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Industrial Safety and Applied Health Physics Annual Report for 1980

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INDUSTRIAL SAFETY AND APPLIED HEALTH PHYSICS ANNUAL REPORT FOR 1980

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NOTICE This document contains information of a preliminary nature. It is subject to revision or correction and therefore does not represent a final report.

OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37830
operated by
UNION CARBIDE CORPORATION
for the
DEPARTMENT OF ENERGY

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FOREWORD

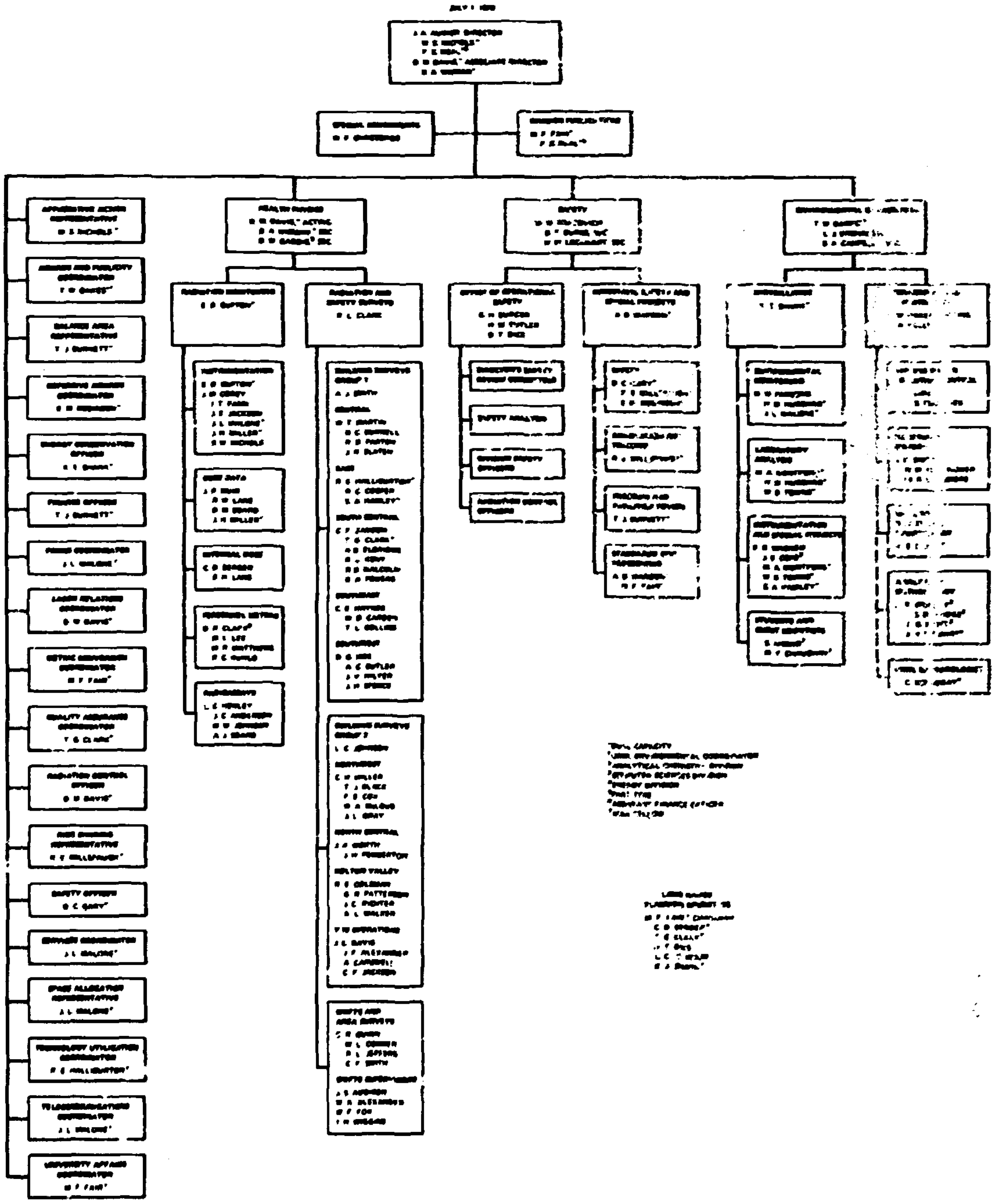
This report is a description and summary of the activities of the Industrial Safety and Applied Health Physics Division. Information in this report was contributed by, and/or compiled by the staff members of the following departments of the Industrial Safety and Applied Health Physics Division.

Health Physics Department

Safety Department

Environmental Management Department

INDUSTRIAL SAFETY AND APPLIED HEALTH PHYSICS DIVISION



2.0 SUMMARY

Radiation Quantities and Units

The four radiation quantities (and units) used in this report are: exposure (roentgen and coulomb per kilogram), absorbed dose (rad and gray), dose equivalent (rem and sievert), and activity (curie and becquerel). The term "dose" shall mean dose equivalent.

RADIATION MONITORING

Personnel Monitoring

There were no external or internal exposures to personnel which exceeded the standards for radiation protection as defined in DOE Manual Chapter 0524. Only 35 employees received whole body dose equivalents of 10 mSv (1 rem) or greater. The highest whole body dose equivalent to an employee was about 29 mSv (2.9 rem). The highest internal exposure was less than one-half of a maximum permissible dose for any calendar quarter.

Health Physics Instrumentation

During 1980, 26 portable instruments were added to the inventory and 25 retired. The total number in service on January 1, 1981, was 979. There were 25 facility radiation monitoring instruments installed and 14 retired during 1980. The total number in service on January 1, 1981, was 1,032.

ENVIRONS SURVEILLANCE

Atmospheric Monitoring

There were no releases of gaseous waste from the Laboratory which were of a level that required an incident report to DOE. The average concentration of beta radioactivity in the atmosphere at the perimeter of the DOE-controlled area was less than one tenth of one percent of the value applicable to releases to uncontrolled areas.

Water Monitoring

There were no releases of liquid radioactive waste from the Laboratory which were of a level that required an incient report to DOE. The quantity of those radionuclides of primary concern in the Clinch River, based on the concentration measured at White Oak Dam and the dilution afforded by the Clinch River, averaged 0.16 percent of the concentration guide.

Radiation Background Measurements

The average background level at the PAM stations during 1980 was 9.0 μrad/h (0.090 μGy/h).

Soil and Grass Samples

Soil samples were collected at all perimeter and remote monitoring stations and analyzed for eleven radionuclides including plutonium and uranium. Plutonium-239 content ranged from 0.37 Bq/kg (0.01 pCi/g) to 1.5 Bq/kg (0.04 pCi/g), and the Uranium-235 content ranged from 0.7 Bq/kg (0.02 pCi/g) to 16 Bq/kg (0.43 pCi/g).

Grass samples were collected at all perimeter and remote monitoring stations and analyzed for twelve radionuclides including plutonium and uranium. Plutonium-239 content ranged from 0.04 Bq/kg (0.001 pCi/g) to 0.07 Bq/kg (0.002 pCi/g), and the Uranium-235 content ranged from 0.37 Bq/kg (0.01 pCi/g) to 12 Bq/kg (0.33 pCi/g).

RADIATION AND SAFETY SURVEYS

Laboratory Operations Monitoring

During 1980, the Radiation and Safety Surveys personnel continued to assist the operating groups in keeping contamination, air concentrations, and personnel exposure levels below the established maximum permissible levels. They assisted in reducing or eliminating a number of problems associated with radiation protection at the Laboratory.

Radiation Incidents

Five radiation incidents involving radioactive materials were recorded during 1980. All were of minor significance.

Laundry Monitoring

Of the 570,000 articles of wearing apparel and 214,000 articles, such as mops, laundry bags, towels, etc., monitored during 1980 about five percent were found to be contaminated.

INDUSTRIAL SAFETY AND SPECIAL PROJECTS

Accident Analysis

Two lost workday cases occurred at ORNL in 1980, an incidence rate of 0.05. The Recordable Injury and Illness frequency rate for 1980 was 0.96. The frequency rates for 1979 were 0.07 and 1.05, respectively.

Summary of Lost Workday Cases

A total of 147 days were lost or charged for the two lost workday cases in 1980. The days lost or charged in 1979 were 69 for three lost workday cases and 55 in 1978 for three lost workday cases.

Safety Awards

The National Safety Council Award of Honor was earned by the Laboratory in 1980. This is the sixth consecutive year the Laboratory has earned this award. The Laboratory also earned DOE's Award of Excellence.

3.0 RADIATION MONITORING

3.1 Personnel Monitoring

All persons who enter Laboratory areas where there is a likelihood of exposure to radiation or radioactive materials are monitored for the kinds of exposure they are likely to sustain. External radiation dosimetry is accomplished mainly by means of badge-meters, pocket ion chambers, and hand exposure meters. Internal deposition is determined from bioassays and *in vivo* counting.

3.1.1 Dose Analysis Summary, 1980

(a) External Exposures - No employee received a whole body radiation dose which exceeded the standards for radiation protection, DOE Manual Chapter 0524. The maximum whole body dose sustained by an employee was about 31 mSv (3.1 rem) or 62 percent of the applicable standard of 50 (5 rem). The range of doses to persons using ORNL badge-meters is shown in Table 3.1.1.

As of December 31, 1980, no employee had a cumulative whole body dose which was greater than the applicable standard based on the age proration formula 5(N-18), Table 3.1.2. No employee has an average annual dose that exceeds 0.05 Sv (5 rem) per year of employment, Table 3.1.3. The greatest cumulative whole body dose received by an employee was approximately 1.13 Sv (113 rem). This was accrued over an employment period of about 37 years and represents an average of about 31 mSv (3.1 rem) per year.

The greatest cumulative dose to the skin of the whole body received by an employee during 1980 was about 93 mSv (9.3 rem) or 62 percent of the applicable standard of 150 mSv (15 rem).

The maximum cumulative hand dose recorded during 1980 was about 110 mSv (11 rem) or 15 percent of the applicable standard of 750 mSv (75 rem).

The average of the 10 greatest whole body doses to ORNL employees for each of the years 1976 through 1980 is shown in Table 3.1.4.

(b) Internal Exposures - There were no cases of internal exposure during the year for which the radioactive material within the body averaged as much as one-half the maximum permissible organ burden for the year.

3.1.2 External Dose Techniques

(a) TLD Meters - Standard TLD meters are issued to all employees and to photobadged non-employees who work in radiation zones. Standard TLD meters have two TLD chips, one shielded and one unshielded. Specialized meters, with various complements of TLDs and films are issued to those who may be exposed to other than gamma and energetic X radiation.

TLD meters of radiation workers are exchanged and processed quarterly, or more frequently if required for exposure control. All other meters are exchanged and processed annually.

(b) Pocket Meters - Pocket meters (indirect reading, ionization chambers) are made available at all principal points of entry to ORNL. A pair of pocket meters is carried for the duration of a work shift by persons who work in an area where the potential for an exposure of 0.2 mGy (20 mrad) or more exists during the work shift. Pocket meter pairs are processed each day by Health Physics technicians. Readings of 0.2 mGy (20 mrad) or more are reported to supervision daily. Printouts giving all readings along with weekly totals and accumulative totals are sent to supervision weekly. Pocket meter readings are used for estimating integrated exposure and as a basis for badge-meter processing during a calendar quarter.

(c) Hand Exposure Meters - Hand exposure meters are TLD-loaded finger rings. Hand exposure meters are issued to persons for use during operations where it is likely that the hand dose may exceed 10 mSv (1 rem) during the week. They are issued and collected by Radiation and Safety Surveys personnel who determine the need for this type of monitoring and arrange for a processing schedule.

(d) Metering Resume - Shown in Table 3.1.5 are the quantities of personnel metering devices used and processed during 1980. The number of dosimeters processed is less than the number issued, because those which were issued for accident dosimetry only were not processed unless there was a likelihood of exposure.

3.1.3 Internal Dose Techniques

(a) Bioassay - Urine and fecal samples are analyzed for the purpose of making internal exposure determinations. The frequency of sampling and the type of radiochemical analysis performed is based upon each specific radioisotope and the intake potential. Because of the small quantities of radioactive material in most samples, qualitative analyses are not feasible; and only quantitative analyses for predetermined isotopes are performed routinely.

In most cases, bioassay data require interpretation to determine the dose to the person; computer programs are used for evaluation of extensive data on urinary excretion of ^{239}Pu. An estimate of dose is made for all cases in which it appears that one-fourth of a maximum permissible organ burden averaged over a calendar year may be exceeded.

The analyses performed by the Industrial Safety and Applied Health Physics radiochemical lab during 1980 are summarized in Table 3.1.6.

(b) Whole Body Counter - The Whole Body Counter (an *in vivo* gamma spectrometer) is used for estimating internally deposited quantities of most radionuclides which emit photons.

Approximately 750 whole body, chest, wound, thyroid and liver counts were performed by the Whole Body Counter facility during the year 1980. Most of the subjects counted had ^{137}Cs in the range of 37 to 500 Bq (from fallout from nuclear weapons testing). Small quantities of various fission or activation products were identified in a few individuals, but no individual was found to have an internal deposition of greater than 10 percent of maximum permissible organ burden of that isotope for the year.

(c) Counting Facility - The counting facility determines radioactivity content of samples submitted by the Industrial Safety and Applied Health Physics sections. A summary of analyses is in Table 3.1.7.

3.1.4 Reports

Routine reports of personnel monitoring data are prepared and distributed to divisional supervision and to the Industrial Safety and Applied Health Physics staff.

(a) Pocket Meter Data - A report is prepared and distributed to supervision daily of the names, ORNL divisions, and readings for pocket meters which were 0.2 mGy (20 mrad) or greater during the previous 24 hours.

A computer-prepared report, which includes all pocket meter data for the previous week and summary data for the calendar quarter, is published and distributed weekly.

(b) External Dosimetry Data - A computer-prepared report, which includes data of recorded skin dose and whole body dose for the previous calendar quarter and totals for the current year, is published and distributed quarterly.

(c) Bioassay Data - A computer-prepared report, which includes data of sample status and results for the previous week, is published and distributed weekly. A quarterly and an annual report of results are prepared and distributed also.

(d) Whole Body Counter Data - Preliminary results of analysis are reported on a card form soon after counting is done. A computer-prepared report is published and distributed quarterly and annually.

3.1.5 Records

Permanent records of personnel monitoring data are maintained for each person who is assigned an ORNL photobadge meter.

3.2 Health Physics Instrumentation

The Industrial Safety and Applied Health Physics Division shares with the Instrumentation and Controls Division the responsibility for the selection of electronic radiation monitoring instruments used in the ORNL health physics program. Normally, the Industrial Safety and Applied Health Physics Division is responsible for determining the need for new instrument types and modifications to existing types, for specifying the health physics design requirements, and for approval of the design. The Industrial Safety and Applied Health Physics Division is responsible for calibrating all instruments used in the health physics program and is allocated the funds for maintenance of these instruments. Maintenance is performed or cross-ordered by the Instrumentation and Controls Division.

Non-electronic personnel monitoring devices are designed, tested, calibrated, and maintained by Industrial Safety and Applied Health Physics Division personnel.

3.2.1 Instrument Inventory

The electronic instruments used in the health physics program are divided, for convenience in servicing and calibrating, into two classes: the first class includes battery-powered portable instruments; the second class includes the stationary instruments that are AC powered. Portable instruments are assigned and issued to the Radiation and Safety Surveys complexes. Stationary instruments are the property of the ORNL division which has the monitoring responsibility in the area in which the instrument is located. Table 3.2.1 lists portable instruments assigned at the end of 1980; Table 3.2.2 lists stationary instruments in use at the end of 1980.

Inventory and service summaries for health physics instruments are prepared by computer. These computer-programmed reports enable the Instruments Group to maintain a current inventory on most health physics instrument requirements.

The allocation of stationary health physics monitoring instruments by division is shown in Table 3.2.3.

3.2.2 Calibration Facility

The Industrial Safety and Applied Health Physics Division maintains a calibration facility for the calibration and maintenance of portable radiation instruments and personnel metering devices. The facility is equipped with calibration sources, remote control devices, and shop space for the use of Instrumentation and Controls Division maintenance personnel. Industrial Safety and Applied Health Physics personnel assign, arrange for maintenance of, calibrate, provide delivery services for, and maintain inventory and servicing data on all portable health physics instruments.

The radiation sources used for calibration have been either standardized by the National Bureau of Standards or evaluated by comparison with sources that have been standardized by the National Bureau of Standards.

The recommended maintenance and calibration frequency is two (no more than three) months for instruments that measure exposure, absorbed dose or dose equivalent rates--Cutie Pie, Juno, Fast Neutron Survey Meter, etc., and three (no more than four) months for count rate instruments--Gas Flow, Scintillation, GMSM, Thermal Neutron, Air Proportional, etc. The number of calibrations of portable instruments for 1980 is shown in Table 3.2.4.

3.3 Developments

3.3.1 Hyperpure Germanium Array for Lung Counting

The ORNL Whole Body Counter staff continued development of the 80 cm^2 solid state (hyperpure germanium) array for in-vivo detection of low-energy photon and X-ray emitters in 1980. Computer programs for analysis of lung burdens of ^{239}Pu and ^{241}Am and prediction of background continuums were written based on data acquired from uncontaminated male and female subjects. A nuclide library was compiled for some of the most commonly occurring nuclides and was incorporated into computer programs for rapid identification and quantification of these radionuclides.

3.3.2 Calcium Fluoride-Sodium Iodide Phoswich for Sample Analysis

Experimentation was begun on a CaF_2(Eu)-NaI(Tl) phoswich for beta-gamma spectroscopy of environmental samples. Preliminary investigation on soil samples has been encouraging. Although improvements are still being made, this phoswich system currently demonstrates a reduction in the minimum detectable activity by a factor of approximately 10-20 for ^{239}Pu in 20 g samples of soil--also containing mixed fission products--over existing detector systems (e.g., FIDLER AND ZnS detectors). Upon completion of laboratory experimentation, the possibility of turning this system into a field instrument--useful for ground surveys and decontamination and decommissioning work--will be investigated.

3.3.3 Sample Counting Standards

All calibration sources for the Counting Facility were restandardized by comparison with sources standardized by the National Bureau of Standards.

3.3.4 Bioassay Standards

Solutions containing radioactivity that are used for tracers and control standards for bioassays were restandardized by comparison with solutions standardized by the National Bureau of Standards, if available, or by other means if not.

Table 3.1.1 Dose Data Summary for Laboratory Population Involving Exposure to Whole Body Radiation - 1980

Group		Dose Range							Total
	mSv rem	0-1 0-0.1	1-10 0.1-1	10-20 1-2	20-30 2-3	30-40 3-4	40-50 4-5	50 up 5 up	
ORNL Employees		364	243	35	10	1	0	0	653
ORNL-Monitored Non-Employees		300	25	0	0	0	0	0	325
TOTAL		664	268	35	10	1	0	0	978

Table 3.1.2 Average Dose Per Year Since Age 18 - 1980

Group		Dose Range						Total
	mSv rem	0-10 0-1	10-20 1-2	20-30 2-3	30-40 3-4	40-50 4-5	50 up 5 up	
ORNL Employees		615	31	7	0	0	0	653

Table 3.1.3 Average Dose Per Year of Employment ORNL -1980

Group		Dose Range						Total
	mSv rem	0-10 0-1	10-20 1-2	20-30 2-3	30-40 3-4	40-50 4-5	50 up 5 up	
ORNL Employees		563	80	5	5	0	0	653

Table 3.1.4 Average of the Ten Highest Whole Body Doses and the Highest Individual Dose by Year

Year	Average of the Ten Highest Doses mSv	(rem)	The Highest Dose mSv	(rem)
1976	26.8	2.68	34.9	3.49
1977	28.4	2.84	36.2	3.62
1978	23.9	2.39	33.4	3.34
1979	22.4	2.24	28.0	2.80
1980	24.6	2.46	31.4	3.14

Table 3.1.5 Personnel Meters Services

	1978	1979	1980
A. Pocket Meter Usage			
1. Number of Pairs Used			
ORNL	70,512	70,238	69,410
CPFF*	20,748	8,022	5,026
Total	91,260	78,260	74,436
2. Average Number of Users Per Quarter			
ORNL	678	679	671
CPFF	399	174	109
Total	1,077	853	780
B. Meters Processed for Monitoring Data			
1. Beta-Gamma Badge-Meter	30,630	30,520	15,260
2. Neutron Badge-Meter	710	800	1,030
3. Hand Meter	670	720	460

*Cost Plus Fixed Fee Contractors - Rust Engineering.

Table 3.1.6 Radiochemical Lab Analyses - 1980

Radionuclide	Urine	Feces	Milk	Water	Controls
Plutonium, Alpha	330	5	--	52	89
Transplutonium Alpha	295	5	--	52	61
Uranium, Alpha	269	3	--	--	25
Strontium, Beta	245	11	420	--	52
Tritium	169	--	--	120	10
Iodine-131	--	--	420	--	52
Other	19	--	--	--	--
Totals	1,327	24	840	224	331

Table 3.1.7 Counting Facility Analyses - 1980

Types of Samples	Number of Samples		Unit Total
	Alpha	Beta	
Facility Monitoring			
Smears	21,991	23,026	45,017
Air Filters	14,704	13,990	28,694
Environs Monitoring			
Air Filters	3,092	3,092	6,184
Fallout		2,990	2,990
Rainwater		721	721
Surface Water		321	321

Table 3.2.1 Portable Instrument Inventory - 1980

Instrument Type	Instruments Added 1980	Instruments Retired 1980	In Service Jan. 1, 1981
G-M Survey Meter	11	9	311
Cutie Pie	7	16	309
Alpha Survey Meter	8	0	249
Neutron Survey Meter	0	0	101
Miscellaneous	0	0	5
TOTAL	26	25	979

Table 3.2.2 Inventory of Facility Radiation Monitoring Instruments for the Year - 1980

Instrument Type	Installed During 1980	Retired During 1980	Total Jan. 1, 1981
Air Monitor, Alpha	3	0	110
Air Monitor, Beta	0	2	161
Lab Monitor, Alpha	6	2	184
Lab Monitor, Beta	6	1	228
Monitron	9	9	203
Other	1	0	146
TOTAL	25	14	1,032

Table 3.2.3 Health Physics Facility Monitoring Instruments
Divisional Allocation - 1980

ORNL Division	α Air Monitor	β Air Monitor	α Lab Monitor	β Lab Monitor	Monitron	Other	Total
Analytical Chemistry	8	10	16	19	14	4	71
Chemical Technology	52	39	77	48	41	35	292
Chemistry	7	1	13	14	2	4	41
Metals and Ceramics	15	15	22	12	8	17	89
Operations	15	84	39	89	110	46	383
All Others	13	12	17	46	28	40	156
TOTAL	110	161	184	228	203	146	1,032

Table 3.2.4 Calibrations Facility Resume - 1980

Item	Number of Calibrations
Beta-Gamma Survey Meters	2,361
Neutron Survey Meters	358
Alpha Survey Meters	877
Personal Dosimeters	3,745
Badge Dosimetry Components	1,420

4.0 ENVIRONMENTAL MANAGEMENT PROGRAM

During CY 1980 the Environmental Management Program consisted of the Office of Environmental Coordinator and the Department of Environmental Management.

4.1 Department of Environmental Management

The Department of Environmental Management of the Industrial Safety and Applied Health Physics Division monitors for airborne radioactivity in the East Tennessee area using three separate monitoring networks. The local air monitoring (LAM) network consists of 23 stations that are positioned relatively close to ORNL operational activities; the perimeter air monitoring (PAM) network consists of nine stations located on the perimeter of the DOE-controlled area and provides data for evaluating the impact of all Oak Ridge operations on the immediate environment; and the remote air monitoring (RAM) network consists of seven stations located outside the DOE-controlled area at distances of 19 to 121 km (12 to 75 miles) from ORNL (see Figs. 4.1.1-4.1.4). The monitoring networks provide for the collection of (1) airborne radioactivity by air filtration techniques, (2) radioparticulate fallout material by impingement on gummed paper trays, (3) rainwater for measurement of fallout occurring as rainout, (4) radioiodine using charcoal cartridges, and (5) tritium using silica gel (selected LAMs).

Low-level radioactive liquid wastes originating from ORNL operations are discharged, after treatment, to White Oak Creek, which is a small tributary of the Clinch River. The radioactive content of White Oak Creek discharge is determined at White Oak Dam, which is the last control point along the stream prior to the entry of White Oak Creek into the Clinch River. Water samples are also collected at several locations in the Clinch River, beginning at a point above the entry of the wastes into the river and ending at Kingston Water Plant near Kingston, Tennessee, the nearest population center downstream (Fig. 4.1.5).

Samples of White Oak Creek effluent are collected at White Oak Dam by a continuous proportional sampler and analyzed weekly for gross beta, gross alpha, ^{3}H, ^{60}Co, ^{90}Sr, ^{106}Ru, ^{137}Cs, plutonium, and transplutonium elements. Calculations are made of the concentrations of radioactivity in the Clinch River at the point of entry of White Oak Creek (Clinch River Mile [CRM] 20.8), using the concentrations measured at White Oak Dam and the dilution provided by the river. To verify the calculated concentrations, two sampling stations are maintained in the Clinch River below the point of entry of the wastes; one at the Oak Ridge Gaseous Diffusion Plant (ORGDP) water intake (CRM 14.5) and the other at Kingston Water Plant near Kingston, Tennessee (TRM 568, near CRM 0.0). An additional sampling station is maintained in the Clinch River at Melton

Hill Dam (CRM 23.1) above the point of entry of the waste to provide baseline data and at the mouth of White Oak Creek for backup measurements of White Oak Dam station.

The ORGDP water sampling station collects a sample from the Clinch River proportional to the flow in the river near the water intake of the ORGDP water system. The samples are brought into the Laboratory at weekly intervals, and an aliquot is composited for quarterly analysis of tritium. The remaining portion of the sample is passed over anion and cation resins to remove nuclides. At quarterly intervals, the resin columns are eluted, and the eluate is analyzed for gross activity and for individual radionuclides that may be present in significant amounts.

