content.

Fig. 7. Location map of PCB sampling points.

3.4.2 Results

The results from these samples will be used to help detect sources of PCB contamination and provide a history of PCB concentrations in the ORNL area.

The concentrations of PCB in water during July through September 1990 were below the analytical quantitation limit at all sampling sites. Analyses were performed for seven aroclors of PCB; all were below the quantitation limits. The quantitation limit for PCB aroclors 1016, 1221, 1232, 1242, and 1248 is 0.5 $\mu\text{g/L}$. The quantitation limit for PCB aroclors 1254 and 1260 is 1.0 $\mu\text{g/L}$.

3.4.3 Trends

Current trends in the concentration of PCB found at these sites are assessed by comparing the maximum and average values for the quarter to the historic concentration of PCB at the same locations for the last two years. All values remain within the distribution of maximum and average value for the last two years.

4. METEOROLOGICAL PROCESSES

Meteorological processes are continuously monitored at Oak Ridge National Laboratory (ORNL) so that current weather conditions may be taken into account, as needed, in response to emergencies that may arise. Weather records are also kept for climatological studies and for supportive information in hydrologic modeling and monitoring, facility design, scheduling of construction activities, and interpretation of nonmeteorological data (e.g., total suspended solids in surface water) that may depend on recent weather conditions.

4.1 WIND

Anita E. Osborne-Lee

4.1.1 Program Description

The ORNL wind tower network consists of towers A and B, each with sensors mounted at 10 and 30 meters, and tower C with sensors mounted at 10, 30, and 100 meters. Locations of these towers are shown in Fig. 8. Data from the sensors are acquired, stored, edited, and formatted by a data collection system consisting of a central processor and remote data logger. One-minute vector averages of wind velocity are calculated in the conventional way and retained 24 hours. These velocities are processed into 15-minute averages using a procedure that avoids the unrealistically low windspeed values obtained when appreciable winds of nearly opposite direction are vector averaged in the conventional way. This alternative averaging procedure involves calculating a unit vector to represent the direction of each 1-minute wind velocity, finding the vector average of those unit vectors, scaling that average to a unit vector, and multiplying the result by the mean (scalar) windspeed. A similar calculation is used to convert the 15-minute averages into hourly averages. The 15-minute averages are retained for one day and the hourly averages are stored for at least one year, then archived.

4.1.2 Results

The hourly averages are used to generate wind roses (Figs. 9-15) for the quarter. Examination of these quarterly wind roses reveals that the prevailing winds are almost equally split into two directions that are 180° apart: one prevailing direction is from the SW to WSW sector and the other prevailing direction is from the NE to ENE sector. The winds are strongly aligned along these directions because of the channeling effect induced by the ridge and valley structure of the area. This channeling effect is least evident at 100 m elevation, where the winds are more south-southwesterly. Another feature observed from the wind roses is that the wind speeds increase with height (tower level) at each of the towers. On the average, the wind speeds can be expected to increase steadily from ground level to 100 m.

4.1.3 Trends

An examination of the wind roses generated for the previous quarters has shown a consistency in results. This is due primarily to the static locations of the meteorological towers and the virtually unchanging topology of the land. These findings are consistent with expectations.

ORNL-DWG 86-9142R4

Fig. 8. Location map of meteorological towers at ORNL.

with 68.1% of possible data

Fig. 9 Wind rose at 10-m level of meteorological tower A,
July-August 1990

with 70.7% of possible data

Fig. 10 Wind rose at 30-m level of meteorological tower A,
July-August 1990

with 93.2% of possible data

ORNL-DWG 90-15328

Fig. 11 Wind rose at 10-m level of meteorological tower B,
July-August 1990

with 93.2% of possible data

ORNL-DWG 90-15329

Fig. 12 Wind rose at 30-m level of meteorological tower B,
July-August 1990

Fig. 13 Wind rose at 10-m level of meteorological tower C,
July-August 1990

Fig. 14 Wind rose at 30-m level of meteorological tower C,
July-August 1990

Fig. 15 Wind rose at 100-m level of meteorological tower C,
July-August 1990

5. BIOLOGICAL MONITORING

Michael R. Powell

The environmental surveillance programs include biotic and abiotic environments that may be affected by the releases from the Oak Ridge Department of Energy (DOE) facilities or may provide pathways of exposure to people. Biological monitoring consists of milk samples which are analyzed for radionuclides and nonradioactive chemicals.

Milk is a potentially significant pathway for the transfer of radionuclides from their point of release to humans because of the relatively large surface area that can be grazed daily by the cow, the rapid transfer of milk from producer to consumer, and the importance of milk in the diet. Strontium-90 and I-131 are radionuclides that are especially important in this atmosphere to pasture to cow to milk food chain. The milk samples are collected biweekly, except for May through September in which the samples are collected monthly.

5.1 MILK

5.1.1 Program Description

Raw milk from five locations, including one dairy, within a radius of 80 km of Oak Ridge, is monitored for I-131 and total radioactive strontium. Samples are collected each month from the stations located near the Oak Ridge area (Fig. 15). Samples are analyzed for I-131 by gamma spectroscopy and for total radioactive strontium by chemical separation and low-level beta counting. Instrument background values are subtracted from the measured values of I-131 and strontium in milk samples, and net activity concentrations are summarized. No milk was available for the month of September, for this quarter, from station 1.

5.1.2 Results

Values of I-131 for the first quarter were often less than instrument background, as is indicated by negative values in Table 33. The estimated overall average concentration of I-131 at the stations in the immediate Oak Ridge area was -0.014 Bq/L. There were detectable concentrations of I-131 at station 8. This coincided with increases in iodine emissions from Melton Valley. Concentrations of total radioactive strontium are shown in Table 34. The estimated overall average concentration of total radioactive strontium at the stations in the immediate Oak Ridge area was 0.069 Bq/L, which is significantly greater than zero.