A "grab" sample is collected daily at the Kingston Water Plant sampling station which is located near the mouth of the Clinch River at TRM 568. The daily grab samples are composited and analyzed on a quarterly basis. The preparation of these samples and the analyses performed are the same as those for the ORGDP water sampling station.

The Melton Hill Dam sampling station collects a sample proportional to the flow of water through the power-generating turbines, which represents all of the discharge from the Dam other than a minor amount discharged in the operation of the locks. Samples are collected from the station at weekly intervals, processed, and analyzed in the same manner as for the ORGDP water sampling station.

Samples of ORNL's potable water are collected daily, composited, and stored. At the end of each quarter, these composites are analyzed radiochemically for ^{90}Sr content and are assayed for long-lived gamma-emitting radionuclides by gamma spectrometry.

Raw milk is collected at 12 sampling stations located within a radius of 50 miles from ORNL. Samples are taken on a weekly basis from seven stations located outside the DOE-controlled area within a 20-mile radius of ORNL (Fig. 4.1.6). Samples are collected every five weeks from the five remaining stations located more remotely with respect to Oak Ridge operations out to distances of about 50 miles (Fig. 4.1.7). The purpose of the milk sampling program is twofold: first, samples collected in the immediate vicinity of ORNL provide data by which one may evaluate the possible effect of effluents from ORNL operations; second, samples collected remote to the immediate vicinity of ORNL provide background data which are essential in establishing a proper index from which releases of radioactive materials originating from Oak Ridge operations may be evaluated. The milk samples are analyzed by radiochemical techniques for strontium-90 and iodine-131. The minimum detectable concentrations of strontium-90 and iodine-131 in milk are 18.5 mBq/ℓ (0.5 pCi/ℓ) and 16.7 mBq/ℓ (0.45 pCi/ℓ), respectively.

External gamma radiation background measurements are made routinely at the local and perimeter air monitoring stations, at one station located near Melton Hill Dam and at the remote monitoring stations; measurements are made using calcium fluoride thermoluminescent dosimeters suspended one meter above the ground. Dosimeters at the perimeter stations and Melton Hill Dam are collected and analyzed monthly. Those at local and remote stations are collected and analyzed semiannually.

External gamma radiation measurements are also made routinely along the bank of the Clinch River from the mouth of White Oak Creek to points several hundred yards downstream (Fig. 4.1.8). These measurements were used to evaluate gamma radiation levels resulting from ORNL liquid effluent releases and "sky shine" from an experimental ^{137}Cs plot located near the river bank. Radiation measurements were made using lithium fluoride thermoluminescent dosimeters suspended one meter above the ground surface.

Various species of fish, which are commonly caught and eaten in eastern Tennessee, are taken from the Clinch River quarterly from CRM 20.8 (intersection of White Oak Creek and the Clinch River) and annually from other locations in the Clinch River. Ten fish of each species are composited for each sample; and the samples are analyzed by gamma spectrometric and radiochemical techniques for the critical radionuclides, which may contribute significantly to the potential radiation dose to man.

Soil and grass samples are collected semiannually and annually, respectively, from locations near the PAM and RAM stations. Ten samples, approximately 8 cm in diameter and 5 cm thick, are collected from five 400-cm^2 plots at each location, composited, and analyzed by gamma spectroscopy, and radiochemical techniques for uranium, plutonium, and various other radioisotopes.

4.2 Office of Environmental Coordinator

The major functions of the Office during 1980 were:

1. Coordinated the Laboratory's pollution abatement and monitoring programs.

2. Served as liaison between the various ORNL groups involved in pollution control, ORNL management and UCC-ND Office of Safety and Environmental Protection.

3. Determined the pollutants (radioactive and nonradioactive) to be monitored in effluents and environmental media and the location and frequency of the measurements.

4. Identified areas where development work, additional monitoring equipment, and changes in waste disposal practices are required for pollution abatement.

5. Maintained adequate records on significant effluents within the installation

6. Reviewed, or provided for review, the design, acquisition, and installation of required pollution control equipment.

7. Prepared environmental assessments for those Laboratory construction projects which require them.

8. Prepared monthly, quarterly, and annual reports on radioactive and nonradioactive effluents as required by UCC-ND management and the DOE.

9. Reviewed Laboratory construction projects for environmental impact.

4.3 Atmospheric Monitoring

4.3.1 Air Concentrations

The average concentrations of alpha radioactivity in the atmosphere, as measured with filters from the LAM, PAM, and RAM networks during 1980, were as follows:

Network	Concentration Bq/m^3 (μCi/cc)
LAM	0.72E-04 (0.19E-14)
PAM	0.36E-04 (0.97E-15)
RAM	0.42E-04 (0.11E-14)

All networks are less than 10% of 0.74E-03 Bq/m^3 (2×10^{-14} μCi/cc), the MPCU$_a$[1] for a low level unidentified alpha emission in an uncontrolled area. The values for each station are given in Table 4.3.1.

The average concentrations of beta radioactivity in the atmosphere, as measured with filters from the LAM, PAM, and RAM networks during 1980, were as follows:

Network	Concentration Bq/m^3 (μCi/cc)
LAM	0.19E-02 (0.52E-13)
PAM	0.11E-02 (0.29E-13)
RAM	0.11E-02 (0.29E-13)

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[1] The MPCU$_a$ is defined as the maximum permissible concentration for an unknown mixture of radioisotopes in air. DOE Manual Chapter 0524, Appendix, Annex A, gives exposure values applicable to various mixtures of radionuclides and establishes guidelines for deriving the MPCU$_a$.

The LAM network value of 0.19E-02 Bq/m^3 (0.52E-13 μCi/cc) is less than 0.002% of the MPCU$_a$ based on occupational exposure of 1.1E + 02 Bq/m^3 (3 x 10^{-9} μCi/cc).^{a} Both the PAM and RAM network values represent < 0.03% of the MPCU$_a$ of 3.7 Bq/m^3 (1 x 10^{-10} μCi/cc) applicable to releases to uncontrolled areas. A tabulation of data for each station in each network is given in Table 4.3.2. The weekly values for each network are illustrated in Table 4.3.3.

4.3.2 Fallout (Gummed Paper Technique)

The average activity per square foot on gummed paper for the three air monitoring networks is shown in Table 4.3.4.

4.3.3 Rainout (Gross Analysis of Rainwater)

The average concentration of beta radioactivity in rain water collected from the three networks during 1980 was as follows:

Network	Concentration Bq/m^3 (μCi/mℓ)
LAM	0.82E+03 (0.22E-07)
PAM	0.73E+03 (0.20E-07)
RAM	0.11E+04 (0.29E-07)

The average concentration measured at each station within each network is presented in Table 4.3.5. The average concentration for each network for each week is given in Table 4.3.6.

4.3.4 Atmospheric Radioiodine (Charcoal Cartridge Technique)

Atmospheric iodine sampled at the perimeter stations averaged 0.50E-04Bq/m^3 (0.13E-14 μCi/cc) during 1980. This average represents < 0.005% of the maximum permissible concentration of 3.7 Bq/m^3 (1 x 10^{-10} μCi/cc) applicable to inhalation of ^{131}I released to uncontrolled areas. The maximum concentration observed for one week was 0.74E-04 Bq/m^3 (0.20E-14 μCi/cc).

The average radioiodine concentration at the local stations was 0.13E-03 Bq/m^3 (0.34E-14 μCi/cc). This concentration is < 0.001% of the maximum permissible concentration for inhalation by occupational personnel. The maximum concentration for one week was 0.43E-03 Bq/m^3 (1.1E-13 μCi/cc).

Table 4.3.7 presents the ^{131}I weekly average concentration data for both the local area and the perimeter area air monitoring networks. The weekly average ^{131}I concentration in air measured by stations in the LAM and PAM networks are given in Table 4.3.8.

The results of the specific radionuclide analyses of the filters from the three networks are given in Table 4.3.9.

4.3.5 Nonradioactive Air Particulates

Environmental air sampling for nonradioactive air particulates has recently been initiated at Oak Ridge National Laboratory due to the conversion of the steam plant from gas to coal burning.

Suspended particulates are measured at air monitoring stations 1, 3, 6, 7, and 15 (Fig. 4.1.1). The method for the determination of suspended particulates is the high volume method recommended by EPA. Particulates are collected by drawing air through weighed filter papers. The filter paper is allowed to equilibrate in a humidity-controlled atmosphere and the filter is reweighed. From the weight of particulates, the sampling time, and the air flow rate, the particulate concentration in micrograms per cubic meter is calculated. The sampling period is 24 hours. Air monitoring data for suspended particulates are presented in Table 4.3.10. All samples taken had values below the allowable standards.

4.3.6 Milk Analysis

The yearly average and maximum concentrations of ^{90}Sr and ^{131}I in raw milk are given in Tables 4.3.11 and 4.3.12. If one assumes the average intake of milk per individual to be one ℓ/day, the concentrations of ^{131}I in milk collected near ORNL and in milk collected more remotely from ORNL are within FRC Range I.[2] The concentrations of ^{90}Sr in milk from both the immediate and remote environs of ORNL are also within FRC Range I.

4.3.7 ORNL Stack Releases

The radionuclide releases from ORNL stacks are summarized in Table 4.3.13.

4.4 Water Monitoring

4.4.1 White Oak Lake Waters

Yearly discharges of specific radionuclides to the Clinch River, 1968 through 1980, are shown in Table 4.4.1.

Values for radionuclide concentrations at various locations in the Clinch River are given in Table 4.4.2. The calculated percentages of maximum permissible concentration values in water (MPC_w) are presented in Table 4.4.3.

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[2] The Federal Radiation Council ranges are still accepted values even though the FRC has been incorporated into the EPA.

The annual average percent MPC_w of beta emitters, other than tritium in the Clinch River, 1968 through 1980, is given in Table 4.4.4. Table 4.4.5 lists the annual average percent MPC_w of tritium in the Clinch River, 1968 through 1980.

Trends in radionuclide discharges and MPC_w levels are presented in Figs. 4.4.1 through 4.4.3. Discharges of ^{3}H and ^{90}Sr are shown in Fig. 4.4.1 as these nuclides contribute the majority of the radiological dose downstream.

Water samples are collected for the analysis of nonradioactive substances at the same locations discussed previously under radioactive water sampling. All samples are composited for monthly analyses. Samples are analyzed for a variety of water quality parameters related to process release potential and background information needs by analytical procedures recommended by the Environmental Protection Agency.

Data on chemical concentrations in surface streams are given in Tables 4.4.6, and 4.4.7. The average concentrations of all substances analyzed were in compliance with Tennessee guidelines. The National Pollutant Discharge Elimination System compliance on water quality is presented in Table 4.4.8.

4.4.2 Potable Water

The average quarterly concentrations of ^{90}Sr in potable water at ORNL during 1980 were as follows:

Quarter Number	Bq/ℓ	μCi/mℓ
1	8.5E-3	0.23E-9
2	6.7E-3	0.18E-9
3	1.9E-3	0.05E-9
4	83E-3	2.27E-9
Average for Year	25E-3	0.68E-9

The average value of 2.5×10^{-2} Bq/ℓ (68.0×10^{-11} μCi/mℓ) represents < 0.2% of the MPC_w for drinking water applicable to individuals in the general population.

4.4.3 Clinch River Fish

The results of the analyses of fish samples are tabulated in Bq/kg and (pCi/kg) of wet weight (Table 4.4.9) for each radionuclide of significance. An estimate of man's intake of radionuclides from eating the fish is made by assuming an annual rate of fish consumption of 16.8 kg (37 lbs). An estimated percentage of maximum permissible intake is calculated by assuming a maximum permissible intake of fish to be comparable to a daily intake of 2.2 liters of water containing the MPC_w of these radionuclides for a period of one year. Mercury concentrations were compared to the FDA proposed action level.

4.5 Radiation Background Measurements

Data on the average external gamma radiation background rates are given in Tables 4.5.1 and 4.5.2. The difference between the average levels in the perimeter and remote environs is considered to be within the variation in background levels normally experienced in East Tennessee which is dependent upon elevation, topography, and geological character of surrounding soil.[3]

The average external gamma radiation levels along the bank of the Clinch River adjacent to an experimental cesium field are given in Table 4.5.3.

4.6 Soil and Grass Samples

Data on uranium, plutonium, and other radioisotope concentrations in soil and grass samples are given in Tables 4.6.1 and 4.6.2.

4.7 Deer Samples

Occasionally, deer are killed by automobiles on the DOE Reservation. Nineteen road-killed deer were analyzed during 1980 for gamma emitters and the data is presented in Table 4.7.1. It should be noted that hunting is illegal on the Oak Ridge Reservation.

4.8 Calculation of Potential Radiation Dose to the Public

Potential radiation doses resulting from plant effluents were calculated for a number of dose reference points within the Oak Ridge environs. All significant sources and modes of exposure were examined, and a number of general assumptions were used in making the calculations.

The site boundary for the Oak Ridge complex was defined as the perimeter of the DOE-controlled area.

Gaseous effluents are discharged from several locations within ORNL. For calculational purposes, the gaseous discharges are assumed to occur from only one vent. Concentrations of radionuclides contained in the air and deposited on the ground were estimated at distances up to 50 miles from the Oak Ridge facilities with the Gaussian plume model developed by Pasquill[4] and Gifford[5] incorporated in a computer program. The concentration has been averaged over the crosswind direction to give

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[3] T. W. Oakes, K. E. Shank, and C. E. Easterly, "Natural and Man-Made Radionuclide Concentrations in Tennessee Soil," in Proceedings of the Health Physics Society Tenth Midyear Topical Symposium, Saratoga Springs, New York, October 11-13, 1976, pp. 322-333.

[4] F. Pasquill, Atmospheric Diffusion, D. Van Nostrand Co., Ltd., London, 1962.

[5] F. A. Gifford, Jr., The Problem of Forecasting Dispersion in the Lower Atmosphere, USAEC, DTI, 1962.

the estimated ground level concentration downwind of the source of emission. The deposition velocities used in the calculations were 10^{-6} cm/sec for krypton and xenon, 10^{-2} cm/sec for iodine and 1 cm/sec for particulates. Meteorological data is shown in Fig. 4.8.1; the length of the bars indicates the percentage of the time that wind is blowing in that direction. Populations used are shown in Table 4.8.1.

Exposures to radionuclides that originate in the effluents released from the Oak Ridge facilities were converted to estimates of radiation dose to individuals using models and data presented in publications of the International Commission on Radiological Protection, other recognized literature on radiation protection, personal communication, and computer programs incorporating some of these models and data. Radioactive material taken into the body by inhalation or ingestion will continuously irradiate the body until removed by processes of metabolism and radioactive decay; thus the estimates for internal dose are called "dose commitments"; they are obtained by integration over an assumed working lifetime of 50 years for the exposed individual.

The radiation doses to the total body and to internal organs from external exposures to penetrating radiation are approximately equal, but they may vary considerably for internal exposures because some radionuclides concentrate in certain organs of the body. For this reason, estimates of radiation dose to the total body, thyroid, lungs, bone, liver, kidneys, and gastrointestinal tract were considered for various pathways of exposure. These estimates were based on parameters applicable to an average adult. The population dose estimate (in man-rem) is the sum of the total body doses to exposed individuals within a 50-mile radius of the Oak Ridge facilities.

Maximum Potential Exposure - The point of maximum potential exposure ("fence-post" dose) on the site boundary is located along the bank of the Clinch River adjacent to a cesium field experimental plot and is due primarily to "sky shine" from the plot. A maximum potential whole body dose of 2.3 mSv/y (226 mrem/y) was calculated for this location assuming that an individual remained at this point for 24 h/day for the entire year. The calculated maximum potential exposure is 45% of the allowable standard.[6] This is an atypical exposure location and the probability of an exposure of the magnitude calculated is considered remote since access is only by boat.

The total body dose to a "hypothetical maximum exposed individual" at the same location was calculated using a more realistic residence time of 240 h/y. The calculated dose under these conditions was 0.06 mSv/y (6.6 mrem/y) which is 1.2% of the allowable standard and represents what is considered a probable upper limit of exposure.

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[6] DOE Manual Chapter 0524.

A more probable exposure potential might be considered to occur at other locations beyond the site boundary as a result of airborne or liquid effluent releases.

The dose commitment to an individual continuously occupying the residence nearest the site boundary would result from inhalation and ingestion and is based on an inhalation rate for the average adult of 2 x 10^4 ℓ/day. The calculated dose commitments at this location were 0.17 mSv (16.6 mrem) ± 300% to the lung (the critical organ) and 0.02 mSv (1.8 mrem) ± 300% to the total body; uranium-234 is the important radionuclide contributing to this dose. These levels are 1.1% and 0.36% respectively, of the allowable annual standard. The large error bounds are due to the uncertainties in the meterological and source-term data.

The most important contribution to dose from radioactivity within the food-chain is by the atmosphere-pasture-cow-milk food-chain pathway. Measurements of the two principal radionuclides entering into this pathway, ^{131}I and ^{90}Sr (see Tables 4.3.11 and 4.3.12), indicates that the maximum dose to an individual in the immediate environs from ingestion of 1 ℓ/day of milk is 0.0002 mSv (0.02 mrem) to the thyroid and 0.02 mSv (1.5 mrem) to the bone at Station 6 (see Fig. 4.1.6). The average concentrations for the remote stations were assumed to be background and were subtracted from the perimeter station data in making the calculations.

The public water supply closest to the liquid discharges from the Oak Ridge facilities is located approximately 26 km (16 miles) downstream at Kingston, Tennessee.

Measurements of untreated river water samples at Kingston (see Table 4.4.2) indicate that the maximum dose commitment resulting from the ingestion of 20% of the daily adult requirement (about 2 ℓ/day) is 0.07 mSv (6.6 mrem) to the bone, and 0.02 mSv (1.5 mrem) to the whole body. The average concentrations for Melton Hill water (background) were subtracted from the values obtained at Kingston.

Estimates of the 50-year dose commitment to an adult were calculated for consumption of 16.8 kg (37 lbs) of fish per year from the Clinch River. The consumption of 16.8 kg (37 lbs) is about 2.5 times the national average fish consumption and is used because of the popularity of fishing in East Tennessee. From the analysis of edible parts of the fish examined (see Table 4.4.9), the maximum organ dose commitment to an individual from the bluegill samples taken from CRM 20.8 is estimated to be 0.72 mSv (72 mrem) to the bone from ^{90}Sr. The maximum total body dose to an individual was calculated to be 0.014 mSv (1.4 mrem). These doses are 5% and 0.3% respectively, of the allowable standard. Fish samples taken from above White Oak Creek were analyzed to determine background conditions.

Summaries are given in Table 4.8.2 of the potential radiation doses to adult members of the general public at the points of highest potential exposure from gaseous and liquid effluents from the Oak Ridge facilities.

Dose to the Population - The Oak Ridge population received the largest average individual total body dose as a population group. The average yearly total body dose to an Oak Ridge resident was estimated to be 0.0011 mSv (0.11 mrem) as compared to approximately 1 mSv (100 mrem) from natural background radiation; the average dose commitment to the lung of an Oak Ridge resident was 0.012 mSv (1.2 mrem). The maximum potential dose commitment to an Oak Ridge resident was calculated to be 0.17 mSv (16.6 mrem) to the lung. This calculated dose is 0.3% of the allowable annual standard.

The cumulative total body dose to the population within a 50-mile radius of the Oak Ridge facilities resulting from 1980 plant effluents was calculated to be 0.09 man-mSv (8.8 man-rem). This dose may be compared to an estimated 74,000 man-rem to the same population resulting from natural background radiation. About 14% of the collective dose from the effluents of the Oak Ridge facilities is estimated to be to the Oak Ridge population.

4.9 Environmental Monitoring Samples

A listing of environmental monitoring samples processed by type, sample, type of analyses, and number of samples is given in Table 4.9.1.

4.10 Highlights or Other Major Activities of the Environmental Management Program

4.10.1 Environmental Protection Awards

An Environmental Protection Award has been initiated by the Department of Environmental Management to be presented annually. The award is presented to an individual or group for outstanding contributions to the environmental protection program. A selection committee will judge the applicants based on the following points: (a) scientific and technical merit of the achievement; (b) potential cost savings for the Laboratory; and (c) innovation.

4.10.2 Waste Oil Investigation Committee

Repeated occurrences of improper discharges of oil at ORNL resulted in the formation of the ORNL Waste Oil Investigation Committee on March 14, 1979. The Committee has completed its investigation and a report is in progress.

4.10.3 ORNL Committee of Meteorological Data Users

In August 1980, a committee was established to ensure the maximum use of existing and new meteorological data. This Committee has three functions: (1) to review the availability of existing data; (2) to review the capabilities of the three proposed meteorological towers (a 1981 GPP project) to ensure that the maximum amount of data is collected; and (3) to review the format of the data to be collected to ensure that it is compatible with existing program needs.

There are nine regular members of the Committee. ORNL has seven members representing six divisions: Industrial Safety and Applied Health Physics Division - T. W. Oakes, Chairman, and B. A. Kelly, Secretary; Energy Division - F. C. Kornegay; Environmental Sciences Division - R. J. Luxmoore; Health and Safety Research Division - C. W. Miller; Computer Sciences Division - R. J. Raridon; and Fuel Recycle Division - M. B. Sears. In addition, a representative of NOAA's Atmospheric Turbulence Diffusion Laboratory (D. Matt) and a consultant from the University of Tennessee's Department of Civil Engineering (E. S. Hougland) participated in the Committee's work. Representatives from Y-12 and ORGDP also participated to ensure that ORNL's meteorological data collection system is compatible with theirs.

4.10.4 Resource Conservation and Recovery Act (RCRA) - State and Federal Permits

In May 1980, the Environmental Protection Agency, as required by RCRA of 1976, took steps to establish a national hazardous waste management system. Prior to the compliance date of these regulations, November 19, 1980, ORNL was requried to notify EPA of its hazardous waste activities. During 1980 several lengthy permit applications and supporting documents dealing with hazardous waste management at ORNL were prepared by this Department to satisfy federal and state requirements. Presently the Laboratory is licensed, on an interim status permit, as a generator, storage facility, transporter, and treatment facility of hazardous wastes.

4.10.5 Hazardous Waste Analysis Laboratory

Presently there are over 400 hazardous chemicals/wastes, either from specific sources or as discarded hazardous chemicals listed by the Environmental Protection Agency under the Resource Conservation and Recovery Act. Many waste streams are generated at ORNL for which the hazardous nature is not known. For these types of wastes, EPA regulations currently require testing of specific parameters e.g., ignitability, corrosivity, reactivity, and toxicity, to determine if a waste must be treated as a hazardous waste.

To accomplish this mission, a Hazardous Waste Analysis Laboratory has been established. To date, approximately fifty ignitability tests have been performed and toxicity measurements have recently commenced.

4.10.6 Polychlorinated Biphenyl (PCB) Sampling Program

In June 1980, the Department of Energy requested that all sources of oil at their facilities be checked for the presence of PCB's. The Department of Environmental Management took samples from 1,802 such sources. Analytical results showed that 233 of the samples contained PCB's in concentrations greater than five parts per million. Plans are now underway to label the sources containing PCB's and to replace this oil with new oil.

4.10.7 Chemical Waste Disposal at ORNL

During 1980, approximately 390 disposal requests were handled by the Hazardous Materials Group of the Department of Environmental Management. These disposal requests represent over 110,000 kg (242,000 lbs) of hazardous and non-hazardous wastes generated at the Laboratory. By utilizing approved off-site commerical facilities for disposal, the Laboratory was able to comply with existing regulations. Also, there was approximately 6,800 kg (14,960 lbs) of non-contaminated waste oils recycled for further use.

4.10.8 Soil Contamination Analyses

The DEM provided assistance to the Engineering Division in evaluating contamination levels near proposed construction sites. Ten cores were analyzed and the results sent to Engineering for evaluation.

4.10.9 Prototype Air Monitoring Station

The DEM, in conjunction with the Instrumentation and Controls and Computer Sciences Divisions, has developed a prototypic replacement for the air monitors in its environmental monitoring network. The prototype was designed to emphasize the needs of real-time analytical capability, maintainability, and flexibility for monitoring additional parameters in the future. Parameters monitored continuously include gross beta/gamma radioactivity (using a GM counter), gamma-emitting radionuclides (using a GE(Li) spectrometer system), alpha fallout radioactivity, beta/gamma fallout radioactivity, and rainfall. In addition, sampling is performed for particulates, radioiodine, fallout (wet and dry), and tritium. The readings for monitored variables are collected by a station microprocessor, which stores them (up to 24 hours), checks them against alarm setpoints, and transmits them upon request to a centralized readout station. The station microprocessor also checks the instruments to ensure proper operation and sends an alarm signal if a malfunction is detected. The centralized readout station is a minicomputer-controlled terminal, based on a Nuclear Data 680 system. The terminal provides a digital display of the monitoring data, stores the data on a floppy disc, and displays alarms. Analytical and other programs can also be run on the system. The system is currently undergoing operational check-out.

4.10.10 Clark Center Recreational Park (CCRP) Drinking Water System Improvements

The DEM coordinated the design, construction, check-out, and operational monitoring of two new drinking water systems at CCRP. The new systems received approval from the State of Tennessee and operated for the majority of the 1980 park season.

4.10.11 ORNL Steam Plant Stack Testing

In August 1980, the DEM coordinated the testing of one of four new electrostatic precipitators at ORNL's Steam Plant. The results of this test, along with evaluations performed by the DEM and its consultants, were used to ensure proper performance of the Steam Plant when it is burning coal.

4.10.12 Environmental Assessments

Nineteen environmental assessments were completed during 1980. The projects for which environmental assessments were written are:

- Improvements to Fusion Energy Facilities
- Water Pollution Control
- Environmental and Effluent Monitoring Systems Upgrading
- Laboratory Emergency Response Center
- Modifications Aimed at Compliance with OSHA
- Low Level Waste Pilot Facility
- Cytological Laboratory
- Toxic Substances Laboratory and Animal Facility
- Mutagenic Screening and Testing Facility for Synthetic Fuels
- High Temperature Materials Laboratory
- Accelerator and Reactor Improvement Project
- Materials Warehouse Upgrading
- Large Coil Test Facility
- Energy Systems Research Laboratory
- Core Flow Test Loop Facility
- Utilities Upgrade Project
- Meteorological Towers - ORNL
- Elmo Bumpy Torus - Proof of Principle Experiment
- ORNL Visitor Overlook.

4.10.13 New and Improved Facilities

The DEM initiated work on three projects which are still ongoing: (1) the installation of two plastic tanks in the 7000 area to store spent photographic processing solutions; (2) the installation of a continuous residual chlorine analyzer at ORNL's Sewage Treatment Plant; and (3) the design and construction of a treatment system for Coal Yard Runoff. Work also continued on two proposed line item projects: Water Pollution Control and Environmental and Effluent Monitoring Systems Replacement.

4.10.14 Computerized Data Processing

An effort is underway to computerize, as much as is practicable, the storage, manipulation and reporting of environmental data. Revised programs include the ones for processing of milk, air and water data. New programs have been developed for reporting air and milk data in a ready-for-publication format. Programs for processing National Pollutant Discharge Elimination System (NPDES) data are scheduled to be completed by 1981.

4.10.15 Hazardous Materials Tracking System

The Department, in cooperation with Computer Sciences Division personnel, has been developing a Hazardous Materials Tracking System (HMTS) designed to track hazardous materials at ORNL from the time they are received or generated through their usage and storage in the Laboratory, up until their final disposal (cradle-to-grave).

At the present time, an information file containing pertinent data on over 1,700 chemicals is on line and is available to Laboratory personnel who have access to a terminal. A prototype of the complete system is to be tested sometime during the latter part of 1981.

4.10.16 Bar Code Reader System

A system for following the location and status of environmental samples was developed which will utilize a bar code reader system. The bar code reader system will be similar to those used in grocery stores. The system will provide for bar code entry of parameters such as sample number, sample type, location, and technician's initials. The reader should reduce the amount of labor required for sample accounting and help reduce the number of data errors. The reader system has been ordered and should be received before October 1981.

4.10.17 ORNL Environmental and Safety Report

A consulting firm was given a contract to write an ORNL Environmental and Safety Report (ESR). The document to be produced will serve as a preliminary document upon which an ORNL Environmental Impact Statement or an Environmental Assessment for ORNL can be based. The ESR is to be completed during 1981.

As part of the preparatory work for the EIS, an aerial survey of the Oak Ridge Reservation and surrounding areas (out to 10 km from the reservation boundaries) was conducted.

4.10.18 Radiological Assessment of Radioactive Waste Disposal Areas at Oak Ridge National Laboratory

Results of 1979 and 1980 TLD surveys of the solid waste disposal areas are being compiled into a report. TLD data for perimeter air monitor and remote air monitor stations are included for comparison. The report should be completed in 1981.

4.10.19 Burial Ground Survey Report

This publication,[7] in the final draft stage, contains the results of a February 1979 radiation survey of the intermediate-level waste system pipeline. Survey techniques and recommendations for health physics monitoring during cleanup are included.

4.10.20 Water Quality

In 1980, DEM established sixteen monitoring stations along White Oak Creek and Melton Branch. The stations 1 to 5 (P-permanent) and 1 to 9 (T-temporary) were chosen because of their locations near solid waste disposal areas, settling basins, seepage pits, and trenches. Stations P-6 and T-10 served as background stations. Samples (water and sediments) were collected from the monitoring stations for a minimum of four weeks and a maximum of 37 weeks and analyzed for 30 parameters. The parameters included carbon, sulfate, nitrate, phosphorus, alkalinity, hardness, solids (suspended and dissolved), phenol, ammonia, nitrogen, chemical oxygen demand, biochemical oxygen demand, polychlorinated biphenyl (water and sediment), chlorine, oil and grease, and turbidity. The results were compared to the criteria compliance values and measured values of the Environmental Protection Agency (EPA), National Pollutant Discharge Elimination System (NPDES), and the literature respectively. The report is being written and should be completed in 1981.

4.10.21 Foodstuff Project

The foodstuff project has been completed and a report[8] published on this project.

Food samples were obtained from commercial markets and analyzed for stable elements and radionuclides. The concentrations of most stable elements (Ag, Al, As, Au, Ba, Br, Ca, Ce, Cl, Co, Cr, Cs, Cu, Fe, Hf, I, K, La, Mg, Mn, Mo, Na, Rb, Sb, Sc, Se, Sr, Ta, Th, Ti, V, Zn, Zr) were

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[7] An Environmental Radiological Survey of the Intermediate-Level Waste System Pipeline, to be published as ORNL/TM-7858.

[8] M. A. Montford, et al., "Elemental Concentrations in Food Products," in Proceedings of University of Missouri's 14th Annual Conference on Trace Substances in Environmental Health, Columbia, Missouri, June 2-5, 1980, pp. 155-164.

determined using multiple-element neutron activation analysis, while the concentrations of other stable elements (Cd, Hg, Ni, Pb) were determined using atomic absorption techniques. The concentrations of ^{40}K, ^{60}Co, ^{95}Zr-Nb, ^{106}Ru, ^{125}Sb, ^{137}Cs, ^{226}Ra, and ^{232}Th were determined using gamma-ray spectrometry. The concentrations found are compared to other literature values.

4.10.22 Manuals

A manual[9] has been prepared in an effort to promote uniformity among methods of analyzing air, water, terrestrial, and biological samples. It is intended as a bench manual and, therefore, contains considerable detail that would not normally be in such a manual. The procedures will be upgraded and transmitted to those on the distribution list.

Environmental Protection Manual - Procedures

Changing federal and state regulations require frequent updating and addition of procedures. All of the original procedures in the manual were recently updated. Three new procedures were written. These new procedures are for environmental assessments, disposal of used and unwanted chemicals, and air emission permits.

Hazardous Materials Management and Control Manual

The ORNL Hazardous Materials Management and Control Manual was prepared to provide employees with the information necessary for the procurement, use, storage, transportation, and disposal of hazardous materials/wastes. The Manual is an annual report and will be revised and updated each year. The current edition was published in January 1981.

The program, as outlined in the Manual, is administered by two Hazardous Materials Coordinators, one in the Industrial Hygiene Department and one in the Department of Environmental Management. The coordinators act as contacts between the user of hazardous materials and the various Laboratory departments which serve as support groups in their areas of expertise.

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[9] T. W. Oakes, et al., "Methods and Procedures Utilized in Environmental Management Activities at Oak Ridge National Laboratory, ORNL/TM-7212, March 1981.

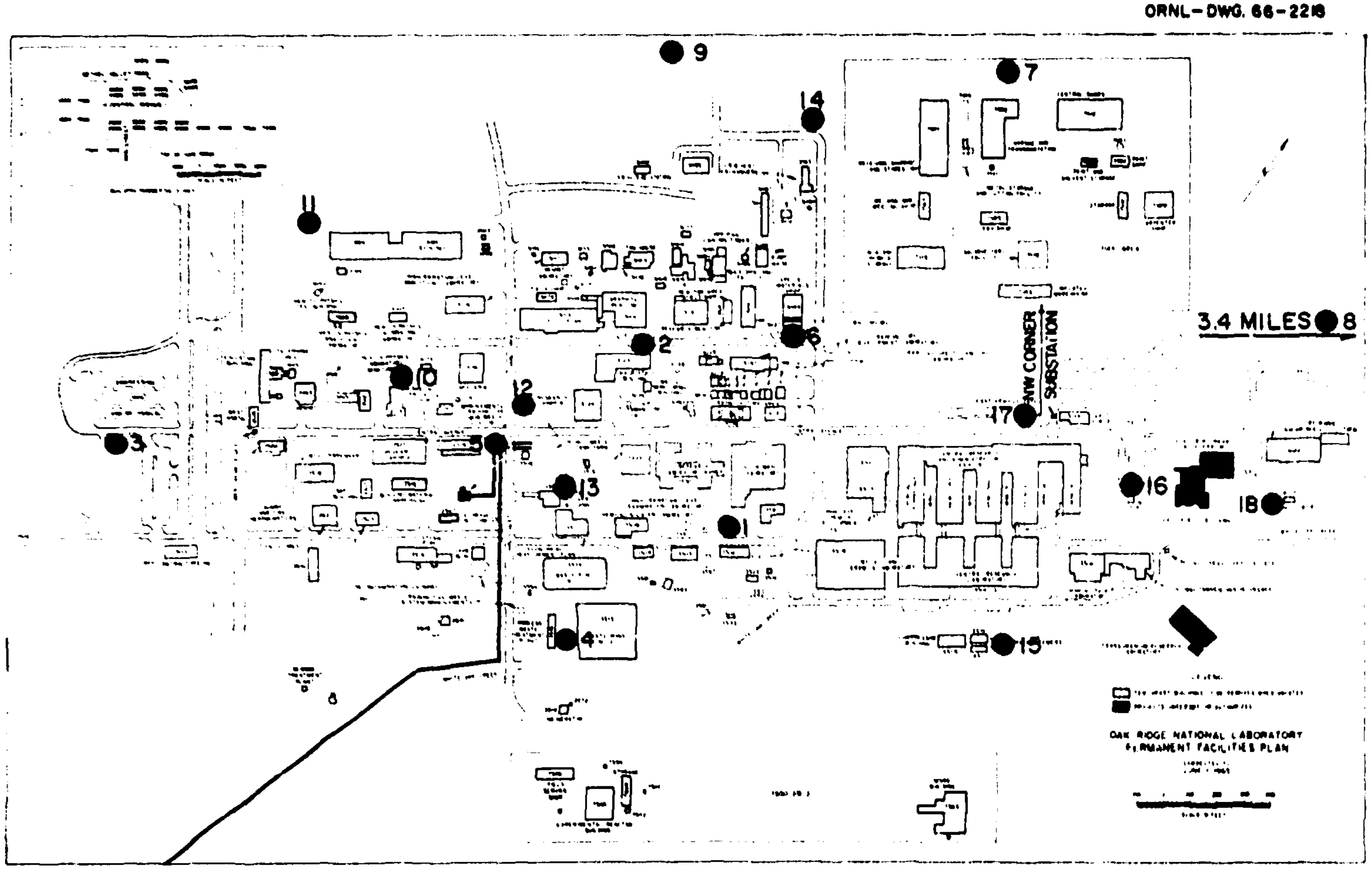

Fig. 4.1.1 Local Air Monitoring (LAM) Network - Bethel Valley

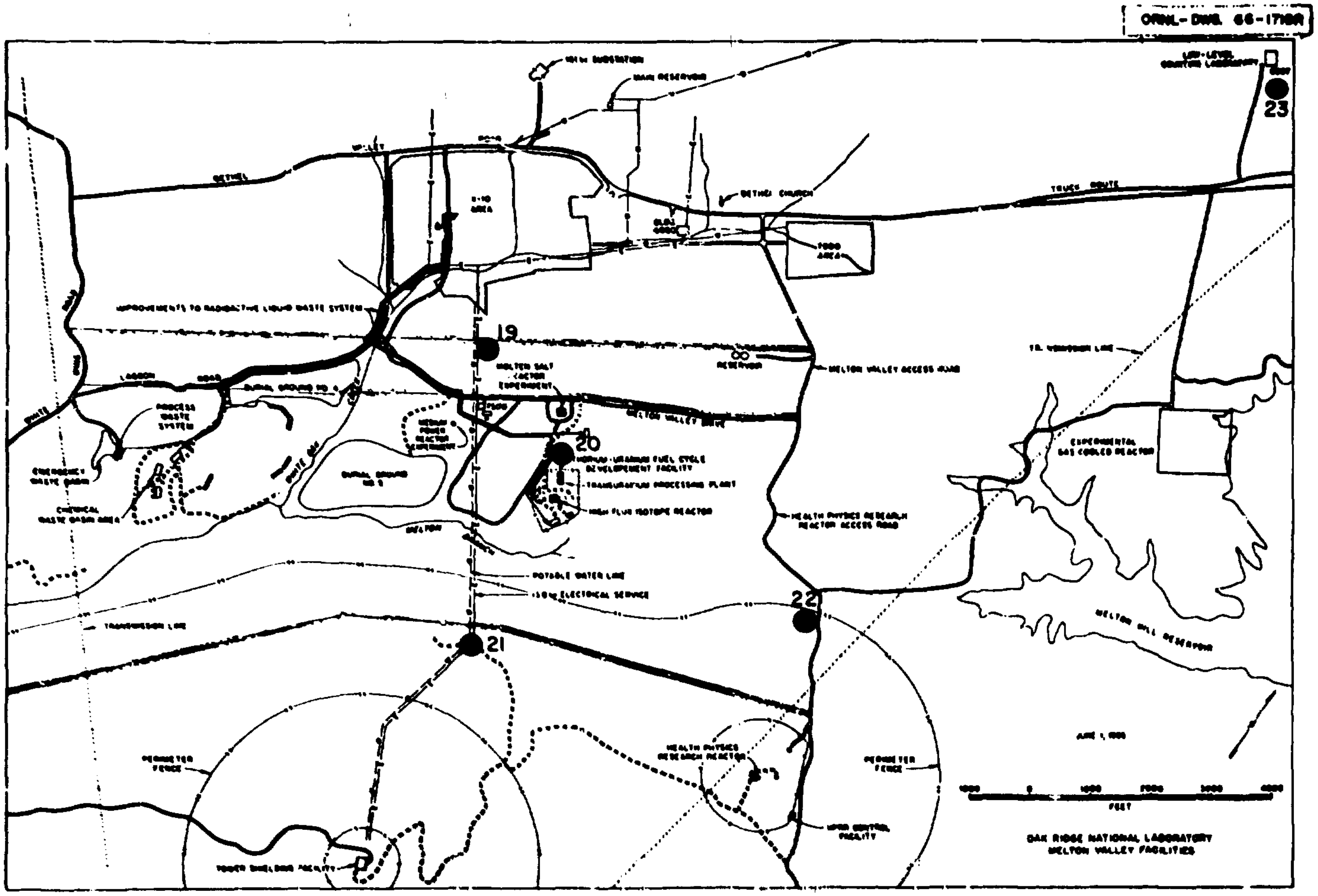

Fig. 4.1.2 Local Air Monitoring (LAM) Network - Outlying Stations

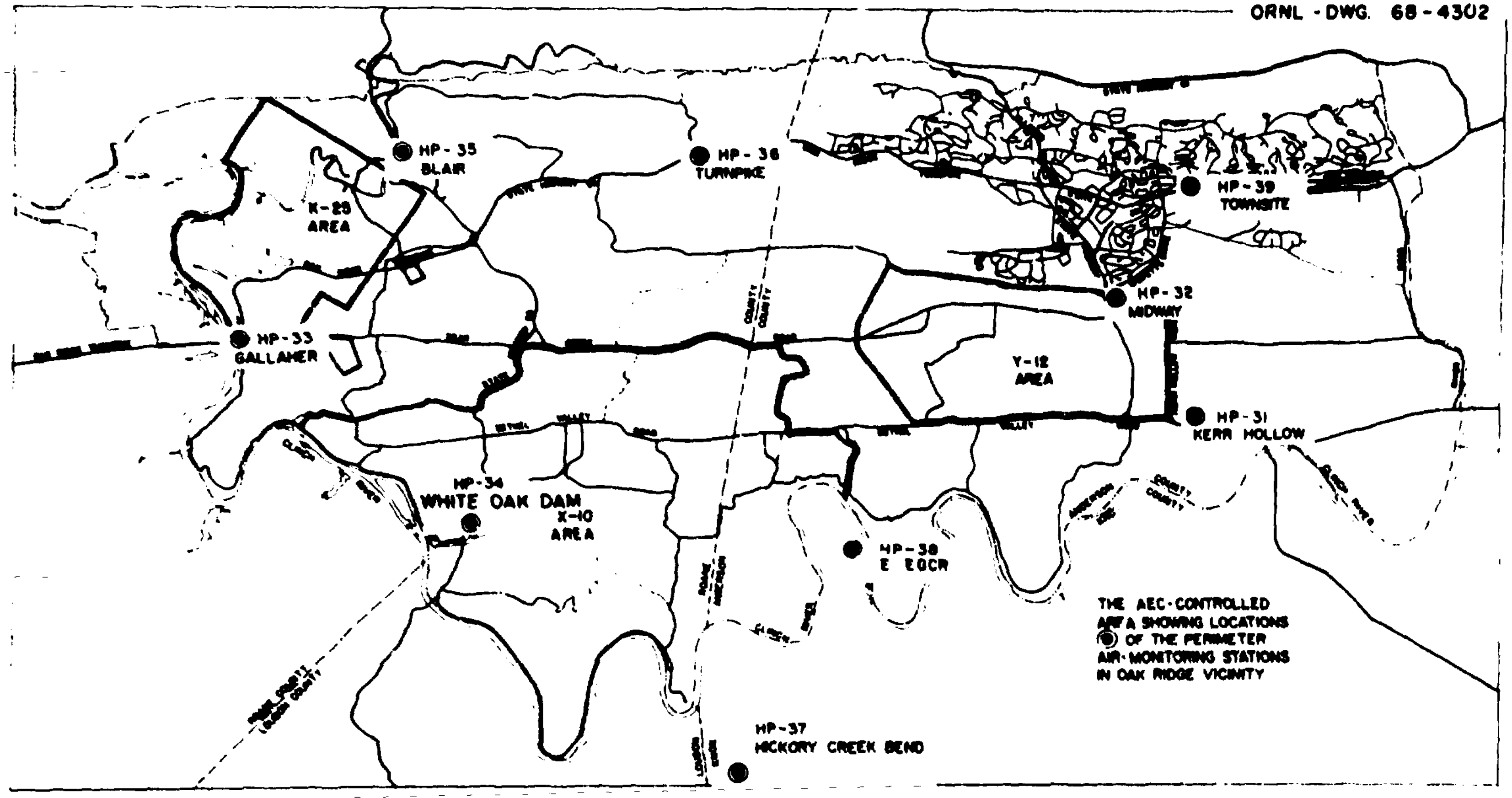

Fig. 4.1.3 Perimeter Air Monitoring (PAM) Network

ORNL-DWG 66-1719

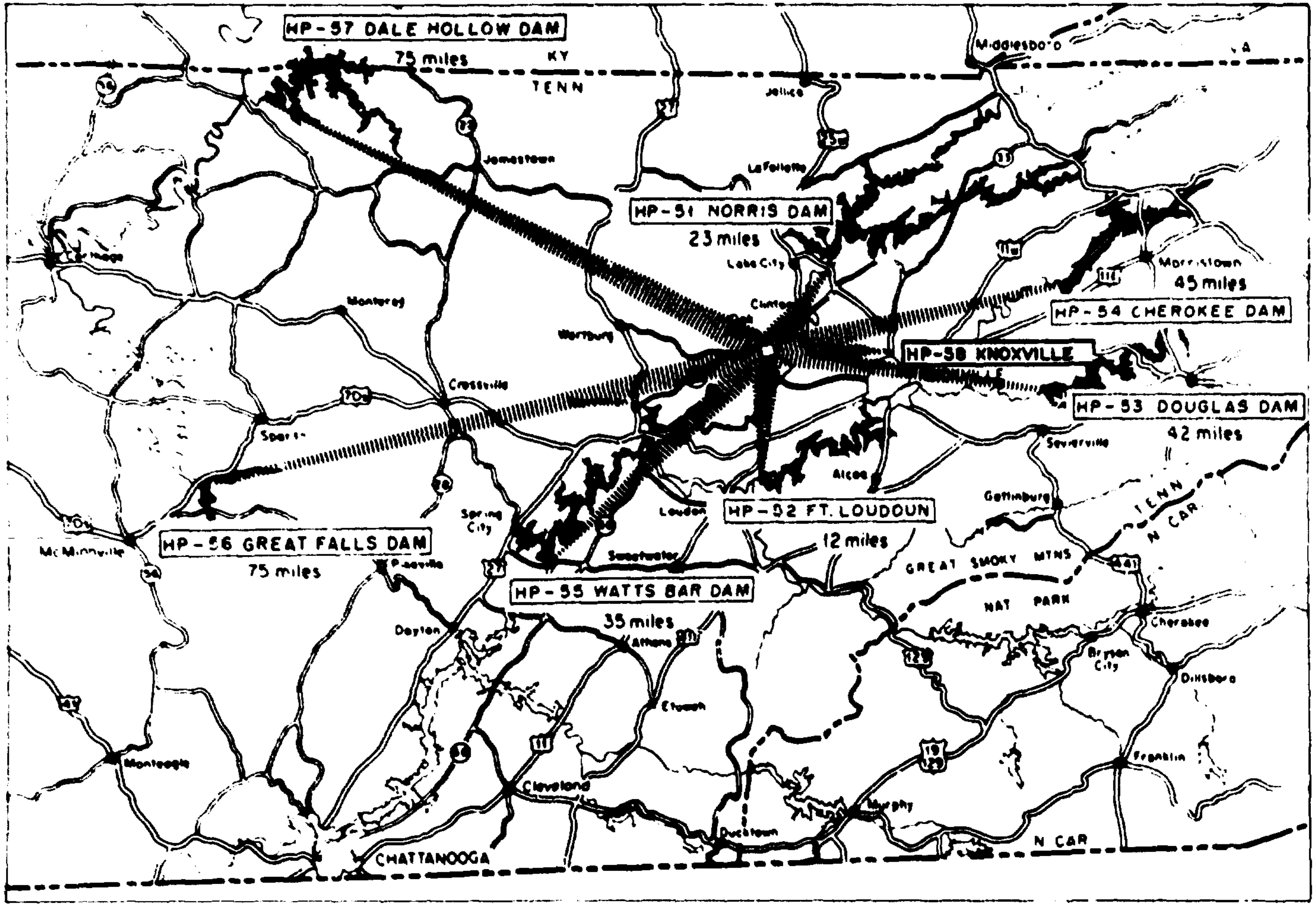

Fig. 4.1.4 Remote Air Monitoring (RAM) Network

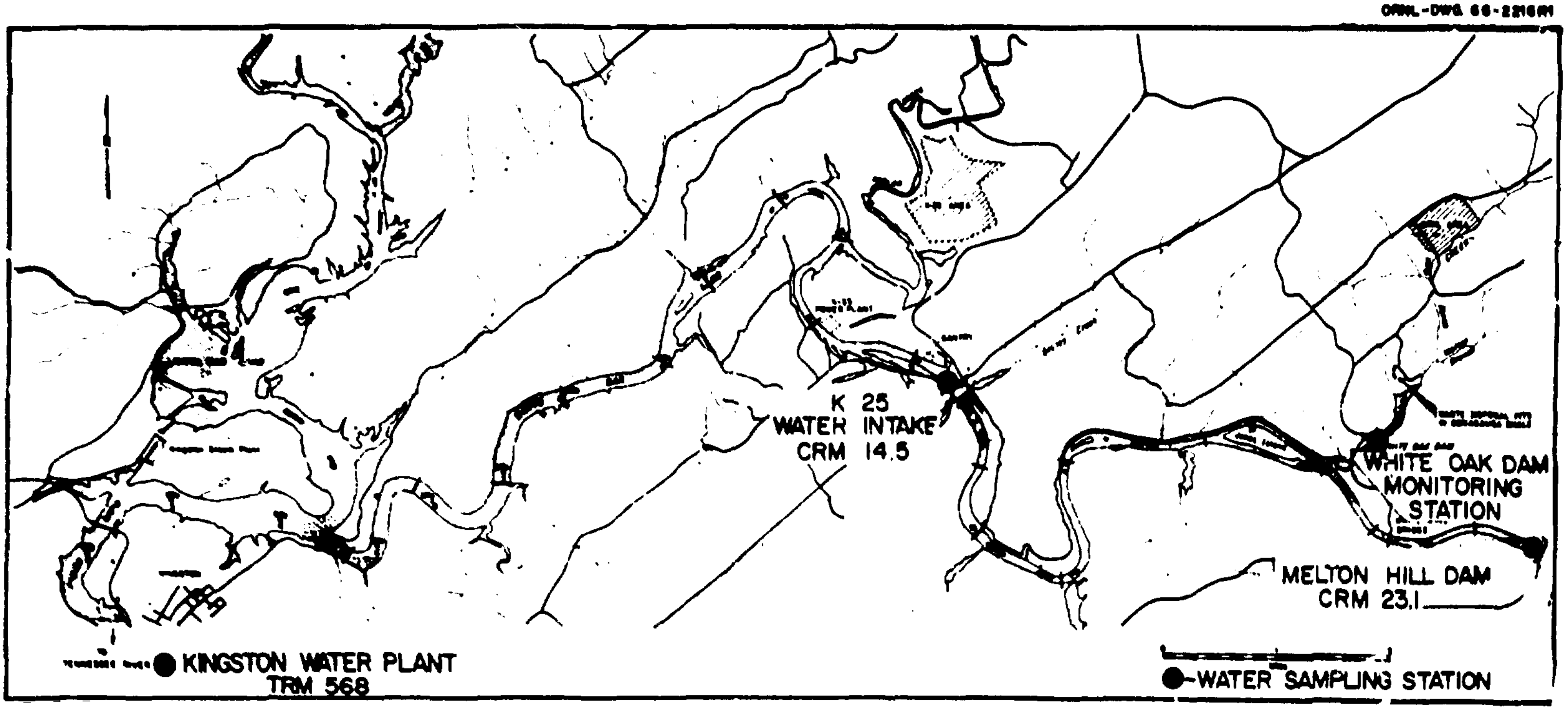

Fig. 4.1.5 Map Showing Water Sampling Locations in the East Tennessee Area

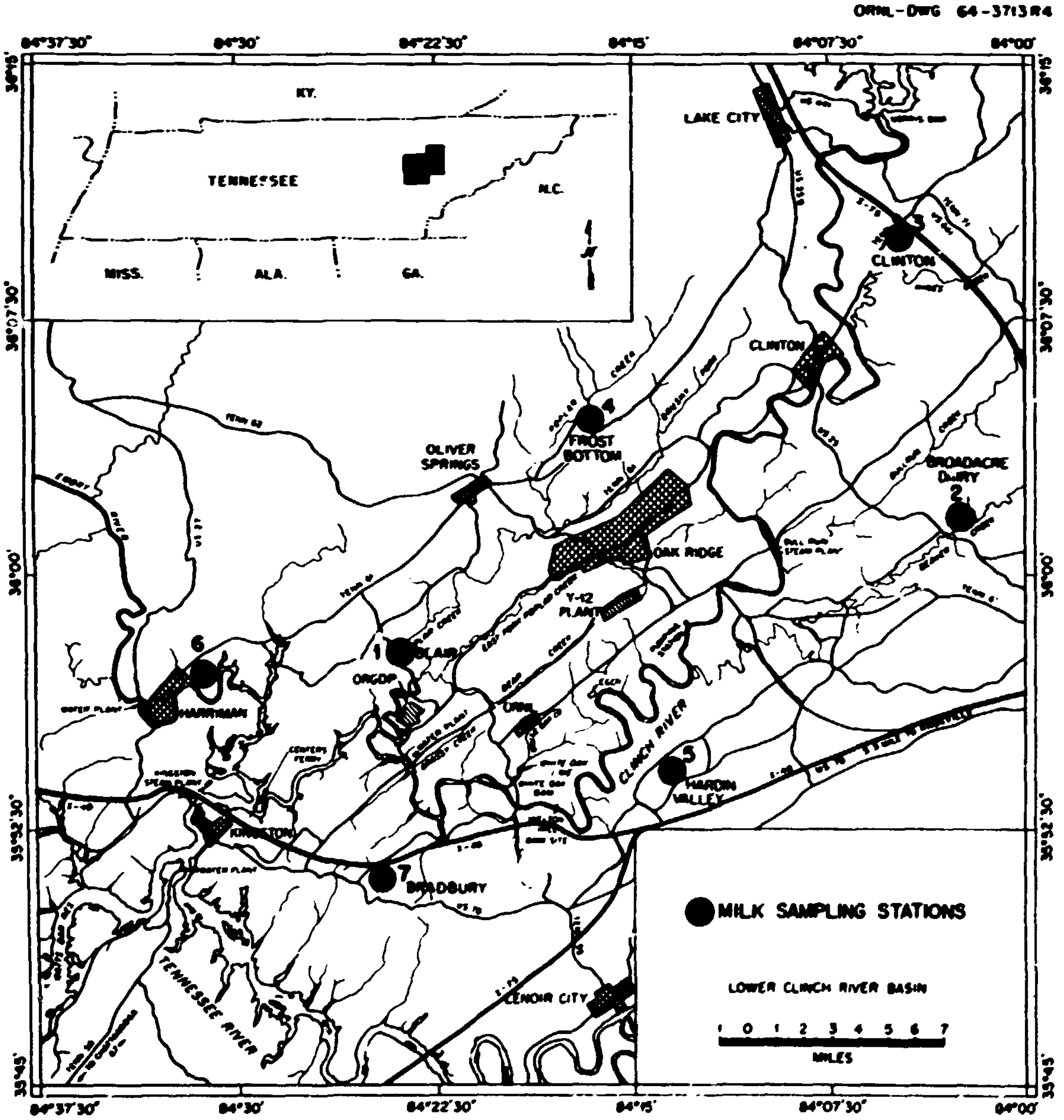

Fig. 4.1.6 Location of Milk Sampling Stations (Within 20-Mile Radius of ORNL)