Dose was calculated for a station when the average value obtained was statistically greater than zero. The measured average concentrations of I-131 and total radioactive Sr (assuming 100% Sr-90) in milk were used to calculate the potential 50-year committed effective dose equivalents given in Tables 33 and 34. This calculation is based on the assumption that 1 L/day of milk is ingested at these concentrations for 365 days. Doses resulting from ingestion of milk were less than 1% of DOE's guideline of 1000 uSv.

Fig. 16. Location map of milk-sampling stations near the Oak Ridge facilities.

Table 33. Concentrations of I-131 in milk and calculated doses,^a
July-September 1990

Station	Number of Samples	Concentration (Bq/L)			Standard error ^b	Dose (μ Sv) ^c
		Max	Min	Av		
Immediate environs ^d						
1	2	-0.030	-0.10	-0.065	0.035	
2	3	0.010	-0.10	-0.060	0.035	
3	3	0.040	-0.10	-0.027	0.041	
4	3	0.070	-0.10	0.0033	0.052	
8	3	0.10	0.040	0.062 ^e	0.019	0.31
Network Summary	14	0.10	-0.10	-0.014	0.019	

^aRaw milk samples; Station 2 is a dairy.

^bStandard error of mean.

^cPotential 50-year committed effective dose equivalents from drinking 365 L of milk per year using average radionuclide concentrations at each location.

^dSee Fig. 16.

^eDose is estimated for stations whose average value is statistically greater than zero.

Table 34. Concentrations of total radioactive Sr in milk and calculated doses,^a July-September 1990

Station	Number of Samples	Concentration (Bq/L)			Standard error ^b	Dose (μSv) ^c
		Max	Min	Av		
Immediate environs ^d						
1	2	0.051	0.020	0.036	0.016	
2	3	0.044	0.020	0.029 ^e	0.0077	0.37
3	3	0.15	0.040	0.078	0.036	
4	3	0.079	0.050	0.064 ^e	0.0084	0.82
8	3	0.16	0.080	0.13 ^e	0.025	1.7
Network Summary	14	0.16	0.020	0.069 ^e	0.013	0.89

^aRaw milk samples; Station 2 is a dairy.

^bStandard error of mean.

^cPotential 50-year committed effective dose equivalents from drinking 365 L of milk per year using average radionuclide concentrations at each location.

^dSee Fig. 16.

^eDose is estimated for stations whose average value is statistically greater than zero.

5.1.3 Trends

Current trends in the I-131 and strontium concentration are assessed by comparing the maximum and average values for the quarter to the historic concentrations of these isotopes in milk for the last two years. In the current quarter, I-131 concentrations are below the average values for the last two years at all stations except station 8. Iridium-131 concentrations have exceeded the highest previous average concentration at station 8. Strontium values at stations 1 and 3 are not significantly greater than zero. These stations' maxima and average values are below the respective maxima and average values for the last two years. Estimated strontium activities are significantly greater than zero at stations 2, 4, and 8. The maximum and the average value for strontium at these stations is below the two-year maximum.

INTERNAL DISTRIBUTION

1. M. E. Baldwin	26. C. E. Nix
2. F. P. Baxter	27. F. R. O'Donnell
3. T. J. Blasing	28-30. A. E. Osborne-Lee
4. D. M. Borders	31. M. R. Powell
5. H. L. Boston	32. S. M. Robinson
6. R. B. Clapp	33. J. G. Rogers
7. D. R. Cunningham	34. T. H. Row
8. I. V. Darling	35. C. B. Scott
9. J. M. Forstrom	36. W. K. Simon
10. S. B. Garland	37. L. R. Simmons
11. P. Y. Goldberg	38. M. M. Stevens
12. B. M. Horwedel	39. J. R. Stokely
13. D. D. Huff	40. J. H. Swanks
14. C. G. Jones	41-45. M. F. Tardiff
15. R. G. Jordan	46. J. R. Trabalka
16. D. C. Kocher	47. C. K. Valentine
17. F. C. Kornegay	48. L. D. Voorhees
18. J. M. Loar	49. J. B. Watson
19. R. S. Loffman	50. D. A. Wolf
20. L. W. Long	51. D. M. Walls
21. I. L. McCollough	52. Document Reference Section
22. L. E. McNeese	53. Laboratory Records - RC
23. M. E. Mitchell	54. ORNL Laboratory Records
24. J. B. Murphy	55. ORNL Patent Office
25. M. E. Murray	

EXTERNAL DISTRIBUTION

56. H. W. Hibbitts, Environmental Protection Division, Environment, Safety, and Health, DOE Field Office - Oak Ridge, Oak Ridge, TN 37831
57. T. W. Joseph, Environmental Protection Division, Environment, Safety, and Health, DOE Field Office - Oak Ridge, Oak Ridge, TN 37831
58. Richard Pardi, BEAG, Building 475, Brookhaven National Laboratory, Upton, NY 11973
59. J. A. Reafsnyder, Deputy Assistant Manager for Energy Research and Development, DOE Field Office - Oak Ridge, Oak Ridge, TN 37831
60. W. C. Sidle, Environmental Protection Division, Environment, Safety, and Health, DOE Field Office - Oak Ridge, Oak Ridge, TN 37831
- 61-62. Office of Scientific and Technical Information, Oak Ridge, TN 37831

END

**DATE
FILMED**

10/30/91