ORNL DWG 76-12775RAR1

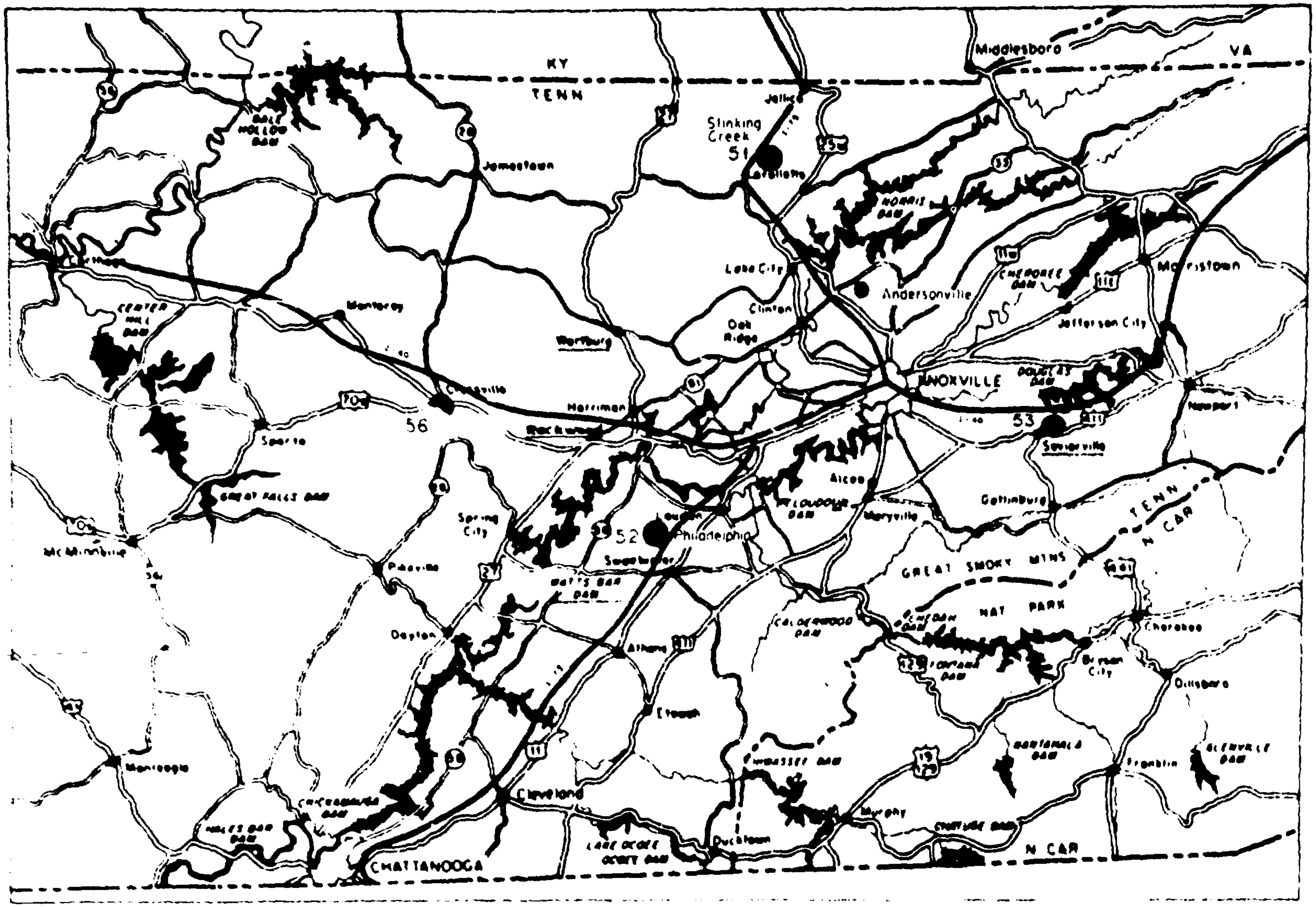

Fig. 4.1.7 Remote Environs Milk Sampling Stations

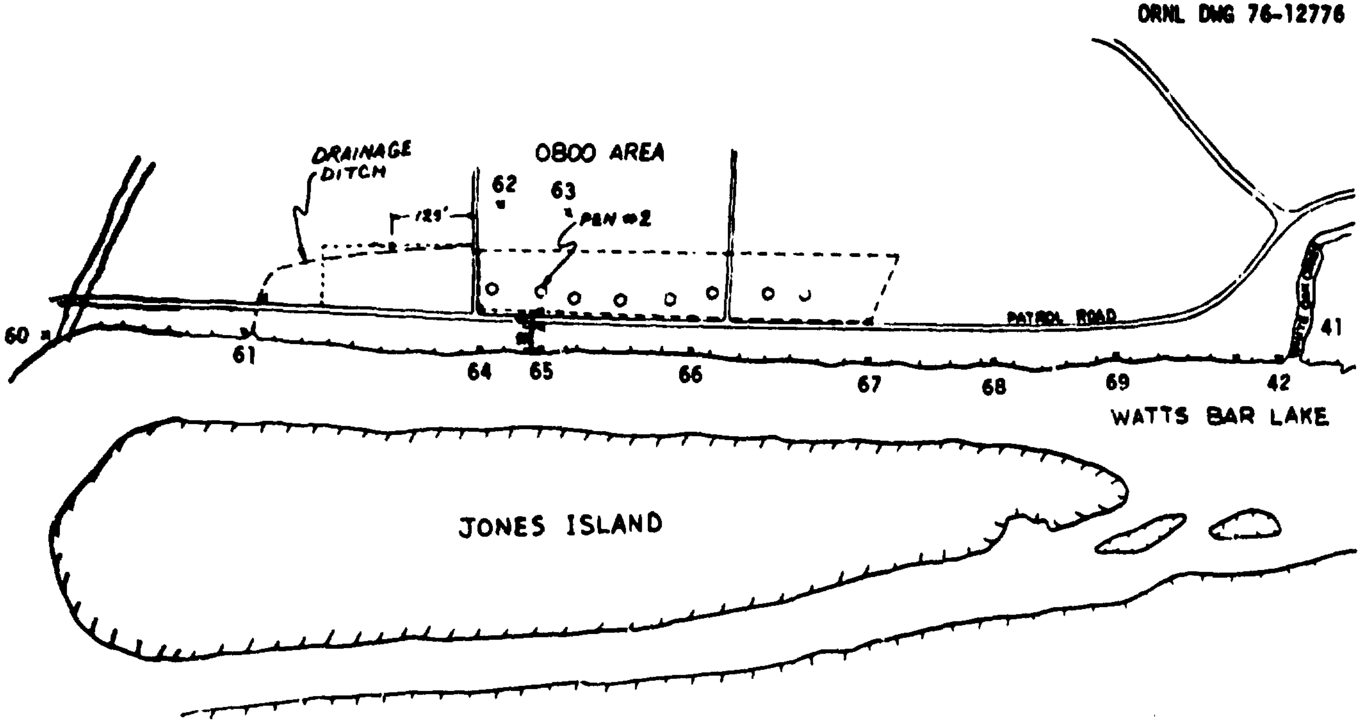

Fig. 4.1.8 Thermoluminescent Dosimeter Locations Along Perimeter of the DOE-Oak Ridge Controlled Area

Table 4.3.1

CONCENTRATION OF ALPHA RADIOACTIVITY IN AIR - 1980
(FILTER PAPER DATA - YEARLY AVERAGE)

STATION NUMBER	LOCATION	LONG-LIVED ACTIVITY MICRO-CI/CC	LONG-LIVED ACTIVITY BECQUERELS/M**3.
	LABORATORY AREA		
HP-1	S 3587	+.1737E-14	+.6427E-04
HP-2	NE 3025	+.1932E-14	+.7147E-04
HP-3	SW 1000	+.2278E-14	+.8429E-04
HP-4	W SETTLING BASIN	+.1692E-14	+.6261E-04
HP-5	E 2506	+.2241E-14	+.8292E-04
HP-6	SW 3027	+.1351E-14	+.4999E-04
HP-7	W 7001	+.2063E-14	+.7633E-04
HP-8	ROCK QUARRY	+.1803E-14	+.6671E-04
HP-9	W BETHEL VALLEY ROAD	+.1802E-14	+.6668E-04
HP-10	W 2075	+.3998E-14	+.1479E-03
HP-16	E 4500	+.1643E-14	+.6080E-04
HP-20	HFIR	+.1443E-14	+.5341E-04
HP-23	WALKER BRANCH	+.1335E-14	+.4941E-04
AVERAGE		+.1948E-14	+.7206E-04
	PERIMETER AREA		
HP-31	KERR HOLLOW GATE	+.8493E-15	+.3142E-04
HP-32	MIDWAY GATE	+.1051E-14	+.3888E-04
HP-33	GALLAHER GATE	+.1040E-14	+.3847E-04
HP-34	WHITE OAK DAM	+.9204E-15	+.3406E-04
HP-35	BLAIR GATE	+.1531E-14	+.5666E-04
HP-36	TURNPIKE GATE	+.7789E-15	+.2882E-04
HP-37	HICKORY CREEK BEND	+.8757E-15	+.3240E-04
HP-38	E EGCR	+.7761E-15	+.2872E-04
HP-39	TOWNSITE	+.8936E-15	+.3306E-04
AVERAGE		+.9684E-15	+.3583E-04
	REMOTE AREA		
HP-51	NORRIS DAM	+.1192E-14	+.4409E-04
HP-52	LOUDOUN DAM	+.1033E-14	+.3822E-04
HP-53	DOUGLAS DAM	+.1006E-14	+.3721E-04
HP-54	CHEROKEE DAM	+.1063E-14	+.3931E-04
HP-55	WATTS BAR DAM	+.1425E-14	+.5274E-04
HP-56	GREAT FALLS DAM	+.1238E-14	+.4580E-04
HP-57	DALE HOLLOW DAM	+.1247E-14	+.4612E-04
HP-58	KNOXVILLE	+.9801E-15	+.3626E-04
AVERAGE		+.1148E-14	+.4247E-04

Table 4.3.2

CONCENTRATION OF BETA RADIOACTIVITY IN AIR - 1980
(FILTER PAPER DATA - YEARLY AVERAGE)

STATION NUMBER	LOCATION	LONG-LIVED ACTIVITY MICRO-CI/CC	 BECQUERELS/M**3.
	LABORATORY AREA		
HP-1	S 3587	+.4546E-13	+.1682E-02
HP-2	NE 3025	+.5237E-13	+.1938E-02
HP-3	SW 1000	+.6496E-13	+.2403E-02
HP-4	W SETTLING BASIN	+.4413E-13	+.1633E-02
HP-5	E 2506	+.1138E-12	+.4211E-02
HP-6	SW 3027	+.4094E-13	+.1515E-02
HP-7	W 7001	+.4632E-13	+.1714E-02
HP-8	ROCK QUARRY	+.4814E-13	+.1781E-02
HP-9	N BETHEL VALLEY ROAD	+.4263E-13	+.1577E-02
HP-10	W 2075	+.6568E-13	+.2430E-02
HP-16	E 4500	+.3766E-13	+.1393E-02
HP-20	HFIR	+.4368E-13	+.1616E-02
HP-23	WALKER BRANCH	+.3470E-13	+.1284E-02
AVERAGE		+.5234E-13	+.1937E-02
	PERIMETER AREA		
HP-31	KERR HOLLOW GATE	+.2516E-13	+.9307E-03
HP-32	MIDWAY GATE	+.3178E-13	+.1176E-02
HP-33	GALLAHER GATE	+.3048E-13	+.1128E-02
HP-34	WHITE OAK DAM	+.3217E-13	+.1190E-02
HP-35	BLAIR GATE	+.3243E-13	+.1200E-02
HP-36	TURNPIKE GATE	+.2529E-13	+.9358E-03
HP-37	HICKORY CREEK BEND	+.3438E-13	+.1272E-02
HP-38	E EGCR	+.2697E-13	+.9978E-03
HP-39	TOWNSITE	+.2387E-13	+.8832E-03
AVERAGE		+.2917E-13	+.1079E-02
	REMOTE AREA		
HP-51	NORRIS DAM	+.2651E-13	+.9810E-03
HP-52	LOUDOUN DAM	+.2649E-13	+.9803E-03
HP-53	DOUGLAS DAM	+.2791E-13	+.1033E-02
HP-54	CHEROKEE DAM	+.1908E-13	+.7061E-03
HP-55	WATTS BAR DAM	+.3171E-13	+.1173E-02
HP-56	GREAT FALLS DAM	+.3836E-13	+.1419E-02
HP-57	DALE HOLLOW DAM	+.3577E-13	+.1324E-02
HP-58	KNOXVILLE	+.2571E-13	+.9511E-03
AVERAGE		+.2894E-13	+.1071E-02

Table 4.3.3

CONCENTRATION OF BETA RADIOACTIVITY IN AIR
AS DETERMINED FROM FILTER PAPER DATA - 1980
(SYSTEM AVERAGE - BY WEEKS)

WEEK NUMBER	LAMS MICRO-CI /CC	LAMS BECQUERELS /M**3	PAMS MICRO-CI /CC	PAMS BECQUERELS /M**3	RAMS MICRO-CI /CC	RAMS BECQUERELS /M**3
1	+.3143E-13	+.1163E-02	+.2110E-13	+.7808E-03	+.2623E-13	+.9706E-03
2	+.4961E-13	+.1835E-02	+.3255E-13	+.1204E-02	+.2873E-13	+.1063E-02
3	+.3929E-13	+.1454E-02	+.1978E-13	+.7320E-03	+.1673E-13	+.6190E-03
4	+.4083E-13	+.1511E-02	+.2577E-13	+.9536E-03	+.2370E-13	+.8769E-03
5	+.3675E-13	+.1360E-02	+.2130E-13	+.7880E-03	+.2026E-13	+.7495E-03
6	+.3949E-13	+.1461E-02	+.2395E-13	+.8863E-03	+.2025E-13	+.7494E-03
7	+.3946E-13	+.1460E-02	+.2138E-13	+.7911E-03	+.1937E-13	+.7167E-03
8	+.4314E-13	+.1596E-02	+.2579E-13	+.9542E-03	+.1828E-13	+.6764E-03
9	+.3316E-13	+.1227E-02	+.2534E-13	+.9376E-03	+.1878E-13	+.6948E-03
10	+.3631E-13	+.1343E-02	+.2193E-13	+.8114E-03	+.1652E-13	+.6112E-03
11	+.4622E-13	+.1710E-02	+.1824E-13	+.6747E-03	+.1464E-13	+.5418E-03
12	+.3371E-13	+.1247E-02	+.1954E-13	+.7230E-03	+.1496E-13	+.5535E-03
13	+.3414E-13	+.1263E-02	+.1777E-13	+.6575E-03	+.1444E-13	+.5341E-03
14	+.6452E-13	+.2387E-02	+.1993E-13	+.7374E-03	+.1810E-13	+.6696E-03
15	+.3549E-13	+.1313E-02	+.2232E-13	+.8257E-03	+.1565E-13	+.5791E-03
16	+.3809E-13	+.1409E-02	+.2141E-13	+.7920E-03	+.1786E-13	+.6609E-03
17	+.3764E-13	+.1393E-02	+.2247E-13	+.8315E-03	+.2122E-13	+.7851E-03
18	+.3451E-13	+.1277E-02	+.2028E-13	+.7505E-03	+.2044E-13	+.7564E-03
19	+.4154E-13	+.1537E-02	+.2486E-13	+.9199E-03	+.2322E-13	+.8591E-03
20	+.3617E-13	+.1338E-02	+.2219E-13	+.8209E-03	+.2160E-13	+.7991E-03
21	+.2856E-13	+.1057E-02	+.1599E-13	+.5916E-03	+.2202E-13	+.8149E-03
22	+.4130E-13	+.1528E-02	+.2543E-13	+.9409E-03	+.3105E-13	+.1149E-02
23	+.3421E-13	+.1266E-02	+.2082E-13	+.7702E-03	+.1787E-13	+.6614E-03
24	+.3951E-13	+.1462E-02	+.2456E-13	+.9086E-03	+.2375E-13	+.8789E-03
25	+.4047E-13	+.1497E-02	+.2226E-13	+.8235E-03	+.1899E-13	+.7026E-03
26	+.3064E-13	+.1134E-02	+.1969E-13	+.7286E-03	+.1752E-13	+.6482E-03
27	+.3629E-13	+.1343E-02	+.2532E-13	+.9369E-03	+.2357E-13	+.8722E-03
28	+.3691E-13	+.1366E-02	+.2169E-13	+.8025E-03	+.2846E-13	+.1053E-02
29	+.3125E-12	+.1156E-01	+.4378E-13	+.1620E-02	+.5028E-13	+.1860E-02
30	+.3541E-13	+.1310E-02	+.1900E-13	+.7031E-03	+.2173E-13	+.8040E-03
31	+.4203E-13	+.1558E-02	+.2851E-13	+.1055E-02	+.3318E-13	+.1228E-02
32	+.3923E-13	+.1452E-02	+.2265E-13	+.8382E-03	+.2405E-13	+.8900E-03
33	+.3834E-13	+.1419E-02	+.2477E-13	+.9165E-03	+.2882E-13	+.1066E-02
34	+.3747E-13	+.1386E-02	+.1954E-13	+.7230E-03	+.2606E-13	+.9643E-03
35	+.3819E-13	+.1413E-02	+.2275E-13	+.8419E-03	+.2879E-13	+.1065E-02
36	+.5808E-13	+.2149E-02	+.2390E-13	+.8843E-03	+.3315E-13	+.1226E-02
37	+.4357E-13	+.1612E-02	+.2732E-13	+.1011E-02	+.3571E-13	+.1321E-02
38	+.5301E-13	+.1961E-02	+.2497E-13	+.9238E-03	+.2285E-13	+.8453E-03
39	+.3710E-13	+.1373E-02	+.1733E-13	+.6413E-03	+.2259E-13	+.8359E-03
40	+.3736E-13	+.1382E-02	+.1433E-13	+.5304E-03	+.1811E-13	+.6699E-03
41	+.4686E-13	+.1734E-02	+.2382E-13	+.8815E-03	+.2444E-13	+.9042E-03
42	+.4521E-13	+.1673E-02	+.3628E-13	+.1342E-02	+.3864E-13	+.1430E-02
43	+.4439E-13	+.1642E-02	+.3100E-13	+.1147E-02	+.3592E-13	+.1329E-02
44	+.5681E-13	+.2102E-02	+.3291E-13	+.1218E-02	+.5850E-13	+.2165E-02
45	+.8874E-13	+.3283E-02	+.6107E-13	+.2260E-02	+.5888E-13	+.2179E-02
46	+.7388E-13	+.2734E-02	+.8053E-13	+.2980E-02	+.7316E-13	+.2707E-02
47	+.6387E-13	+.2363E-02	+.4511E-13	+.1669E-02	+.4351E-13	+.1610E-02
48	+.5399E-13	+.1997E-02	+.4222E-13	+.1562E-02	+.4857E-13	+.1797E-02
49	+.8439E-13	+.3123E-02	+.6570E-13	+.2431E-02	+.7242E-13	+.2680E-02
50	+.8376E-13	+.3099E-02	+.7104E-13	+.2628E-02	+.8217E-13	+.3040E-02
51	+.1157E-12	+.4283E-02	+.5999E-13	+.2220E-02	+.6190E-13	+.2290E-02
52	+.1014E-12	+.3751E-02	+.5735E-13	+.2122E-02	+.6148E-13	+.2275E-02
AVERAGE	+.5213E-13	+.1929E-02	+.2922E-13	+.1081E-02	+.3037E-13	+.1124E-02

Table 4.3.4
RADIOPARTICULATE FALLOUT - 1980
(GUMMED PAPER DATA - STATION YEARLY AVERAGE)

STATION NUMBER	LOCATION	LONG-LIVED ACTIVITY MICRO-CI/CC	BECQUERELS/M**3.
	LABORATORY AREA		
HP-1	S 3587	+.5021E-05	+.1999E+01
HP-2	NE 3025	+.4886E-05	+.1945E+01
HP-3	SW 1000	+.3542E-05	+.1410E+01
HP-4	W SETTLING BASIN	+.3956E-05	+.1575E+01
HP-5	E 2506	+.4000E-05	+.1592E+01
HP-6	SW 3027	+.3447E-05	+.1372E+01
HP-7	W 7001	+.3438E-05	+.1369E+01
HP-8	ROCK QUARRY	+.3184E-05	+.1267E+01
HP-9	W BETHEL VALLEY ROAD	+.3388E-05	+.1349E+01
HP-10	W 2075	+.4732E-05	+.1884E+01
HP-16	E 4500	+.3326E-05	+.1324E+01
HP-20	HFIR	+.4159E-05	+.1656E+01
HP-23	WALKER BRANCH	+.4562E-05	+.1816E+01
AVERAGE		+.3972E-05	+.1581E+01
	PERIMETER AREA		
HP-31	KERR HOLLOW GATE	+.3488E-05	+.1389E+01
HP-32	MIDWAY GATE	+.3682E-05	+.1466E+01
HP-33	GALLAHER GATE	+.3979E-05	+.1584E+01
HP-34	WHITE OAK DAM	+.3761E-05	+.1497E+01
HP-35	BLAIR GATE	+.3023E-05	+.1204E+01
HP-36	TURNPIKE GATE	+.3500E-05	+.1393E+01
HP-37	HICKORY CREEK BEND	+.3571E-05	+.1422E+01
HP-38	E EGCR	+.3800E-05	+.1513E+01
HP-39	TOWNSITE	+.3378E-05	+.1345E+01
AVERAGE		+.3576E-05	+.1424E+01
	REMOTE AREA		
HP-51	NORRIS DAM	+.3356E-05	+.1336E+01
HP-52	LOUDOUN DAM	+.3093E-05	+.1231E+01
HP-53	DOUGLAS DAM	+.3614E-05	+.1439E+01
HP-54	CHEROKEE DAM	+.4133E-05	+.1646E+01
HP-55	WATTS BAR DAM	+.2833E-05	+.1128E+01
HP-56	GREAT FALLS DAM	+.3191E-05	+.1271E+01
HP-57	DALE HOLLOW DAM	+.3558E-05	+.1417E+01
HP-58	KNOXVILLE	+.2684E-05	+.1069E+01
AVERAGE		+.3308E-05	+.1317E+01

Table 4.3.5

CONCENTRATION OF BETA RADIOACTIVITY IN RAINWATER - 1980
(YEARLY AVERAGE BY STATIONS)

STATION NUMBER	LOCATION	LONG-LIVED ACTIVITY MICRO-CI/CC	LONG-LIVED ACTIVITY BECQUERELS/M**3.
	LABORATORY AREA		
HP-7	W 7001	+.2063E-07	+.7634E+03
HP-23	WALKER BRANCH	+.2395E-07	+.8862E+03
AVERAGE		+.2229E-07	+.8248E+03
	PERIMETER AREA		
HP-31	KERR HOLLOW GATE	+.1984E-07	+.7342E+03
HP-32	MIDWAY GATE	+.1661E-07	+.6146E+03
HP-33	GALLAHER GATE	+.2405E-07	+.8898E+03
HP-34	WHITE OAK DAM	+.2095E-07	+.7752E+03
HP-35	BLAIR GATE	+.1795E-07	+.6641E+03
HP-36	TURNPIKE GATE	+.1606E-07	+.5941E+03
HP-37	HICKORY CREEK BEND	+.1678E-07	+.6208E+03
HP-38	E EGCR	+.2520E-07	+.9324E+03
HP-39	TOWNSITE	+.1989E-07	+.7359E+03
AVERAGE		+.1970E-07	+.7290E+03
	REMOTE AREA		
HP-51	NORRIS DAM	+.3060E-07	+.1132E+04
HP-52	LOUDOUN DAM	+.4697E-07	+.1738E+04
HP-53	DOUGLAS DAM	+.2432E-07	+.8997E+03
HP-54	CHEROKEE DAM	+.2040E-07	+.7548E+03
HP-55	WATTS BAR DAM	+.2593E-07	+.9594E+03
HP-56	GREAT FALLS DAM	+.2718E-07	+.1006E+04
HP-57	DALE HOLLOW DAM	+.3111E-07	+.1151E+04
HP-58	KNOXVILLE	+.2448E-07	+.9059E+03
AVERAGE		+.2887E-07	+.1068E+04

Table 4.5.6

CONCENTRATION OF BETA RADIOACTIVITY
IN RAINWATER - 1990
(SYSTEM AVERAGE - BY WEEKS)

	LAMS		PAMS		RAMS	
WEEK NUMBER	MICRO-CI /CC	BECQUERELS /M**3	MICRO-CI /CC	BECQUERELS /M**3	MICRO-CI /CC	BECQUERELS /M**3
1	+.3100E-07	+.1147E+04	+.3150E-07	+.1166E+04	+.3050E-07	+.1129E+04
2	+.4700E-07	+.1739E+04	+.1800E-07	+.6660E+03	+.1933E-07	+.7153E+03
3	+.2400E-07	+.8880E+03	+.1356E-07	+.5016E+03	+.2533E-07	+.9373E+03
4	+.3000E-07	+.1110E+04	+.1300E-07	+.4810E+03	+.2067E-07	+.7647E+03
5	+.7000E-08	+.2590E+03	+.1125E-07	+.4163E+03	+.2229E-07	+.8246E+03
6	+.1100E-07	+.4070E+03	+.1600E-07	+.5920E+03	+.4400E-07	+.1628E+04
7	+.0000E+00	+.0000E+00	+.0000E+00	+.0000E+00	+.2286E-07	+.8457E+03
8	+.1400E-07	+.5180E+03	+.1133E-07	+.4193E+03	+.2171E-07	+.8034E+03
9	+.0000E+00	+.0000E+00	+.0000E+00	+.0000E+00	+.2133E-07	+.7893E+03
10	+.1900E-07	+.7030E+03	+.1629E-07	+.6026E+03	+.1873E-07	+.6931E+03
11	+.8000E-08	+.2960E+03	+.1267E-07	+.4687E+03	+.2000E-07	+.7400E+03
12	+.2000E-07	+.7400E+03	+.1244E-07	+.4604E+03	+.1133E-07	+.4193E+03
13	+.1100E-07	+.4070E+03	+.1267E-07	+.4687E+03	+.7200E-07	+.2664E+04
14	+.1000E-07	+.3700E+03	+.1175E-07	+.4348E+03	+.2560E-07	+.9472E+03
15	+.2000E-07	+.7400E+03	+.2156E-07	+.7976E+03	+.2629E-07	+.9726E+03
16	+.0000E+00	+.0000E+00	+.0000E+00	+.0000E+00	+.0000E+00	+.0000E+00
17	+.1900E-07	+.7030E+03	+.1378E-07	+.5098E+03	+.4000E-07	+.1480E+04
18	+.0000E+00	+.0000E+00	+.0000E+00	+.0000E+00	+.0000E+00	+.0000E+00
19	+.8000E-08	+.2960E+03	+.1914E-07	+.7063E+03	+.2500E-07	+.9250E+03
20	+.1300E-07	+.4810E+03	+.1067E-07	+.3947E+03	+.2933E-07	+.1085E+04
21	+.2500E-07	+.9250E+03	+.1578E-07	+.5838E+03	+.2267E-07	+.8387E+03
22	+.0000E+00	+.0000E+00	+.0000E+00	+.0000E+00	+.3800E-07	+.1406E+04
23	+.0000E+00	+.0000E+00	+.0000E+00	+.0000E+00	+.0000E+00	+.0000E+00
24	+.0000E+00	+.0000E+00	+.0000E+00	+.0000E+00	+.0000E+00	+.0000E+00
25	+.6000E-08	+.2220E+03	+.5667E-08	+.2097E+03	+.1000E-07	+.3700E+03
26	+.7000E-08	+.2590E+03	+.1400E-07	+.5180E+03	+.1867E-07	+.6907E+03
27	+.1700E-07	+.6290E+03	+.1229E-07	+.4546E+03	+.2686E-07	+.9937E+03
28	+.2600E-07	+.9620E+03	+.0000E+00	+.0000E+00	+.3300E-07	+.1221E+04
29	+.0000E+00	+.0000E+00	+.0000E+00	+.0000E+00	+.0000E+00	+.0000E+00
30	+.1300E-07	+.4810E+03	+.1622E-07	+.6002E+03	+.2160E-07	+.7992E+03
31	+.1900E-07	+.7030E+03	+.5331E-06	+.1973E+03	+.2200E-07	+.8140E+03
32	+.3700E-07	+.1369E+04	+.3331E-07	+.1233E+04	+.3360E-07	+.1243E+04
33	+.2300E-07	+.8510E+03	+.2200E-07	+.8140E+03	+.2800E-07	+.1036E+04
34	+.1500E-07	+.5550E+03	+.1400E-07	+.5180E+03	+.2000E-07	+.7400E+03
35	+.3200E-07	+.1184E+04	+.2775E-07	+.1027E+04	+.3733E-07	+.1381E+04
36	+.4500E-07	+.1665E+04	+.2933E-07	+.1085E+04	+.3733E-07	+.1381E+04
37	+.1200E-07	+.4440E+03	+.1778E-07	+.6578E+03	+.2800E-07	+.1036E+04
38	+.8000E-08	+.2960E+03	+.1200E-07	+.4440E+03	+.1200E-07	+.4440E+03
39	+.1900E-07	+.7030E+03	+.1378E-07	+.5098E+03	+.1733E-07	+.6413E+03
40	+.1700E-07	+.6290E+03	+.1244E-07	+.4604E+03	+.1040E-07	+.3848E+03
41	+.2200E-07	+.8140E+03	+.1240E-07	+.4588E+03	+.2800E-07	+.1036E+04
42	+.1300E-07	+.4810E+03	+.1244E-07	+.4604E+03	+.1533E-07	+.5673E+03
43	+.3400E-07	+.1258E+04	+.1867E-07	+.6907E+03	+.2067E-07	+.7647E+03
44	+.9000E-08	+.3330E+03	+.1125E-07	+.4163E+03	+.2080E-07	+.7696E+03
45	+.2000E-07	+.7400E+03	+.1125E-07	+.4163E+03	+.3600E-07	+.1332E+04
46	+.6200E-07	+.2294E+04	+.5444E-07	+.2014E+04	+.6800E-07	+.2516E+04
47	+.7100E-07	+.2627E+04	+.6711E-07	+.2483E+04	+.4933E-07	+.1825E+04
48	+.3000E-07	+.1110E+04	+.3467E-07	+.1283E+04	+.4700E-07	+.1739E+04
49	+.3200E-07	+.1184E+04	+.2222E-07	+.8222E+03	+.2880E-07	+.1066E+04
50	+.3200E-07	+.1184E+04	+.2222E-07	+.8222E+03	+.2880E-07	+.1066E+04
51	+.3200E-07	+.1184E+04	+.3600E-07	+.1332E+04	+.5429E-07	+.2009E+04
52	+.3200E-07	+.1184E+04	+.3600E-07	+.1332E+04	+.5429E-07	+.2009E+04
AVERAGE	+.2277E-07	+.8426E+03	+.1944E-07	+.7193E+03	+.2903E-07	+.1074E+04

Table 4.5.7

WEEKLY CONCENTRATION OF I-131 IN AIR - 1989
(SYSTEM AVERAGE - BY WEEKS)

WEEK NUMBER	LAMS MICRO-CI /CC	LAMS BECQUERELS /M**3	PAMS MICRO-CI /CC	PAMS BECQUERELS /M**3
1	+.3291E-14	+.1218E-03	+.1940E-14	+.7177E-04
2	+.2580E-14	+.9546E-04	+.1160E-14	+.4290E-04
3	+.2399E-14	+.8877E-04	+.1203E-14	+.4452E-04
4	+.2973E-14	+.1100E-03	+.1624E-14	+.6008E-04
5	+.3612E-14	+.1336E-03	+.1501E-14	+.5554E-04
6	+.2804E-14	+.1038E-03	+.9161E-15	+.3390E-04
7	+.2161E-14	+.7996E-04	+.1289E-14	+.4770E-04
8	+.3466E-14	+.1282E-03	+.1872E-14	+.6926E-04
9	+.3056E-14	+.1131E-03	+.1428E-14	+.5282E-04
10	+.3534E-14	+.1308E-03	+.1734E-14	+.6415E-04
11	+.3024E-14	+.1119E-03	+.1525E-14	+.5642E-04
12	+.3359E-14	+.1243E-03	+.1565E-14	+.5791E-04
13	+.2644E-14	+.9782E-04	+.1729E-14	+.6397E-04
14	+.8455E-14	+.3128E-03	+.1676E-14	+.6203E-04
15	+.3880E-14	+.1435E-03	+.1730E-14	+.6400E-04
16	+.3714E-14	+.1374E-03	+.1453E-14	+.5374E-04
17	+.3630E-14	+.1343E-03	+.1508E-14	+.5579E-04
18	+.3006E-14	+.1112E-03	+.1322E-14	+.4891E-04
19	+.2508E-14	+.9278E-04	+.1310E-14	+.4846E-04
20	+.2524E-14	+.9340E-04	+.1293E-14	+.4784E-04
21	+.2797E-14	+.1035E-03	+.1453E-14	+.5375E-04
22	+.4323E-14	+.1600E-03	+.1381E-14	+.5109E-04
23	+.2207E-14	+.8168E-04	+.1271E-14	+.4702E-04
24	+.2787E-14	+.1031E-03	+.1276E-14	+.4720E-04
25	+.2901E-14	+.1073E-03	+.1255E-14	+.4644E-04
26	+.2453E-14	+.9076E-04	+.1557E-14	+.5759E-04
27	+.1844E-14	+.6821E-04	+.1856E-14	+.6869E-04
28	+.3901E-14	+.1443E-03	+.1265E-14	+.4680E-04
29	+.3657E-14	+.1353E-03	+.1311E-14	+.4852E-04
30	+.3712E-14	+.1373E-03	+.1481E-14	+.5480E-04
31	+.9342E-14	+.3456E-03	+.1285E-14	+.4752E-04
32	+.2621E-14	+.9698E-04	+.1100E-14	+.4070E-04
33	+.2051E-14	+.7588E-04	+.1353E-14	+.5006E-04
34	+.3114E-14	+.1152E-03	+.1076E-14	+.3983E-04
35	+.2732E-14	+.1011E-03	+.9256E-15	+.3425E-04
36	+.4966E-14	+.1837E-03	+.2000E-14	+.7400E-04
37	+.4282E-14	+.1584E-03	+.1041E-14	+.3851E-04
38	+.1165E-13	+.4312E-03	+.1420E-14	+.5254E-04
39	+.3348E-14	+.1239E-03	+.9715E-15	+.3594E-04
40	+.5452E-14	+.2017E-03	+.1446E-14	+.5350E-04
41	+.2426E-14	+.8978E-04	+.1405E-14	+.5200E-04
42	+.2745E-14	+.1016E-03	+.1181E-14	+.4370E-04
43	+.2269E-14	+.8394E-04	+.1050E-14	+.3883E-04
44	+.3246E-14	+.1201E-03	+.1185E-14	+.4384E-04
45	+.2375E-14	+.8786E-04	+.1093E-14	+.4043E-04
46	+.2819E-14	+.1043E-03	+.1284E-14	+.4752E-04
47	+.2987E-14	+.1105E-03	+.1028E-14	+.3803E-04
48	+.1990E-14	+.7364E-04	+.1245E-14	+.4605E-04
49	+.2581E-14	+.9552E-04	+.1115E-14	+.4127E-04
50	+.2863E-14	+.1059E-03	+.8915E-15	+.3298E-04
51	+.2060E-14	+.7623E-04	+.1103E-14	+.4081E-04
52	+.3047E-14	+.1127E-03	+.1134E-14	+.4194E-04
AVERAGE	+.3426E-14	+.1268E-03	+.1350E-14	+.4997E-04

Table 4.3.8

CONCENTRATION OF IODINE-131 IN AIR - 1980
(YEARLY AVERAGE BY STATIONS)

STATION NUMBER	LOCATION	LONG-LIVED ACTIVITY MICRO-CI/CC	LONG-LIVED ACTIVITY BECQUERELS/M**3.
	LABORATORY AREA		
HP-3	SW 1000	+.5134E-14	+.1900E-03
HP-4	W SETTLING BASIN	+.2396E-14	+.8867E-04
HP-6	SW 3027	+.3918E-14	+.1449E-03
HP-7	W 7001	+.2842E-14	+.1052E-03
HP-8	ROCK QUARRY	+.2740E-14	+.1014E-03
HP-9	W BETHEL VALLEY ROAD	+.3979E-14	+.1472E-03
HP-10	W 2075	+.6117E-14	+.2263E-03
HP-16	E 4500	+.2545E-14	+.9417E-04
HP-20	HFIR	+.2805E-14	+.1038E-03
HP-23	WALKER BRANCH	+.1580E-14	+.5845E-04
AVERAGE		+.3406E-14	+.1260E-03
	PERIMETER AREA		
HP-31	KERR HOLLOW GATE	+.1377E-14	+.5096E-04
HP-32	MIDWAY GATE	+.1425E-14	+.5273E-04
HP-33	GALLAHER GATE	+.1438E-14	+.5319E-04
HP-34	WHITE OAK DAM	+.1364E-14	+.5046E-04
HP-35	BLAIR GATE	+.1329E-14	+.4917E-04
HP-36	TURNPIKE GATE	+.1170E-14	+.4329E-04
HP-37	HICKORY CREEK BEND	+.1550E-14	+.5736E-04
HP-38	E EGCR	+.1203E-14	+.4450E-04
HP-39	TOWNSITE	+.1262E-14	+.4670E-04
AVERAGE		+.1346E-14	+.4982E-04

Table 4.3.9

Continuous Air Monitoring Data Specific Radionuclides in Air—1980

(Composite Samples)

[Units of Bq/m^3 × 10^{-5} and (μCi/cc × 10^{-15})]

	Yearly Average		
Radionuclides	Local Stations	Perimeter Stations	Remote Stations
^{7}Be	380 (104)	360 (96)	303 (82)
^{90}Sr	0.85 (0.21)	0.30 (0.08)	0.41 (0.11)
^{106}Ru	3.7 (0.97)	1.8 (0.49)	1.6 (0.44)
^{125}Sb	N.A.	0.41 (0.11)	0.48 (0.13)
^{137}Cs	3.8 (1.03)	1.4 (0.37)	0.92 (0.25)
^{144}Ce	16 (4.37)	3.6 (0.98)	3.2 (0.87)
^{228}Th	0.18 (0.05)	0.15 (0.04)	0.07 (0.02)
^{230}Th	0.15 (0.04)	0.11 (0.03)	0.04 (0.01)
^{232}Th	0.22 (0.06)	0.11 (0.03)	0.03 (0.009
^{234}U	0.99 (0.27)	2.2 (0.60)	0.15 (0.04)
^{235}U	0.07 (0.02)	0.07 (0.02)	0.01 (0.004)
^{238}U	0.59 (0.16)	1.1 (0.29)	0.07 (0.02)
^{238}Pu	0.01 (0.003)	0.004 (0.001)	0.0015 (0.0004)
^{239}Pu	0.02 (0.006)	0.01 (0.004)	0.0015 (0.0004)

Table 4.3.10 Air Monitoring Data - Suspended Particulates
1980

Location[a]	Number of Samples	Concentration ($\mu g/m^3$)			
		Maximum	Minimum	Average	% Std.[b]
LAM-1	37	135	11	44	59
LAM-3	34	98	9	40	53
LAM-6	34	75	13	42	56
LAM-7	8	95	18	44	59
LAM-15	30	87	11	38	51

[a] See Fig. 4.1.1.

[b] Tennessee Air Pollution Control Regulations-Primary standard based on annual geometric mean is 75.0 $\mu g/m^3$.

Table 4.3.11 [a]
CONCENTRATION OF I-131 IN MILK

1980

STATION NUMBER	NUMBER OF SAMPLES	MAXIMUM		MINIMUM [b]		AVERAGE		COMPARISON WITH STANDARDS [c]
		mBQ/L	PCI/L	mBQ/L	PCI/L	mBQ/L	PCI/L	
						IMMEDIATE ENVIRONS [d]		
1	46	≤ 19.	≤0.45	≤ 19.	≤0.45	≤ 19.±01.	≤0.45±0.0	RANGE I
2	49	≤ 19.	≤0.45	≤ 19.	≤0.45	≤ 19.±01.	≤0.45±0.0	RANGE I
3	48	≤ 19.	≤0.45	≤ 19.	≤0.45	≤ 19.±00.	≤0.45±0.0	RANGE I
4	45	23.	0.6	≤ 19.	≤0.45	≤ 19.±00.	≤0.45±0.0	RANGE I
5	38	23.	0.6	≤ 19.	≤0.45	≤ 19.±00.	≤0.45±0.0	RANGE I
6	48	47.	1.3	≤ 19.	≤0.45	≤ 19.±02.	≤0.45±0.0	RANGE I
7	49	23.	0.6	≤ 19.	≤0.45	≤ 19.±01.	≤0.45±0.0	RANGE I
AVERAGE						≤ 19.±00.	≤0.45±0.0	
						REMOTE ENVIRONS [e]		
51	7	≤ 19.	≤0.45	≤ 19.	≤0.45	≤ 19.±00.	≤0.45±0.0	RANGE I
52	4	≤ 19.	≤0.45	≤ 19.	≤0.45	≤ 19.±00.	≤0.45±0.0	RANGE I
53	9	≤ 19.	≤0.45	≤ 19.	≤0.45	≤ 19.±00.	≤0.45±0.0	RANGE I
56	8	≤ 19.	≤0.45	≤ 19.	≤0.45	≤ 19.±00.	≤0.45±0.0	RANGE I
57	6	≤ 19.	≤0.45	≤ 19.	≤0.45	≤ 19.±00.	≤0.45±0.0	RANGE I
58	7	≤ 19.	≤0.45	≤ 19.	≤0.45	≤ 19.±00.	≤0.45±0.0	RANGE I
AVERAGE						≤ 19.±00.	≤0.45±0.0	

[a] RAW MILK SAMPLES, EXCEPT FOR STATION 2 WHICH IS A DAIRY.

[b] MINIMUM DETECTABLE CONCENTRATION OF I 131 IN MILK IS 19.0 mBQ/L (0.45 PCI/L)

[c] APPLICABLE FRC STANDARD, ASSUMING 1 LITER PER DAY INTAKE:

RANGE I	0-370 mBQ/L (0-10 PCI/L)	ADEQUATE SURVEILLANCE REQUIRED TO CONFIRM CALCULATED INTAKES.
RANGE II	370-3700 mBQ/L (10-100 PCI/L)	ACTIVE SURVEILLANCE REQUIRED.
RANGE III	3700-37000 mBQ/L (100-1000 PCI/L)	POSITIVE CONTROL ACTION REQUIRED.

NOTE: UPPER LIMIT OF RANGE II CAN BE CONSIDERED THE CONCENTRATION GUIDE.

[d] SEE FIGURE 4.1.6

[e] SEE FIGURE 4.1.7

Table 4.3.12

CONCENTRATION OF SR-90 IN MILK[a]

1980

STATION NUMBER	NUMBER OF SAMPLES	MAXIMUM mBQ/L	MAXIMUM PCI/L	MINIMUM[b] mBQ/L	MINIMUM[b] PCI/L	AVERAGE mBQ/L	AVERAGE PCI/L	COMPARISON WITH STANDARDS[c]
IMMEDIATE ENVIRONS[d]								
1	46	175.	4.7	≤ 19.	≤0.5	≤ 65.±07.	≤01.7±0.2	RANGE I
2	48	100.	2.7	25.	0.7	57.±04.	01.5±0.1	RANGE I
3	46	95.	2.6	30.	0.8	59.±05.	01.6±0.1	RANGE I
4	45	260.	7.0	35.	0.9	74.±10.	02.0±0.3	RANGE I
5	32	105.	2.8	30.	0.8	58.±05.	01.6±0.1	RANGE I
6	49	105.	2.8	≤ 19.	≤0.5	≤ 76.±06.	≤02.1±0.2	RANGE I
7	48	100.	2.7	30.	0.8	61.±05.	01.6±0.1	RANGE I
AVERAGE						≤ 63.±01.	≤01.7±0.0	
REMOTE ENVIRONS[e]								
51	7	100.	2.7	30.	0.8	75.±19.	02.0±0.5	RANGE I
52	4	70.	1.9	30.	0.8	44.±18.	01.2±0.5	RANGE I
53	9	100.	2.7	25.	0.7	38.±16.	01.0±0.4	RANGE I
56	8	65.	1.8	30.	0.8	47.±08.	01.3±0.2	RANGE I
57	6	130.	3.5	40.	1.1	88.±29.	02.4±0.8	RANGE I
58	7	70.	1.9	35.	0.9	51.±10.	01.4±0.3	RANGE I
AVERAGE						56.±08.	01.5±0.2	

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[a] RAW MILK SAMPLES, EXCEPT FOR STATION 2 WHICH IS A DAIRY.

[b] MINIMUM DETECTABLE CONCENTRATION OF SR 90 IN MILK IS 19.0 mBQ/L (0.5 PCI/L)

[c] APPLICABLE FRC STANDARD, ASSUMING 1 LITER PER DAY INTAKE:

RANGE I	0-740 mBQ/L (0-20 PCI/L)	ADEQUATE SURVEILLANCE REQUIRED TO CONFIRM CALCULATED INTAKES.
RANGE II	740-7400 mBQ/L (20-200 PCI/L)	ACTIVE SURVEILLANCE REQUIRED.
RANGE III	7400-74000 mBQ/L (200-2000 PCI/L)	POSITIVE CONTROL ACTION REQUIRED.

NOTE: UPPER LIMIT OF RANGE II CAN BE CONSIDERED THE CONCENTRATION GUIDE.

[d] SEE FIGURE 4.1.6

[e] SEE FIGURE 4.1.7

Table 4.3.13 Annual Discharges of Radionuclides to the Atmosphere[a]

Stack Number	^{3}H TBq	^{3}H (kCi)	^{85}Kr TBq	^{85}Kr (kCi)	^{131}I GBq	^{131}I (Ci)	^{133}Xe TBq	^{133}Xe (kCi)	Unidentified Alpha kBq	Unidentified Alpha (µCi)
3039	536	(14.5)	279	(7.6)	4.1	(0.11)	1361	(36.9)		
7025	11	(0.29)								
7911			45	(1.2)	4.1	(0.11)	220	(6.0)		
Bldg. 9204-3 Stack (Y-12)									180	(4.8)
Trans Lab									2.8	(0.08)
4509									1.5	(0.04)
Total	547	(14.8)	324	(8.8)	8.1	(0.22)	1582	(42.8)	180	(4.9)

[a] Data furnished by Operations Division.

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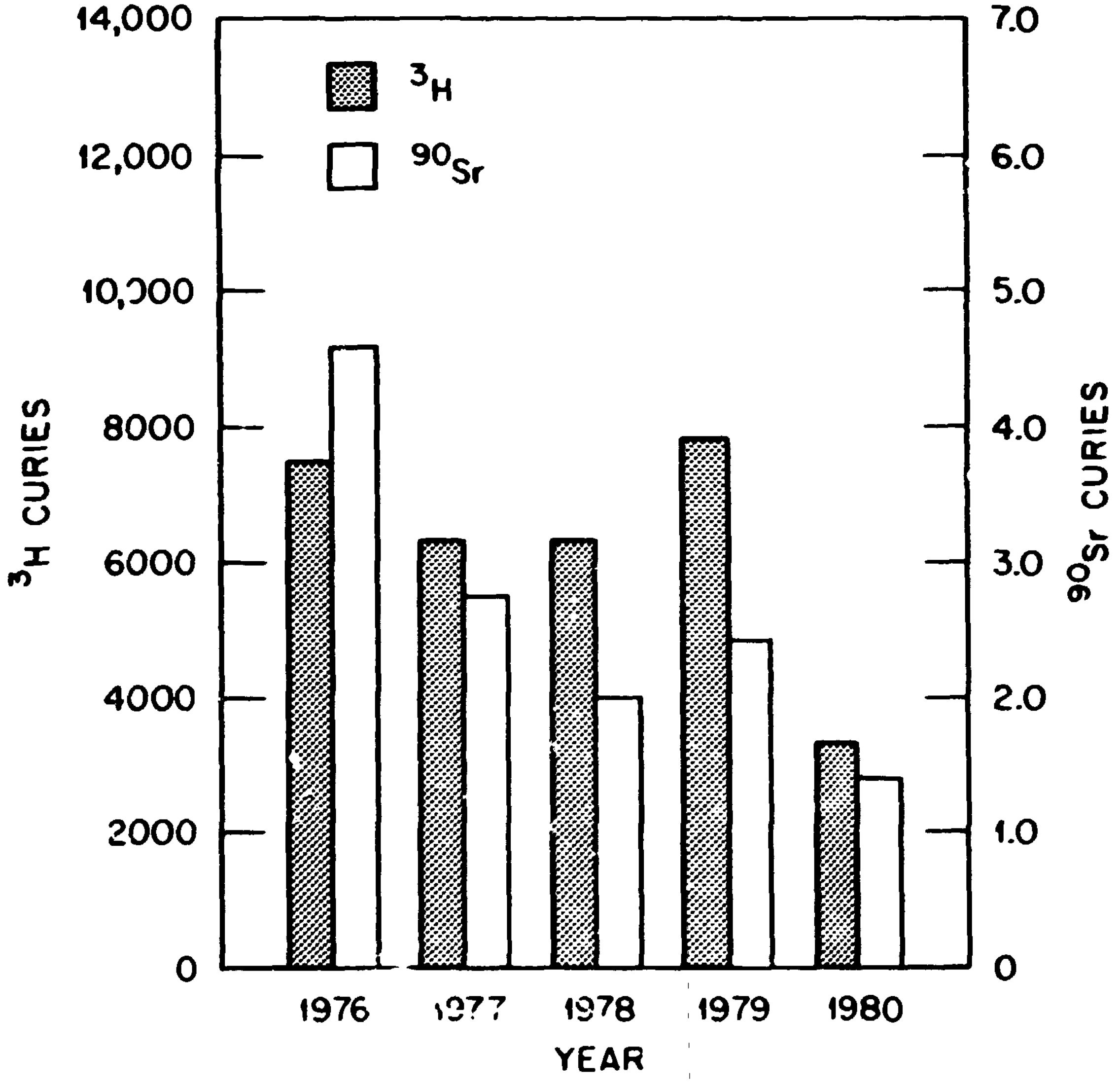

Fig. 4.4.1 Curies[a] Discharged Over White Oak Dam

[a] To convert to tera becquerels, multiply curies by 0.037.

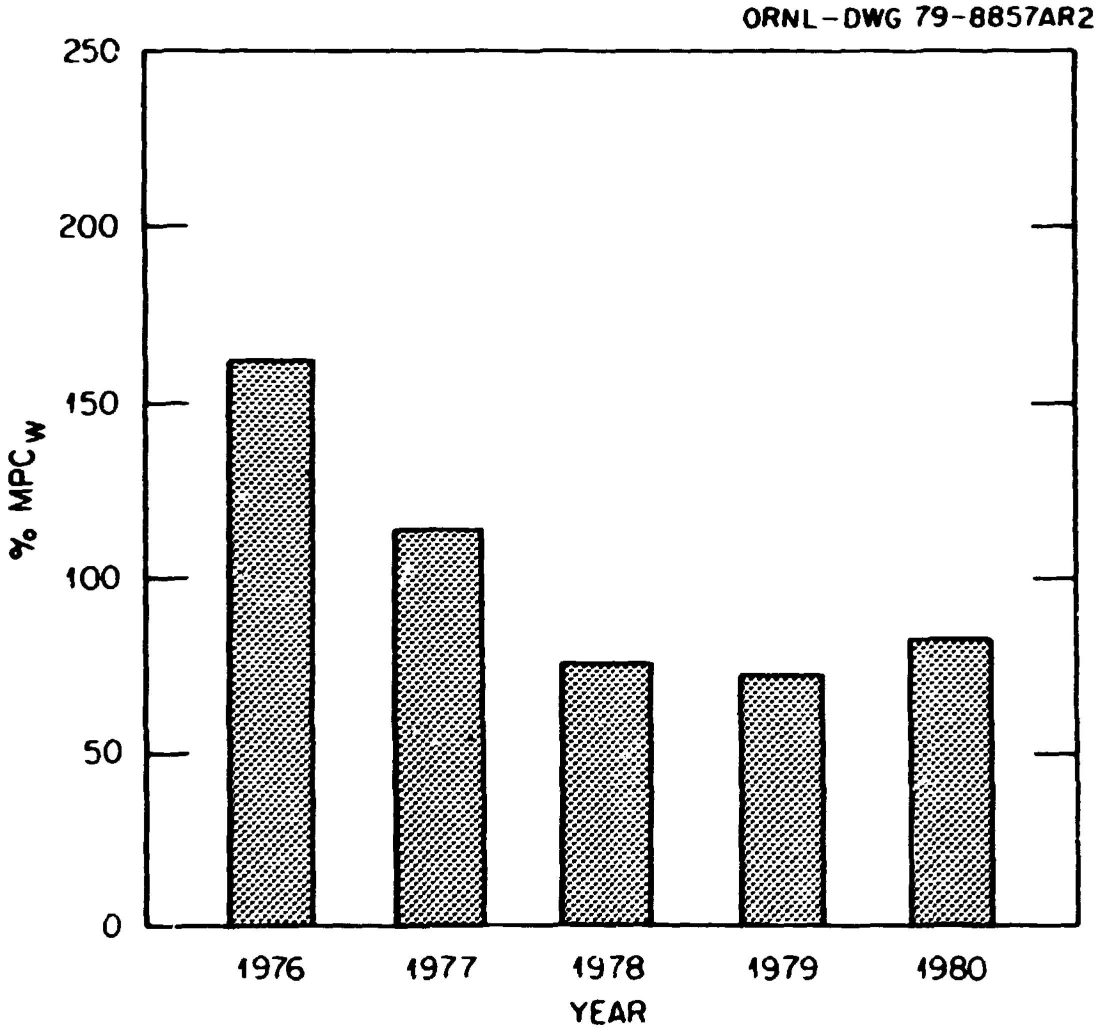

Fig. 4.4.2 Total MPC$_w$ Levels Discharged Over White Oak Dam

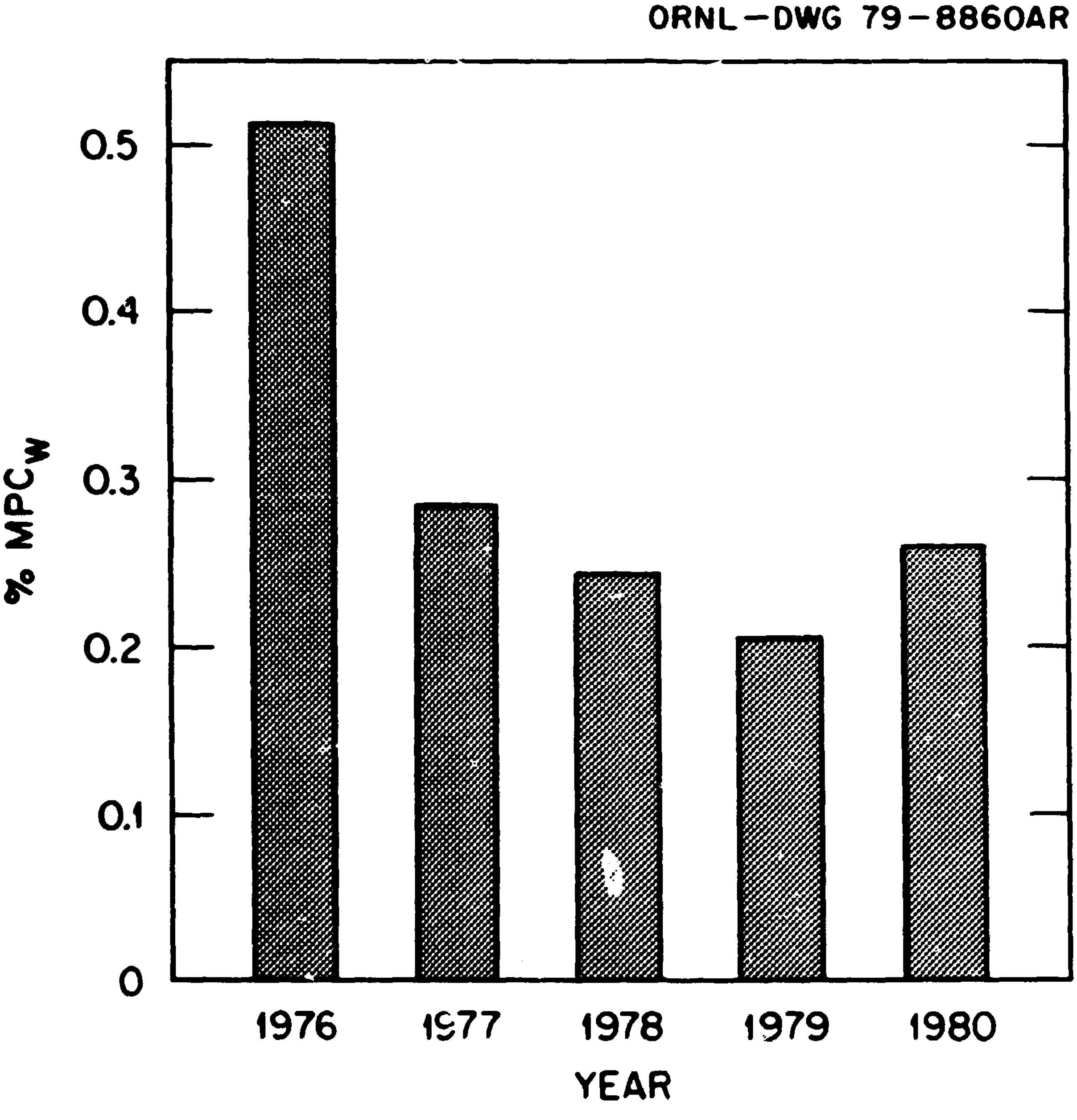

Fig. 4.4.3 Percentage Concentration Guide Levels in the Clinch River (Values given are calculated values based on those concentrations measured at White Oak Dam and dilution afforded by the Clinch River)

Table 4.4.1 Annual Discharges of Radionuclides to the Clinch River (Curies) [a]

Year	^{137}Cs	^{106}Ru	^{90}Sr	Trans U Alpha	^{3}H
1968	1.1	5.2	2.8	0.04	9700
1969	1.4	1.7	3.1	0.2	12200
1970	2.0	1.2	3.9	0.4	9500
1971	0.93	0.50	3.4	0.05	8900
1972	1.7	0.52	6.5	0.05	10600
1973	2.3	0.69	6.7	0.08	15000
1974	1.2	0.22	6.0	0.02	8600
1975	0.62	0.30	7.2	0.02	11000
1976	0.24	0.16	4.5	0.01	7400
1977	0.21	0.20	2.7	0.03	6250
1978	0.27	0.21	2.0	0.03	6292
1979	0.24	0.13	2.4	0.03	7700
1980	0.62	0	1.5	0.04	4554

[a] To convert to tera becquerels, multiply curies by 0.037.

Table 4.4.2

RADIONUCLIDES IN THE CLINCH RIVER
1980

Location	Number of samples	Range	Concentration of Radionuclides of Primary Concern [Units of Bq/L × 10^{-2} and (μCi/ml × 10^{-9})]					
			^{90}Sr	^{137}Cs	^{106}Ru	^{60}Co	^{3}H*	% CG^{a}
C-2 CRM 23.1 Melton Hill	4	Max	0.85 (0.23)	0.67 (0.18)	1.0 (0.27)	0.85 (0.23)	3138 (848)	
		Min.	0.19 (0.05)	0.0 (0)	0.19 (0.05)	0.19 (0.05)	2571 (695)	
		Avg.	0.41 (0.11)	0.26 (0.07)	0.63 (0.17±)	0.41 (0.11)	2827 (64)	0.07
C-3 CRM 14.5 Gallaher	4	Max	6.7 (1.82)	0.6 (0.18)	1.0 (0.27)	1.5 (0.41)	11962 (3233)	
		Min.	0.67 (0.18)	0.0 (0)	0.19 (0.05)	0.33 (0.09)	2756 (745)	
		Avg.	2.8 (0.75)	0.30 (0.08)	0.63 (0.17±)	0.77 (0.21)	5580 (508)	0.16
C-5 TRM 568 Kingston Water Plant	4	Max	13.0 (3.55)	6.7 (1.8)	5.0 (1.36)	0.67 (0.18)	6867 (1856)	
		Min.	0.33 (0.09)	0.0 (0)	0.33 (0.09)	0.19 (0.05)	2202 (595)	
		Avg.	4.4 (1.2)	0.26 (0.07)	2.4 (0.64)	0.30 (0.08±)	3548 (959)	0.11

[a] Most restrictive concentration guide for each isotope used for calculating percent concentration guide. The method for calculating percent of concentration guide for a known mixture of radionuclides is given in DOE Manual, Appendix 0524, Annex A.[1]

Table 4.4.3 Calculated Percent MPC_w of ORNL Liquid Radioactivity Releases at White Oak Dam, Intersection of White Oak Creek and Clinch River, and in the Clinch River Water Below the Mouth of White Oak Creek - 1980

Month	WOD	Intersection of WOC & CR	Calculated Value for C. R.[a]
January	87	25	0.2
February	102	44	0.3
March	94	36	0.7
April	104	37	0.3
May	100	27	0.2
June	65	10	0.04
July	61	7	0.03
August	80	4	0.03
September	45	5	0.02
October	77	4	0.05
November	69	23	0.1
December	111	14	0.3
AVERAGE	83	20	0.2

[a] Values @ WOD divided by dilution of Clinch River.

Table 4.4.4 Annual Average Percent MPC_w of Beta Emitters, Other than Tritium, in the Clinch River[a]

Year	CRM 23.1[b]	Calculated Value for C.R.[c]	CRM 14.5[b]	CRM 4.5[b]
1968	0.17	0.83	0.37	0.52
1969	0.30	0.36	0.48	0.41
1970	0.22	0.27	0.55	0.47
1971	0.21	0.20	0.65	0.44
1972	0.18	0.26	0.58	0.48
1973	0.24	0.49	0.47	0.62
1974	0.06	0.36	0.26	0.21
1975	0.03	0.43	0.14	0.12
1976	0.05	0.44	0.23	0.15
1977	0.05	0.21	0.07	0.10
1978	0.04	0.20	0.06	0.05
1979	0.03	0.20	0.06	0.02
1980	0.04	0.18	0.27	0.43

[a] Values are predominately from ^{90}Sr.

[b] Values given for this location are based on analyses of water taken directly from the river.

[c] Values given for this location are calculated from the levels of radionuclides released from White Oak Dam and dilution provided by the Clinch River.

Table 4.4.5 Annual Average Percent MPC_w of Tritium in the Clinch River

Year	CRM 20.8[a]
1968	0.07
1969	0.11
1970	0.05
1971	0.04
1972	0.04
1973	0.07
1974	0.04
1975	0.06
1976	0.07
1977	0.05
1978	0.05
1979	0.04
1980	0.03

[a] Values given are calculated from the level of waste released from White Oak Dam and dilution provided by the Clinch River.

Table 4.4.6 Chemical Water Quality Data
White Oak Dam - 1980

Substance	No. of Samples	Concentration (mg/ℓ)			Std.[a]	% Std.
		Maximum	Minimum	Average		
Cr	10	< 0.01	< 0.01	< 0.01	0.05	< 20
Zn	10	< 0.02	< 0.02	< 0.02	0.1	< 20
NO_3(N)	10	9.8	0.01	4.6 ± 2.2	10	46
Hg	12	< 0.001	< 0.001	< 0.001	0.005	< 20

[a] Tennessee Stream Guidelines.

Table 4.4.7 Chemical Water Quality Data
Melton Hill Dam - 1980

Substance	No. of Samples	Concentration (mg/ℓ)			Std.[a]	% Std.
		Maximum	Minimum	Average		
Cr	10	< 0.01	< 0.01	< 0.01	0.05	< 20
Zn	10	< 0.02	< 0.02	< 0.02	0.1	< 20
$NO_3(N)$	10	2.2	0.1	0.55 ± 0.5	10	< 6
Hg	11	< 0.001	< 0.001	< 0.001	0.005	< 20

[a] Tennessee Stream Guidelines.

Table 4.4.8 National Pollutant Discharge Elimination System (NPDES) Experience - 1980

Discharge Point	Effluent Parameters	Effluent Limits		Percentage Measurements in Compliance
		Daily Average mg/ℓ	Daily Average mg/ℓ	
ORNL				
001				
(White Oak Creek)	Dissolved Oxygen (min.)	5	--	95
	Dissolved Solids	--	2000	97
	Oil and Grease	10	15	100
	Chromium (total)	--	0.05	96
	pH (pH units)	--	6.0-9.0	98
002				
(Melton Branch)	Chromium (total)	--	0.05	98
	Dissolved Solids	--	2000	92
	Oil and Grease	10	15	100
	pH (pH units)	--	6.0-9.0	100
003				
(Main Sanitary Treatment Facility)	Ammonia (N)	--	5	29
	BOD	--	20	83
	Chlorine Residual	--	0.5-2.0	93
	Fecal Coliform Bact. (no./100 mℓ)	200[a]	400[b]	100
	pH (pH units)	--	6.0-9.0	100
	Suspended Solids	--	30	89
	Settleable Solids (mℓ/ℓ)	--	0.5	98
004				
(7900 Area Sanitary Treatment Facility)	BOD	--	30	No Discharges From This Facility
	Chlorine Residual	--	0.5-2.0	
	Fecal Coliform Bact. (no./100 mℓ)	200[a]	400[b]	
	pH (pH units)	--	6.0-9.0	
	Suspended Solids	--	30	
	Settleable Solids (mℓ/ℓ)	--	0.5	

[a] Monthly average.

[b] Weekly average.

Table 4.4.9

RADIONUCLIDE CONTENT IN CLINCH RIVER FISH1980

(Bq/kg (pCi/kg) Wet Weight)

Location	Species[a]	^{90}Sr	^{238}Pu	^{239}Pu	^{228}Th	^{230}Th	^{232}Th	^{137}Cs	^{60}Co	^{40}K	%MPI[b]	Hg(ng/g)	%FAL[c]
CRM 5.0	Bass	0.081 (2.2)	0.0004 (0.01)	0.0004 (0.01)	0.0037 (0.1)	0.0007 (0.02	0.011 (0.3)	4.50 (122)	0.056 (1.5)	130.0 (3573)	0.03	157	31
	Blue Gill	0.190 (5.2)	0.0004 (0.01)	0.0019 (0.05)	0.0096 (0.26)	0.0022 (0.06)	0.016 (0.42)	2.40 (66)	0.052 (1.4)	140.0 (3900)	0.04	220	44
	Carp	0.710 (19.2)	0.0048 (0.13)	0.0022 (0.06)	0.027 (0.72)	0.0067 (0.18)	0.052 (1.4)	2.50 (67)	0.089 (2.4)	160.0 (4277)	0.14	199	40
	Shad	0.65 (17.6)	0.0011 (0.03)	0.0011 (0.03)	0.18 (4.8)	0.0180 (0.48)	0.24 (6.6)	3.60 (97)	0.15 (4)	140.0 (3917)	0.08	25	5
	Crappie	0.51 (13.9)	0.0004 (0.01)	0.0004 (0.01)	0.23 (6.3)	0.0078 (0.21)	0.035 (0.94)	2.80 (77)	0.21 (5.6)	140.0 (3831)	0.11	65	13
CRM 12.0	Bass	0.33 (9)	0.0048 (0.13)	0.0004 (0.01)	0.027 (0.72)	0.0041 (0.11)	0.041 (1.1)	12.0 (334)	0.29 (7.9)	130.0 (3475)	0.10	430	86
	Blue Gill	0.53 (14.4)	0.0033 (0.09)	0.0044 (0.12)	0.052 (1.4)	0.0041 (0.11)	0.089 (2.4)	1.30 (34.6	0.20 (5.3)	180.0 (4771)	0.10	470	94
	Carp	0.1 (4.2)	0.0004 (0.01)	0.0004 (0.01)	0.014 (0.38)	0.0019 (0.05)	0.019 (0.52)	1.0 (27.5,	0.10 (2.7)	130.0 (3480)	0.03	102	20
	Shad	2.0 (53)	0.0063 (0.17)	0.0015 (0.04)	0.44 (11.9)	0.028 (0.75)	0.60 (16.3	2.40 (66)	0.16 (4.4)	110.0 (2948)	0.38	18.2	4
	Crappie	0.40 (10.8)	0.0011 (0.03)	0.0030 (0.08)	0.012 (0.32)	0.0022 (0.06)	0.018 (0.50)	2.9 (79)	0.12 (3.2)	120.0 (3338	0.09	122	24
CRM 20.8	Bass	0.53 (14.4)	0.0026 (0.07)	0.0015 (0.04)	0.0059 (0.16)	0.0015 (0.04)	0.011 (0.3)	5.0 (136)	0.25 (6.8)	120.0 (3278)	0.11	99	20
	Blue Gill	14.0 (381)	0.010 (0.28)	0.0096 (0.26)	0.052 (1.4)	0.016 (0.44)	0.052 (1.4	48.0 (1289)	2.2 (59)	160.0 (4406)	2.86	219	44
	Carp	1.80 (49)	0.0019 (0.05)	0.0004 (0.01)	0.012 (0.32)	0.0022 (0.06)	0.018 (0.49)	8.60 (233)	0.57 (15.3)	130.0 (3584)	0.17	193	39
	Shad	0.69 (18.7)	1.90 (0.53)	0.0026 (0.07)	0.089 (2.4)	0.010 (0.28)	0.14 (3.7)	13.0 (345)	1.3 (34)	120.0 (3163)	0.17	24	5
	Crappie	0.48 (12.9)	0.0093 (0.25)	0.0004 (0.01)	0.043 (1.1)	0.0059 (0.16)	0.048 (1.3)	1.7 (47)	0.19 (5.1)	130.0 (3625)	0.10	45	9
CRM 25.0	Bass	0.20 (5.4)	0.0011 (0.03)	0.0011 (0.03)	0.025 (0.68)	0.021 (0.57)		0.17 (4.7)	0.092 (2.5)	150.0 (4057)	0.04	11	2
	Blue Gill	0.28 (7.7)	0.0037 (0.1)	0.0059 (0.16)	0.063 (1.7)	0.019 (0.52)		0.52 (14)	0.18 (4.8)	170.0 (4608)	0.06	59	12
	Carp	0.12 (3.2	0.0007 (0.02)	0.0011 (0.03)	0.018 (0.5)	0.0030 (0.08)		0.31 (8.4)	0.063 (1.7)	110.0 (2854)	0.02	21	4
	Shad	0.24 (6.6)	0.0016 (0.43)	0.0030 (0.08)	0.018 (0.48)	0.0026 (0.07)		0.33 (9)	0.081 (2.2)	150.0 (4136)	0.05	7.4	1
	Crappie	0.027 (0.72)	0.0011 (0.03)	0.0059 (0.16)	0.048 (1.3)	0.028 (0.75)		0.12 (3.4)	0.11 (2.9)	150.0 (3949)	0.01	109	22

[a] Composite of 10 fish in each species

[b] Maximum Permissible Intake. Intake of radionuclide from eating fish is calculated to be equal to a daily intake of 2.2 liters of water over a period of one year, containing the concentration guide of radionuclides in question. Consumption of fish is assumed to be 16.8 kg/yr of the species in question. Only man-made radionuclides were used in the calculation.

[c] Percent of proposed FDA Mercury in fish action level of 500 ng/g. Mercury data included in this table as a matter of convenience.

[d] Average of quarterly samples

Table 4.5.1 External Gamma Radiation Measurements at Local Air Monitoring Stations - 1980

Station Number	μGy/h[a]	(μrad/h)	mGy/yr[b]	(mrad/yr)
HP-1	0.25	(25)	2.20	(220)
HP-2	0.60	(60)	5.26	(526)
HP-3	0.08	(8)	0.74	(74)
HP-4	1.60	(160)	13.99	(1399)
HP-5	0.41	(41)	3.55	(355)
HP-6	0.34	(34)	3.02	(302)
HP-7	0.06	(6)	0.54	(54)
HP-8	0.07	(7)	0.59	(59)
HP-9	0.11	(11)	0.96	(96)
HP-10	0.13	(13)	1.12	(112)
HP-11	0.09	(9)	0.82	(82)
HP-12	0.48	(48)	4.17	(417)
HP-13	1.88	(188)	16.49	(1649)
HP-14	0.11	(11)	0.96	(96)
HP-15	0.11	(11)	0.98	(98)
HP-16	0.08	(8)	0.70	(70)
HP-17	0.10	(10)	0.88	(88)
HP-18	0.08	(8)	0.68	(68)
HP-19	0.13	(13)	1.11	(111)
HP-20	0.10	(10)	0.89	(89)
HP-21	0.08	(8)	0.74	(74)
HP-22	0.11	(11)	0.96	(96)
Average	0.31	(31)	2.78	(278)

[a] Average of two samples.

[b] Calculated assuming that an individual remained at this point for 24 hours/day for the entire year.

Table 4.5.2 External Gamma Radiation Measurements - 1980

Station Number	Location	Number of Measurements Taken	Background			
			µGy/h	(µrad/h)	mGy/yr	(mrad/yr)
<u>Perimeter Stations</u>[a]						
HP-31	Kerr Hollow Gate	12	0.083	(8.3)	0.73	(73)
HP-32	Midway Gate	11	0.097	(9.7)	0.85	(85)
HP-33	Gallaher Gate	12	0.078	(7.8)	0.68	(68)
HP-34	White Oak Dam	12	0.160	(16.0)	1.40	(140)
HP-35	Blair Gate	11	0.076	(7.6)	0.67	(67)
HP-36	Turnpike Gate	11	0.073	(7.3)	0.64	(64)
HP-37	Hickory Creek Bend	10	0.089	(8.9)	0.78	(78)
HP-38	East of EGCR	12	0.080	(8.0)	0.70	(70)
HP-39	Townsite	12	0.073	(7.3)	0.64	(64)
Average			0.090	(9.0)	0.79	(79)
<u>Remote Stations</u>[b]						
HP-51	Norris Dam	2	0.054	(5.4)	0.47	(47)
HP-52	Loudoun Dam	2	0.071	(7.1)	0.62	(62)
HP-53	Douglas Dam	2	0.073	(7.3)	0.64	(64)
HP-55	Watts Bar Dam	2	0.062	(6.2)	0.54	(54)
HP-56	Great Falls Dam	2	0.080	(8.0)	0.70	(70)
HP-57	Dale Hollow Dam	2	0.097	(9.7)	0.85	(85)
HP-58	Knoxville	2	0.102	(10.2)	0.89	(89)
Average			0.077	(7.7)	0.67	(67)

[a] See Fig. 4.1.3.

[b] See Fig. 4.1.4.

Table 4.5.3 External Gamma Radiation Measurements Along the Perimeter of the DOE - Oak Ridge Controlled Area - 1980

Location[a]	μGy/h	(μrad/h)	mGy/yr	(mrad/hr)[b]
HP-60	0.12	(12.0)	1.05	(105)
HP-61	0.17	(16.7)	1.46	(146)
HP-62	0.30	(30.2)	2.65	(265)
HP-63	0.60	(60.0)	5.26	(526)
HP-64	0.36	(35.6)	3.12	(312)
HP-65	0.33	(33.4)	2.93	(293)
HP-66	0.34	(34.0)	2.98	(298)
HP-67	0.22	(21.9)	1.92	(192)
HP-68	0.13	(12.7)	1.12	(112)
HP-69	0.10	(10.7)	0.94	(94)

[a] See Fig. 4.1.8.

[b] Calculated assuming that an individual remained at this point for the entire year.

Table 4.6.1

RADIOACTIVITY IN SOIL SAMPLES FROM PERIMETER AND REMOTE MONITORING STATIONS 1980

[Units of Bq/kg and (pCi/g)-Dry Weight]

Sampling Location[a]	^{90}Sr	^{137}Cs	^{234}U	^{235}U	^{238}U	^{238}Pu	^{239}Pu
				Perimeter[b]			
HP-31	7.4 (0.2)	56 (1.5)	26 (0.7)	16 (0.43)	6.7 (0.18)	0.07 (0.002)	0.7 (0.02)
HP-32	22 (0.6)	63 (1.7)	44 (1.2)	2.2 (0.06)	24 (0.66)	0.07 (0.002)	0.7 (0.02)
HP-33	11 (0.3)	89 (2.4)	15 (0.4)	0.7 (0.02)	11 (0.29	0.1 (0.003)	1.1 (0.03)
HP-34	7.4 (0.2)	33 (0.9)	11 (0.3)	0.7 (0.02)	8.5 (0.23)	0.07 (0.002)	0.37 (0.01)
HP-35	7.1 (0.2)	48 (1.3)	19 (0.5)	0.7 (0.02)	13 (0.35)	0.04 (0.001)	0.37 (0.01)
HP-36	7.4 (0.2)	52 (1.4)	11 (0.3)	1.1 (0.03)	8.9 (0.24)	0.04 (0.001)	0.7 (0.02)
HP-37	7.4 (0.2)	22 (0.6)	22 (0.6)	3 (0.08)	12 (0.33)	0.1 (0.003)	0.37 (0.01)
HP-38	7.4 (0.2)	41 (1.1)	11 (0.3)	0.37 (0.01)	8.9 (0.24)	0.04 (0.001)	0.37 (0.01)
HP-39	11 (0.3)	81 (2.2)	26 (0.7)	1.5 (0.04)	15 (0.41)	0.04 (0.001)	1.1 (0.03)
Average	11 (0.3)	56 (1.5)	22 (0.6)	3.0 (0.08)	12 (0.33)	0.07 (0.002)	0.7 (0.02)
				Remote[c]			
HP-51	12 (0.32)	37 (1.0)	19 (0.51)	1.1 (0.03)	15 (0.41)	0.04 (0.001)	1.1 (0.03)
HP-52	8.5 (0.23)	70 (1.9)	12 (0.32)	0.7 (0.02)	11 (0.30)	0.04 (0.001)	0.7 (0.02)
HP-53	11 (0.30)	41(1.1)	18 (0.49)	2.6 (0.07)	15 (0.41)	0.04 (0.001)	0.37 (0.01)
HP-55	31 (0.84)	56 (1.5)	14 (0.38)	0.7 (0.02)	12 (0.32)	0.07 (0.002)	1.1 (0.03)
HP-56	18 (0.49)	59 (1.6)	16 (0.43)	0.7 (0.02)	14 (0.38)	0.04 (0.001)	0.7 (0.02)
HP-57	19 (0.51)	130 (3.5)	24 (0.65)	1.5 (0.04	20 (0.54)	0.1 (0.003)	1.5 (0.04)
HP-58	5.2 (0.14)	56 (1.5)	15 (0.41)	1.1 (0.03)	12 (0.32)	0.04 (0.001)	0.7 (0.02)
Average	15 (0.40)	63 (1.7)	17 (0.46)	0.7 (0.02)	14 (0.38)	0.04 (0.001	0.7 (0.02)

[a] See Figures 4.1.3 and 4.1.4.

[b] Average of two samples.

[c] One sample.

Table 4.6.2

RADIOACTIVITY IN GRASS SAMPLES FROM PERIMETER AND REMOTE MONITORING STATIONS 1980

[Bq/kg (pCi/g)-Dry Weight]

Sampling Location[a]	^{7}Be	^{90}Sr	^{137}Cs	^{239}Pu	^{238}Pu	^{238}U	^{235}U	^{234}U
				Perimeter[b]				
HP-51	629 (17)	26 (0.7)	3.7 (0.1)	0.07 (0.002)	0.04 (0.001)	1.9 (0.05)	0.59 (0.016)	4.1 (0.11)
HP-32	444 (12)	22 (0.6)	ND	0.07 (0.002)	0.04 (0.001)	0.37 (0.10)	0.48 (0.013)	12 (0.33)
HP-33	185 (5)	44 (1.2)	3.7 (0.1)	0.04 (0.001)	0.04 (0.001)	1.1 (0.03)	0.19 (0.005)	1.5 (0.04)
HP-34	296 (8)	41 (1.1)	7.4 (0.2)	0.07 (0.002)	0.04 (0.001)	0.74 (0.02)	0.22 (0.006)	1.1 (0.03)
HP-35	666 (18)	30 (0.8)	3.7 (0.1)	0.04 (0.001)	0.04 (0.001)	1.1 (0.03)	0.26 (0.007)	2.6 (0.07
HP-36	111 (3)	30 (0.8)	ND	0.04 (0.001)	0.04 (0.001)	1.1 (0.03)	1.2 (0.033)	1.5 (0.04)
HP-37	370 (10)	15 (0.4)	3.7 (0.1)	0.04 (0.001)	0.04 (0.001)	0.74 (0.02)	0.11 (0.003)	1.1 (0.03)
HP-38	259 (7)	19 (0.5)	ND	0.04 (0.001)	0.04 (0.001)	0.37 (0.01)	0.11 (0.003	1.1 (0.03)
HP-39	555 (15)	26 (0.7)	3.7 (0.1)	0.04 (0.001)	0.04 (0.001)	1.5 (0.04)	0.19 (0.005)	2.6 (0.07)
Average	407 (11)	30 (0.8)	3.7 (0.1)	0.04 (0.001)	0.04 (0.001)	1.5 (0.04)	0.37 (0.01)	3.0 (0.08)
				Remote[c]				
HP-51		7.4 (0.2)	ND	0.04 (<0.001)	0.01 (<0.0003)	0.74 (0.02)	0.11 (0.003)	0.74 (0.02)
HP-52		19 (0.5)	2.2 (0.06)	0.04 (0.001)	0.007 (<0.0002)	0.37 (0.01)	0.15 (0.004)	0.37 (0.01)
HP-53		11 (0.3)	4.1 (0.11)	0.04 (0.001)	0.007 (0.0002)	1.5 (0.04)	0.19 (0.005)	1.5 (0.04)
HP-55		11 (0.3)	2.2 (0.06)	0.07 (0.002)	0.04 (<0.0011)	0.74 (0.02)	0.48 (0.013)	1.1 (0.03)
HP-56		26 (0.7)	4.1 (0.11)	0.04 (0.001)	0.007 (<0.0002)	0.74 (0.02)	0.41 (0.011)	0.74 (0.02)
HP-57		22 (0.6)	ND	0.04 (0.001)	0.007 (<0.0002)	0.37 (0.01)	0.52 (0.014)	1.5 (0.04)
HP-58		7.4 (0.2)	ND	0.04 (0.001)	0.02 (<0.0006)	0.37 (0.01)	0.30 (0.008)	0.37 (0.01)
Average		15 (0.4)	3.3 (0.09)	0.04 (<0.001)	0.01 (<0.0004)	0.74 (0.02)	0.30 (0.008)	0.74 (0.02)

[a] See Figures 4.1.3 and 4.1.4

[b] Average of two samples.

[c] One sample.

[d] Not detectable.

Table 4.7.1 ^{137}Cs Concentration in Deer Samples - 1980
(pCi/kg Wet Weight)[a]

Sample Number	Muscle	Liver
1	10	43
2	30	< 10
3	< 10	< 10[b]
4	27	15
5	< 10	< 10
6	< 10	< 10
7	< 10	< 10
8	10	< 10
9	27	< 10
10	41	< 10
11	27	17
12	68	38
13	60	30
14	< 10	< 10
15	< 10	< 10
16	78	15
17	103	70
18	24	< 10
19	30	< 10

[a] To convert to Bq/kg, multiply by 0.037.

[b] This liver sample contained 18 pCi/kg.

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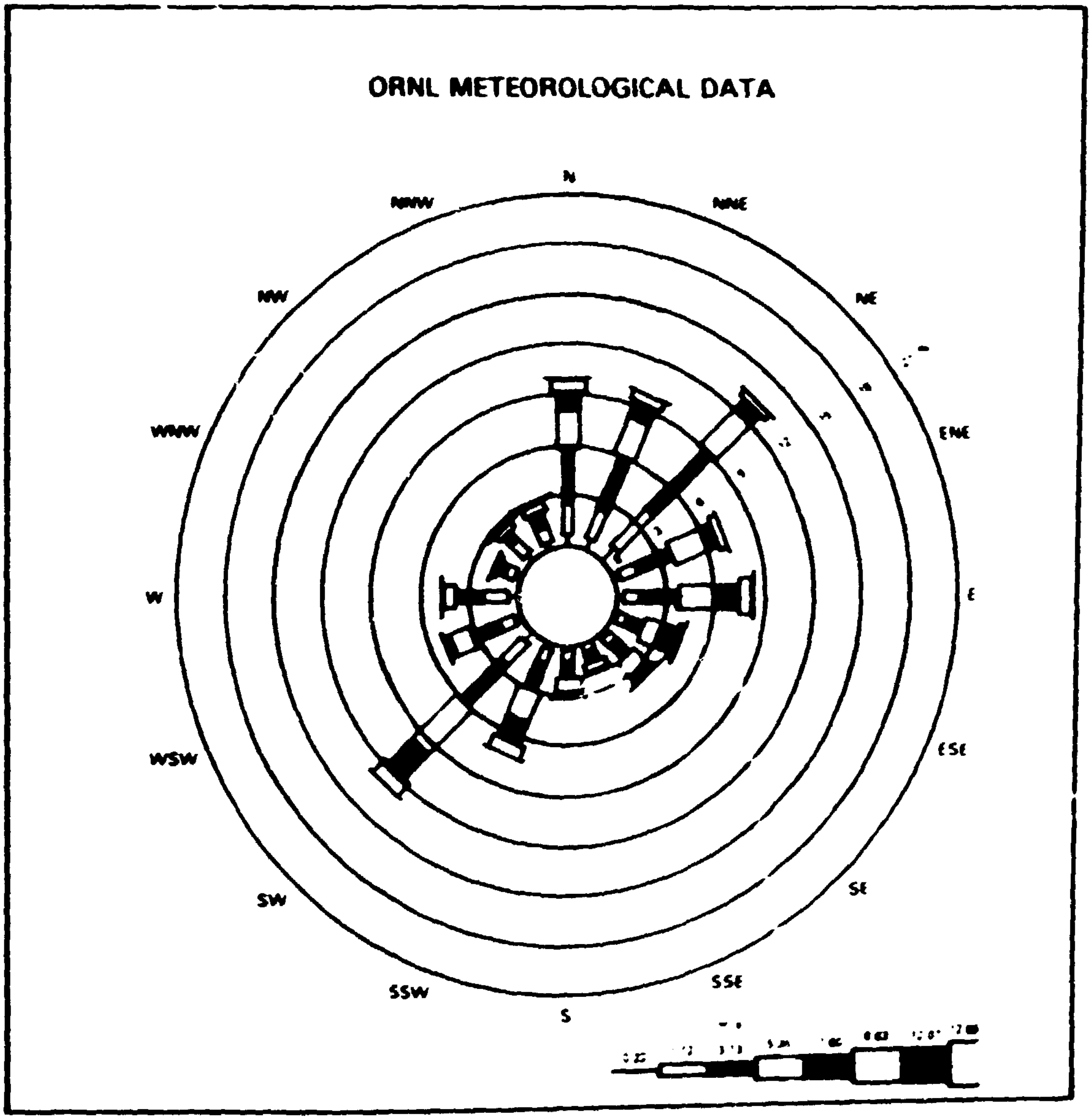

Fig. 4.8.1 Meteorological Data for the Oak Ridge Reservation

Table 4.8.1 Incremental Population Table in the Vicintiy of ORNL

Distance, Miles Distance, KM	0-1 0-1.6	1-2 1.6-3.2	2-3 3.2-4.8	3-4 4.8-6.4	4-5 6.4-8.0	5-10 8-16	10-20 16-32	20-30 32-48	30-40 48-64	40-50 64-80
Direction										
E	0	0	0	0	0	3,059	44,880	100,500	11,790	12,390
ENE	0	0	0	0	0	0	27,460	74,690	18,720	13,870
NE	0	0	0	0	0	9,713	12,480	7,167	4,392	7,476
NNE	0	0	0	0	1,461	13,780	4,362	11,190	12,670	6,119
N	0	0	0	0	1,490	5,578	2,177	1,441	2,223	4,508
NNW	0	0	0	0	0	1,495	0	1,152	4,559	4,676
NW	0	0	0	0	0	1,073	4,804	1,538	1,896	7,552
WNW	0	0	0	0	0	587	2,971	1,543	0	4,151
W	0	0	0	0	0	666	13,100	4,595	9,038	7,318
WSW	0	0	0	0	0	622	9,862	3,495	4,562	4,204
SW	0	0	0	0	0	733	1,840	1,909	3,962	8,578
SSW	0	0	0	0	0	721	2,055	7,897	21,580	10,530
S	0	0	0	0	0	943	8,742	7,309	6,560	1,222
SSE	0	0	0	0	1,374	7,277	1,290	4,091	469	0
SE	0	0	0	0	0	1,167	4,304	15,010	46	0
ESE	0	0	0	0	0	6,096	5,343	36,020	4,132	6,840
TOTAL	0	0	0	0	4,325	53,510	145,670	279,547	106,599	99,434
CUMULATIVE TOTAL	0	0	0	0	4,325	57,835	203,505	483,052	589,651	689,085

Table 4.8.2 Summary of the Estimated Radiation Dose to an Adult Individual During 1980 at Locations of Maximum Exposure

Pathway	Location	Dose μSv (millirem)	
		Total Body	Critical Organ
Gaseous Effluents			
Inhalation plus direct radiation from air and ground	Nearest resident to site boundary	18 (1.8)	166(16.6)(lung)
Terrestrial food chains	Milk sampling stations (^{90}Sr)	0.2 (0.02)	15 (1.5)(bone)
Liquid Effluents			
Aquatic food chains	Clinch-Tennessee River System (^{90}Sr)	11 (1.1)	530(53)(bone)
Drinking water[a]	Kingston, Tennessee (^{90}Sr)	1.5 (0.15)	66 (6.6)(bone)
Direct radiation along water, shores, and mud flats[b]	Downstream from White Oak Creek near experimental CS field plots	62 (6.2)	62 (6.2)(total body)

[a] Based on the analysis of raw (unprocessed) water.

[b] Assuming a residence time of 240 hr/yr.

NOTE: Average background total body dose in the U.S. is 106 mrem/yr.

Table 4.9.1 Environmental Monitoring Samples - 1980

Sample Type	Type of Analyses	Number of Samples
Monitoring Network Air Filters	Gross Alpha, Gross Beta	1,560
Monitoring Network Air Filters	Gamma Spectrometry, Wet Chemistry	12 Groups
Gummed Paper Fallout Trays	Autoradiogram	676
Gummed Paper Fallout Trays	Long Lived Activity Count	1,560
Charcoal Cartridge	^{131}I	985
Fish	Radiochemical, Gamma Spectrometry	38 Groups
Rainwater	Gross Beta	964
Raw Milk	^{131}I, ^{90}Sr	360
White Oak Dam Effluent	Gross Beta, Radiochemical, Gamma Spectrometry	410
White Oak Creek	Gross Beta, Radiochemical Gamma Spectrometry	238
Clinch River Water	Radiochemical, Gamma Spectrometry	54
Potable Water	Radiochemical, Gamma Spectrometry	8
Soil Samples	Gamma Spectrometry, Wet-Chemistry	32 Groups
Grass Samples	Gamma Spectrometry, Wet-Chemistry	32 Groups
Deer Samples	Gamma Spectrometry	38
TLDs	External Gamma Radiation	144
Hi Vols	Particulates	143
Tritium	HTO	42

5.0 RADIATION AND SAFETY SURVEYS

5.1 Laboratory Operations Monitoring

During 1980 members of the Radiation and Safety Surveys Section provided radiation surveillance services to the research and operating groups in support of efforts to keep personnel exposures, concentrations of airborne radioactivity, and levels of surface contamination well within permissible limits. This assistance in coping with the problems associated with radiation work was provided through seminars, safety meetings, and discussions with those planning, supervising, and performing the work. Following is a brief review of some of the more salient events in which they participated.

5.1.1 HRLAL, Cell Exhaust Filter Replacement, Building 2026

Over a period of ∿ 15 years, a gradual increase in the pressure drop across the HRLAL cell exhaust roughing filters necessitated their replacement. Replacements for the 105 filter units were no longer commercially available. Building 2026 supervision decided to replace the 21 roughing filter racks with new racks, fabricated at ORNL. Each new rack received a commercially available filter that replaced five of the old filter units.

Personnel of the Analytical Chemistry, Plant and Equipment, and Industrial Safety and Applied Health Physics Divisions collaborated in planning for and developing detailed written procedures for the replacement. Radiation measurements were made which aided in the design of the used filter containment boxes and a reusable shield. Readings at several inches from individual filter units were in the range of ∿ 10 to 20 mGy/h (2 to 3 rad/h). Gross alpha contamination was also indicated. Remote tools were designed and fabricated which eliminated the need for personnel to enter the grossly contaminated filter pits and permitted removal, as a unit, of each old filter rack and the five used filters therein. All filter frames and filters were successfully replaced over a four-day period with no personnel dose exceeding 1 mSv (100 mrem) and with no release of radioactive contamination.

5.1.2 Bulk Shielding Reactor, Building 3010

The Bulk Shielding Reactor, operated by the Operations Division, is utilized primarily by research divisions at ORNL for brief irradiation of samples. One such project, related to the Coal Gasification Program, uses this facility to irraaiate coal tar samples so that multi-element analyses can be performed. These samples are inserted and removed from the core with health physics surveillance and with caution, resulting in no appreciable radiation exposures to personnel.

5.1.3 Radiochemical Pilot Plant Operations, Building 3019

During the year, Pilot Plant participation in two programs was completed and considerable attention was given to equipment maintenance, to decontamination and decommissioning of several facilities, and to preparation for several new programs. In general, control of personnel exposures and radioactive materials was very good. The few unusual occurrences which took place were of a very minor nature. Approximately one hundred-forty Radiation Work Permits were certified for Pilot Plant operations.

Participation in the Argonne National Laboratory Zero Power Reactor Program terminated in February with the final shipment of $^{233}U_3O_8$-loaded packets. The Light Water Boiling Reactor Program participation was concluded after a series of dissolver runs, which resulted in recovery of ∿ 700 kg of thorium and ∿ 18 kg of ^{233}U from "scrap pellets" generated by Bettis Atomic Power Laboratory.

Equipment maintenance included a thorough, extensive testing of process instrumentation and instrumentation lines between the Penthouse and process vessels in the cells and pipe tunnel. Many leaks were located and repaired.

Decommissioning of the Room 303A, Sol-gel (^{233}U, ^{235}U) Facility was initiated and decommissioning of the Room 211, High Alpha Development Laboratory (^{233}U, ^{239}Pu), was completed. After removal of highly contaminated equipment and gross alpha contamination from the Room 211 glove boxes, the boxes were contained and consigned to the solid waste storage area. Room surfaces were cleaned of significant transferable contamination.

Room 209 was decommissioned as an analytical chemistry laboratory and is being prepared for installation of glove boxes to be used in a plutonia-urania fuel development program. Contaminated equipment and floor surfaces were removed.

5.1.4 CEUSP, Building 3019

The Consolidated Edison Uranium Solidification Program (CEUSP) was initiated to solidify some 7,500 liters of solution containing a mixture of ^{233}U and ^{235}U (∿ 10^3 kg total U). The uranium was recovered from the Consolidated Edison Indian Point Reactor fuel and had been stored over ten years in the Thorium Reactor Uranium Storage Tank (TRUST) south of Building 3019. Pilot Plant Cell #3 will be utilized to solidify and encapsulate the uranium. Sealed containers will be stored in existing Cell #4 storage wells. CEUSP site preparation included: drilling duct and piping penetrations in Cell #3 walls; removing the air duct between the Penthouse and Cell #3 Plenum; and enlarging the Cells 3 and 4 Plenum (to be the CEUSP Control Room) by relocating the south wall and by removing the Cell #4 stairway enclosure. All these operations involved some potential for release of alpha contamination previously bonded to surfaces.

5.1.5 Decommissioning of Radiochemical Waste System, Building 3026-C

Radiation and Safety Surveys personnel provided monitoring and surveillance for the decommissioning of the Radiochemical Waste System for Building 3026-C. The facility, originally used for the storage of radioactive waste solutions for the building, contained thirteen tanks and associated piping arranged in the shielded enclosure on two levels. Radiation levels, prior to draining and transfer of material in the tanks to the Intermediate Level Waste System (ILW), ranged from 2 mGy/h (0.2 rad/h) at the top to 0.9 Gy/h (90 rad/h) at the side of one of the large tanks near the bottom of the enclosure. After extensive decontamination, careful planning, and the use of remote tools, all equipment and debris were removed and transferred to the Solid Waste Storage area. The maximum radiation levels on the tank packages sent to the burial ground were 5 mGy/h (0.5 rad/h). The empty enclosure required extensive decontamination to reduce the floor and walls to acceptable levels. Radiation levels on the floor ranged up to 0.2 Gy/h (20 rad/h). The final survey of the pit indicated readings of 0.35 mGy/h (35 mrad/h) on the floor and a general background of 0.05 mGy/h (5 mrad/h). The pit was filled with gravel, and a 15 cm cap of concrete was poured on the top to seal the pit. An appropriate marker was attached to the concrete to identify the project. Personnel exposure controls were effective and contamination was confined.

5.1.6 Isotope Area Operations, Building 3038, et al.

Work in this area continued at about the same level as in the previous year. This consisted of the production, packaging, and shipping of radioisotopes for medical, industrial, and experimental uses. Principal isotopes consisted of ^{3}H, ^{67}Ga, ^{75}Se, ^{85}Kr, ^{90}Sr, ^{137}Cs, ^{153}Gd, ^{192}Ir, ^{237}Np, ^{241}Am, and several isotopes of Pu. The Research Materials Laboratory continued the fabrication of dosimeters from various isotopes of uranium, neptunium, thorium, and plutonium. During the year over 2,400 packages of radioactive materials were shipped from the Laboratory. The monitoring of these packages assured that each was in compliance with applicable Department of Transportation regulations.

One major operation involving the replacement of a window in a hot cell was completed in Building 3029. Readings exceeding 1 Gy/h (100 rad/h) inside the cell and 50 to 100 mGy/h (5 to 10 rad/h) at the cell door necessitated extensive decontamination before the window and a broken hoist could be moved. Contamination inside the cell was mainly due to ^{90}Sr. After decontamination efforts and the use of local shielding consisting of plywood and lead sheets, the working background was reduced from 5 mGy/h to 20 mGy/h (500 mrad/h to 2 rad/h). Approximately 60 Plant and Equipment people worked inside the cell during this operation. Close surveillance monitoring by Health Physics personnel succeeded in keeping dose equivalents to all those involved within permissible limits.

5.1.7 Oak Ridge Research Reactor, Building 3042

Radiation and Safety Surveys personnel assisted in the insertion and removal of several experiments at the Oak Ridge Research Reactor Facility during 1980. One such experiment, the Pressure Vessel Simulator, is of some importance to the reactor safety program and is being conducted at the request of the Nuclear Regulatory Commission. The primary objective of the experiment is an improvement in the accuracy of predicting the remaining safe operating lifetime for light water pressure vessels currently in use. Reactor pressure vessel specimens will be irradiated in a controlled environment for a two-year period, after which radiation damage and changes in material properties will be analyzed and the effects assessed. During the insertion and removal of experiments such as this, personnel exposures were maintained at a small fraction of permissible limits, and contamination was successfully confined to established zoned areas.

5.1.8 Decommissioning of ^{60}Co Source, Building 4501, Room 206

A ^{60}Co irradiation unit ($\sim$ 11 tera Bq [297 Ci]) was taken out of service and removed from Room 206 in preparation for its transfer to an off-site location. After all service lines were stripped from the outside of the unit, the source capsule was drawn up into the movable shield. A modified lead plug was then inserted in the cavity below the capsule, secured in place, and the unit was transferred to a storage area by ORNL riggers.

Health Physics surveillance was provided for all phases of the operation and none of the personnel involved in the source manipulation received total doses in excess of 0.2 mSv (20 mrem).

5.1.9 Changing of Glove Box Windows, Building 4508, Room 136

Industrial Safety and Applied Health Physics personnel provided radiation monitoring assistance during the changing of nine windows on five metallography glove boxes in the Ceramic Fuels Alpha Laboratory, Room 136, Building 4508.

The boxes were grossly contaminated on the inside, principally with uranium and plutonium isotopes. Prior to the windows being removed, the insides of the glove boxes were decontaminated and some equipment was removed through the bag-out ports. Repeated efforts in cleaning the boxes resulted in the contamination levels being reduced to $\sim$ 20,000 d/m (paper towel smear). Two coats of Amercoat 33 were then applied to prevent the spread of contamination as windows were being removed.

Plastic work rooms were built around each window for removal of old glass and replacement of new. New gasket material was used at all glass-to-box sealing surfaces. Protective clothing, including respiratory protection, was worn by all personnel involved in the operation. The old windows were placed in individual plywood boxes and transported to the solid waste storage area.

The entire operation was completed without significant spread of contamination or personnel exposure exceeding daily limits.

5.1.10 Transuranium Research Laboratory (TRL), Building 5505

The TRL Industrial Safety and Applied Health Physics staff continued to provide protective technical support to experimental programs involving the investigation of physical and chemical properties of transuranium elements. This activity included working directly with individual researchers in designing appropriate containment enclosures and procedures, assembling and disassembling apparatus, conducting various experiments, decontamination, and the disposal of radioactive wastes. In addition, they continued to function as building operators in charge of all aspects of the TRL ventilation and containment system. Also, two members of the staff assigned to this facility functioned as the Chemistry Division's RCO/DSO and alternate.

5.1.11 Holifield Heavy Ion Facility, Building 6000

Surveys were conducted during initial testing phases of the Heavy Ion Facility in order to determine the location and magnitude of potential radiation hazards. Preliminary calibration checks were also made on the γ-n detectors which comprise a portion of the permissive entry interlock system.

5.1.12 Target Replacement, Oak Ridge Electron Linear Accelerator, Building 6010

Continuous health physics surveillance was provided during the replacement of a highly activated ORELA tantalum target. External exposures to personnel were kept at acceptable levels as a result of close adherence to as-low-as-reasonably-achievable (ALARA) principles.

5.1.13 Building 6025

The 300 KV MFE Deuteron Accelerator was dismantled and relocated in Building 6010. Health physics coverage was present throughout the move in order to ensure the containment of ^3H contamination and minimize the attendant risk of internal deposition.

5.1.14 Nuclear Safety Pilot Plant Operations, Building 7500

The Nuclear Safety Pilot Plant conducted several experiments in which uranium metal was converted to UO_2 by burning in order to simulate fuel aerosol particles which might be generated in the unlikely event of an accident involving the fuel in fast reactors. Sampling studies were made of the resultant fallout and particle deposition on the bottom and sides of the model containment vessel. Sodium metal burning experiments were also conducted in the same vessel. Radiation and conventional safety assistance was provided during these experiments which transpired without incident.

5.1.15 DOSAR Facility, Buildings 7709 and 7710

Radiation hazard surveillance and technological assistance were provided for the research efforts at this unique facility where an unshielded reactor is used in dosimetry development and the study of biological effects of nuclear radiations. Two dosimetry intercomparisons, both international in scope, were conducted during the year. One was related to personnel dosimetry, the other to nuclear accident dosimetry. The program to improve reactor material security systems continued but at a considerably reduced rate. The DOSAR reactor was also used to irradiate Threshold Detector Units in a study for the Industrial Safety and Applied Health Physics Division.

5.1.16 High Flux Isotope Reactor (HFIR), Building 7900

A new facility devoted to basic research on nuclei was installed and began operations at the HFIR. This is the Small Angle Neutron Scattering (SANS) Facility and has both national and international participants involved in the research programs. Consultation and surveillance services were provided by Radiation and Safety Surveys personnel during the construction phase in regard to the need for shielding, as well as work area zoning requirements.

In addition, intensive surveillance was provided during routine reactor operations such as the loading and transfer of spent fuel elements, removal of experiments, and the handling of various highly radioactive sources. Reactor shutdown activities included the repair of some primary heat exchangers, the replacement of drive rods and rod seals, as well as various other operations in the reactor pool tank. These required especially close surveillance and stringent controls due to the high levels of radiation and contamination involved.

5.1.17 Chemical Technology Operations, Building 7920

A new charcoal filter "back-up" system was installed in a pit south of the TRU building. Radiation and Safety Surveys personnel were closely involved in both the planning and the installation of the systems tie-in with the existing hot off-gas line.

Further application of the ALARA concept was carried out with the installation of an elaborate, efficient neutron and gamma shield for the glove box in Room 111. This should result in reduced personnel dose to those routinely working at this glove box. Improvements were also made in waste handling and partitioning to further reduce unnecessary exposure of personnel. Diligent planning and surveillance attention was provided during operations, such as the repair of highly contaminated equipment and the preparation of intensel radioactive sources for shipment.

5.1.18 Modification to 86" Cyclotron, Building 9201-2

Radiation and Safety Surveys personnel provided input to the plans for modification of the Operations Division's 86" Cyclotron. The "upgrade," if implemented as planned, has among other objectives the reduction of radiation exposures sustained by operating personnel bringing them more in line with the ALARA philosophy. Preparatory work, prior to the modifications, will result in modest exposures to maintenance personnel since it involves the removal of the activated dees and liner.

5.1.19 Tank Farm Operation

Close surveillance was provided for contractor (Rust) personnel during excavation work and installation of equipment in conjunction with the Guinte Tank Sludge Removal Project. This project, which will continue for several more months, will result in the transfer of highly contaminated sludge from the tank farm area to newly constructed storage tanks in Melton Valley.

5.2 X Ray and Microwave Safety Programs

5.2.1 X Ray Program

Routine surveys were made on approximately 15 x-ray units. Leakage on all units was within acceptable limits. Safety systems were also checked and found to meet ORNL standards. Two units, however, lacked the requisite fail-safe lights and measures were initiated to bring these units into compliance.

5.2.2 Microwave Program

Five new microwave cooking ovens were checked for microwave leakage and interlock integrity. Appoximately 30 routine surveys were made on other units. Leakage on all ovens was within federal limits and no interlock failures were detected.

5.3 Laundry Monitoring Facility

Approximately 570,000 articles of wearing apparel and 214,000 articles such as mops, laundry bags, towels, etc., were monitored at the laundry during 1980. Appoximately five percent were found contaminated. Of 440,566 khaki garments monitored during the year, only 64 were found contaminated.

A total of 4,525 full-face respirators and 5,296 canisters were monitored during the year. Of these, 118 masks and 254 canisters required further decontamination after the first cleaning cycle.

5.4 Radiation Incidents

The term "radiation incident" is applied to classify an unexpected and undesirable operational occurrence involving radiation or radioactive materials and is further defined in Procedure 2.6 of the ORNL Health Physics Procedure Manual. There were five such occurrences in 1980. All were of minor significance.

6.0 INDUSTRIAL SAFETY AND SPECIAL PROJECTS

Industrial Safety and Special Projects is responsible for developing and implementing accident prevention and loss management programs within the Laboratory. The staff of safety professionals provides consultation and assistance in industrial safety matters. The staff also participates in inspection and evaluation programs to assess the level of safety in various ORNL activities. The staff participates in a variety of safety-related activities, including developing safety policies and procedures; reviewing engineering drawings for safety content; and providing safety orientation and specialized safety education programs. They maintain a library of DOE-prescribed safety standards, safety reference material, and audio-visual aids. The Industrial Safety and Special Projects Section also provides Laboratory-wide on- and off-the-job safety promotion activities. The staff is involved in investigating, analyzing, classifying, and documenting injuries and accidental property losses. The safety staff also provides support to Construction Engineering in carrying out the construction safety program.

During 1980 the Laboratory completed the sixth consecutive year in which the goals set by UCC-ND Management for prevention of injuries were met or improved upon. Two disabling injuries or lost workday cases occurred during the year.

For the sixth straight year, the Laboratory earned the highest award of the National Safety Council. We also earned DOE's Award of Excellence and the Award of Honor.

6.1 ORNL Safety Program Activities - 1980

6.1.1 Achievements

1. National Safety Council's "Award of Honor."
2. Union Carbide Corporation's "Distinguished Safety Award."
3. Qualified for DOE's "Award of Excellence" for 1980.

6.1.2 Action Plans

1. Industrial Safety and Applied Health Physics' Action Plan developed for CY 1981.
2. ORNL's Safety Action Plan developed for CY 1981.
3. All Laboratory Divisions given instructions and required to submit Divisional Safety Action Plans for CY 1981.

6.1.3 Promotional Efforts

1. Central Safety Committee continued to meet monthly. Committee organized in October 1978.
2. Fifteen safety films purchased for visual aid library.

3. Pictures and slides prepared on all RIIs. Location of RIIs identified on area map.
4. Approximately 5000 ice scrapers with safety slogan distributed to personnel on request.
5. Personal Appointment Record Calendars with safety slogans distributed to personnel on request.
6. Large desk memo calendars with safety message available from stores.
7. Distribution of magazines and pamphlets concerning on- and off-the-job safety material.
8. Plant-wide distribution of safety bulletins on subjects of general interest.
9. Five new procedures added to the safety manual and five procedures revised.
10. Amount of safety award value accumulated per employee during 1980 was $13.50.

6.1.4 Training

1. Continuation of defensive driving course. The number of employees completing the course in 1980 was 219. Appoximately 55% of the Laboratory's employees have completed the course.
2. The Supervisors' Development Program, a twelve-hour safety training course for supervisors, was obtained from the National Safety Council. During 1980, forty-one Plant and Equipment foremen completed the course and received certificates after passing the required examination.

6.1.5 Audits and Appraisals

1. Formal quarterly safety appraisals were conducted for each Laboratory division by the Industrial Safety staff.
2. The Laboratory received 1980 safety audits from:
   a. Union Carbide Corporation - Nuclear Division appraisal team.
   b. DOE - Laboratory operations.
   c. DOE - Construction.

6.1.6 OSHA

1. A resurvey was made of ORNL and ORNL facilities at Y-12, aimed at bringing the Laboratory in compliance with OSHA standards. Modifications were made in a Conceptual Design Report submitted in 1976, as well as looking for additional items that might have been overlooked previously.
2. Work Orders issued and records kept on OSHA expenditures of appoximately $130,000 during 1980.

6.1.7 Listing of Industrial Safety Department Representatives for Laboratory Divisions

Location 4500S

A. D. Warden (4-6677)

Computer Sciences
Employee Relations
Finance & Materials*
Operations
Solid State

D. C. Gary (4-6678)

Analytical Chemistry
Chemistry*
Health
Health & Safety Research
Plant & Equipment

R. E. Millspaugh (4-6680)

Chemical Technology
Environmental Sciences
Instrumentation & Controls*
Metals & Ceramics
Physics*

L. L. Huey (6-6792)

Energy*
Industrial Safety & AHP*
Information*
Laboratory Protection*
Quality Assurance & Inspection*

T. J. Burnett (4-6683)

Engineering
Engineering Physics*

*New Assignments - 1/1/81

6.2 Accident Analysis

The injury statistics for ORNL for the period 1971-1980 are shown in Table 6.1.1. Included with this table are the formulas for determining lost workday statistics as contained in ANSI Z16.4-1977.

The disabling injury history or lost workday cases for the past five years is shown in Table 6.1.2; and the disabling injury frequency rate since the inception of Union Carbide's contract as compared with NSC, DOE, and UCC is shown in Table 6.1.3.

Twelve ORNL divisions did not have a recordable injury or illness in 1980. Injury statistics by division are shown in Table 6.1.4.

Disabling injury accident-free periods for ORNL are shown in Table 6.1.5. From May 11, 1980, through December 31, 1980, the Laboratory accumulated over 5 million workhours without a disabling injury.

Table 6.1.6, Figure 6.1.1, and Table 6.1.7 present ORNL injury data as to type, part of body injured, and nature of injury.

A tabulation of the injuries for the four UCC-ND facilities is shown in Table 6.1.8.

Statistics on motor vehicle accidents, fires, and off-the-job injuries are shown in Tables 6.1.9, 6.1.10, and 6.1.11. There was a significant decrease in the number of vehicle accidents during 1980, from 17 in 1979 to 6 in 1980. The decrease in the accident rate was accomplished through a major emphasis being directed to the problem by management and the cooperation of all laboratory employees.

The number of off-the-job injuries reported for 1980 was 63. The number reported in 1979 was 72. Constant effort is being applied by the Safety Department and by all levels of Laboratory management in seeking ways to improve this important phase of the safety program. The two off-the-job fatalities that occurred during the year were the result of a two-car vehicle accident.

6.3 Summary of Disabling Injuries

The following are summaries of two disabling injuries experienced at ORNL in 1980.

Date of Injury - April 16, 1980

A power equipment operator slipped and fell to the ground while stepping down from an excavator. He sustained a fractured vertebrae. Time loss: 80 days.

Date of Injury - May 10, 1980

An engineer, assigned to ORNL, was walking across a recently waxed floor in Building 9204-1 (Y-12) when he slipped and fell, fracturing his left kneecap. Time loss: 67 days.

6.4 Safety Awards

Each Laboratory employee at the X-10 site and on the payroll as of December 31, 1980, earned a $13.50 safety award.

6.5 Long Range Plans for Industrial Safety

Industrial Safety has the responsibility for assisting management in the formulation and direction of the Laboratory's Safety Program and to help develop and maintain a high level of safety awareness among all Laboratory employees, through a program consistent with UCC-ND and UCC safety policies.

In order to fulfill these objectives, the safety staff assists the management line organization and Laboratory personnel in all areas relating to personnel safety and accident prevention. A principal function is to aid Laboratory division representatives in the development of action plans to adequately serve their safety requirements. Included in the action plans are the routine activities normally associated with a successful safety program, i.e., (1) conducting safety meetings and safety inspections; (2) investigating, analyzing, and reporting on all accidents and near misses; (3) formulation and issuance of policies, guides, procedures, and standards; (4) providing education and training services; (6) conducting periodic safety performance appraisals; (7) seeking to improve off-the-job safety performance; and (8) preparing records and reports.

Future action plans within the section include seeking ways to help reduce the number of off-the-job injuries. Off-the-job injuries result in huge monetary loss to the Laboratory, as well as cause pain to the injured. Effort will continue to be made to obtain the best safety material possible (visual aids and written material), as well as discussion of subjects in safety meetings.

Presentation of education and training programs by members of the Safety staff has always been recognized as an important part of the safety effort at the Laboratory. Defensive driving, hazard potential recognition, supervisor development program, and orientation for new hires are some of the programs now underway. Future plans call for continuing these programs and adding others as changes in the Laboratory's major activities may dictate. Also, the safety staff will continue to attend approved outside training courses and seminars that will assure their keeping up to date on modern techniques in the field of safety.

During each of the past five years, the Laboratory has achieved the highest safety award honors that the Union Carbide Corporation and the National Safety Council can bestow. As of January 1, 1980, Union Carbide Corporation has revised the safety award program, making it much more difficult to achieve the top award. (At the present plant population figure, this would mean working approximately two years without a disabling injury.) Achieving this top honor, however, rates as a future challenge for the Industrial Safety Section and all Laboratory personnel.

Table 6.1.1 ORNL Injury Statistics (1971-1980)

	Disabling Injuries (DI)			Lost Workday Cases (LWC)		Recordable Injuries and Illnesses (RII)	
	Number	Frequency Rate[a]	Severity Rate[b]	LWCIR	LWIR	Number	Incidence Rate[c]
1971	4	0.61	298	-	-	38	5.8
1972	7	1.08	52	-	-	49	7.6
1973	2	0.33	24	-	-	35	5.8
1974	5	0.81	51	-	-	30	4.9
1975	2	0.27	24	-	-	82	2.25*
1976	1	0.13	14	-	-	51	1.33
1977	1	0.12	9	-	-	64	1.60
1978	3	0.36	7	0.07	1.30**	59	1.40
1979	3	0.36	8	0.07	1.64	44	1.05
1980	2	0.23	17	0.05	3.45	41	0.96

*Since 1975 the serious injury frequency rate has been based on OSHA system for recording injuries & illnesses.

**Starting with 1978 annual report, the lost workday cases incidence rate (LWCIR) and the lost workday incidence rate (LWIR) is being based on the OSHA system ANSI (Z16.4-1977) for measuring lost workday experience:

$$\text{LWCIR} = \frac{\text{No. of Cases Involving Days Away from Work}}{\text{Exposure of Employee-hours}}$$

$$\text{LWIR} = \frac{\text{Total Lost Workdays or Days Charged X 200,000}}{\text{Exposure or Employee-hours}}$$

[a] $\text{Frequency Rate for DIs} = \frac{\text{Number of Cases with Days Lost or Charged X 1,000,000}}{\text{Employee-hours}}$

[b] $\text{Severity Rate} = \frac{\text{Total Number of Days Lost or Charged X 1,000,000}}{\text{Employee-hours}}$

[c] Incidence Rate for RIIs (1975 and later) $= \frac{\text{Number of RIIs X 200,000}}{\text{Employee-hours}}$

Table 6.1.2 Lost Workday History - ORNL (1976-1980) [a]

	1976	1977	1978	1979	1980
Number of Injuries	1	1	1	3	2
Labor Hours (Millions)	7.6	8.0	8.4	8.4	8.5
Incidence Rate	0.03	0.02	0.07	0.07	0.05
Days Lost or Charged	106	70	55	69	147
Severity Rate	2.8	1.8	1.30	1.64	3.45

[a] Cases involving days away from work.

Table 6.1.3 ORNL Disabling Injury Frequency Rates or Lost Workday Cases Incidence Rate (see Table 6.1.1) Since Inception of Carbide Contract Compared with Rates for NSC, DOE and UCC

Year	ORNL	NSC	DOE	UCC
1949	1.54	10.14	5.35	4.91
1950	1.56	9.30	4.70	4.57
1951	2.09	9.06	3.75	4.61
1952	1.39	8.40	2.70	4.37
1953	1.43	7.44	3.20	3.61
1954	0.79	7.22	2.75	3.02
1955	0.59	6.96	2.10	2.60
1956	0.55	6.38	2.70	2.27
1957	1.05	6.27	1.95	2.41
1958	1.00	6.17	2.20	2.21
1959	1.44	6.47	2.15	2.16
1960	0.94	6.04	1.80	1.92
1961	1.55	5.99	2.05	2.03
1962	1.45	6.19	2.00	2.28
1963	1.55	6.12	1.60	2.10
1964	1.07	6.45	2.05	2.20
1965	2.34	6.53	1.80	2.40
1966	0.64	6.91	1.75	2.57
1967	0.50	7.22	1.55	2.06
1968	0.13	7.35	1.27	2.24
1969	0.27	8.08	1.52	2.49
1970	0.76	8.87	1.28	2.27
1971	0.61	9.37	1.44	2.05
1972	1.08	10.17	1.40	1.73
1973	0.33	10.55	1.45	1.50
1974	0.81	10.20	1.60	0.99
1975	0.27	13.10	2.50	0.61
1976	0.13	10.87	1.04	0.86
1977	0.12	8.07	1.10	0.67
1978	0.07*	2.56	1.20	0.75
1979	0.07	2.67	1.10	0.03[a]
1980	0.05	----	1.10	0.04

[a] Starting with 1978 for ORNL and 1979 for UCC, the OSHA system (ANSI Z16.4-1977) is being used for measuring lost workday experience. This means that rates are now calculated on the basis of 200,000 employee-hours rather than 1,000,000 employee-hours.

Table 6.1.4 Injury Statistics by Division - 1980

Division	Medical Reports Received	Recordable Injuries and Illnesses		Disabling Injuries Lost Workday Cases (LWC)			Exposure Hours (In Millions)
		Number	Incidence	Number	Frequency (LWCIR)	Severity (LWIR)	
Analytical Chemistry	14	2	1.68				.238
Chemistry	6	2	2.06				.195
Central Management	0	0	0				.131
Computer Sciences	3	0	0				.467
Chemical Technology	18	1	0.31				.646
Engineering	6	1	0.45	1	0.45	30.3	.442
Energy	6	0	0				.270
Engineering Physics	3	0	0				.142
Employee Relations	7	0	0				.183
Environmental Sciences	3	1	0.61				.326
Finance & Materials	17	3	1.74				.345
Health	3	0	0				.069
H & S Research	4	0	0				.248
Information	9	0	0				.539
Instr. and Controls	27	1	0.45				.448
Ind. Safety & AHP	6	0	0				.186
Laboratory Protection	20	2	2.23				.179
Metals & Ceramics	18	3	1.10				.543
Operations	34	3	1.14				.527
Physics	2	0	0				.209
Plant & Equipment	180	22	2.32	1	0.11	8.42	1.899
QA & Inspection	2	0	0				.067
Solid State	3	0	0				.212
PLANT TOTAL	393	41	0.96	2	0.05	3.45	8.511

Table 6.1.5 Disabling Injury Accident (Lost Workday Case) Free Periods - ORNL (1972-1980)

Accident-Free Period	Employee-Hours Accumulated
December 12, 1972 - April 25, 1973	2,327,051
April 27, 1973 - July 29, 1973	1,428,975
July 31, 1973 - January 15, 1974	2,760,549
January 17, 1974 - May 6, 1974	1,869,338
May 8, 1974 - June 15, 1974	661,399
June 17, 1974 - August 11, 1974	926,437
August 13, 1974 - December 5, 1974	2,010,547
December 7, 1974 - April 6, 1975	2,570,944
April 8, 1975 - November 10, 1975	4,543,462
November 12, 1975 - September 15, 1976	6,375,994
September 17, 1976 - April 24, 1977	4,588,847
April 26, 1977 - January 14, 1978	5,830,521
January 16, 1978 - September 26, 1978	6,041,210
September 27, 1978 - March 23, 1979	3,826,579
March 26, 1979 - September 14, 1979	4,007,810
September 17, 1979 - October 24, 1979	1,096,371
May 10, 1980 - December 31, 1980	5,405,407
Best Accident-Free Period	
July 4, 1968 - August 20, 1969	8,529,750

Table 6.1.6 Number and Percent of Accidents by Type - 1980

Type of Accident	Number	Percent
Struck Against	142	36.2
Struck By	92	23.7
Slip, Twist	51	12.9
Caught In, On, Between	33	8.4
Contact with Temp. Extremes	13	3.3
Fall, Same Level	39	9.9
Inhalation, Absp., Ingestion	7	1.8
Fall, Different Level	5	1.3
Other	10	2.5
TOTAL	393	100.0

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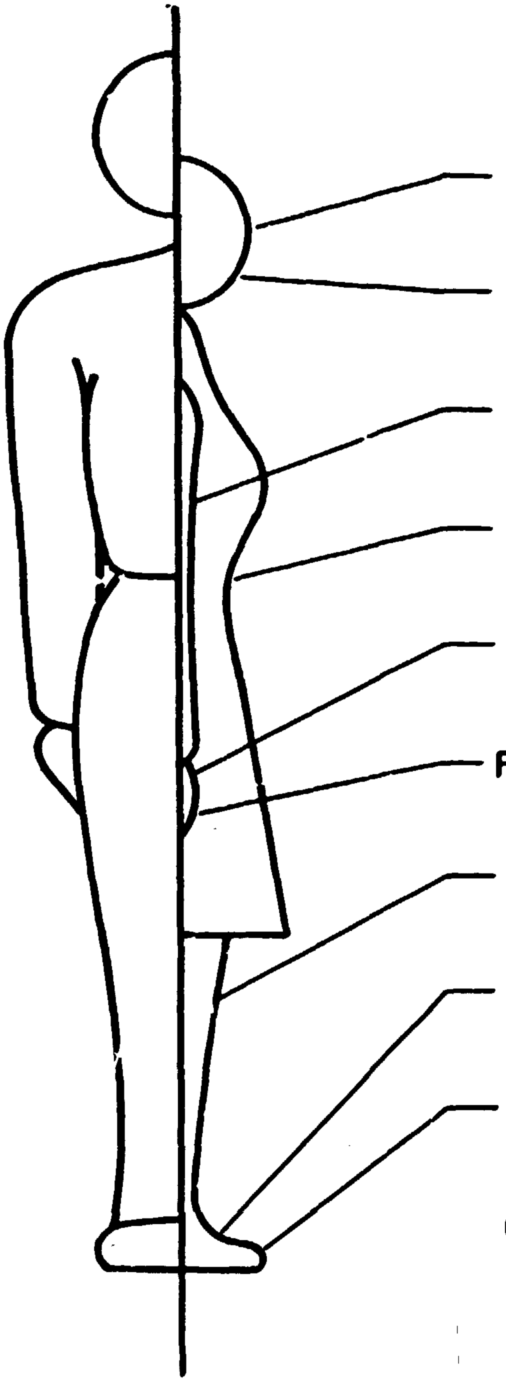

BODY AREA	%	TOTAL INJURIES
EYES	7.6	30
HEAD	11.5	45
ARMS	9.9	39
TRUNK	2.0	8
HANDS	9.9	39
FINGERS	26.0	102
LEGS	10.7	42
FEET	8.7	34
TOES	1.2	5
GENERAL	12.5	49

Fig. 6.1.1 Part of Body Injured

Table 6.1.7 Number and Percent of Accidents by Nature of Injury - 1980

Nature of Injury	Number	Percent
Laceration, Puncture	144	36.6
Contusion, Abrasion	96	24.4
Strain	53	13.5
Burn, Temperature	26	6.6
Sprain	24	6.1
Conjunctivitis	26	6.6
Burn, Chemical	12	3.1
Other	12	3.1
TOTAL	393	100.0

Table 6.1.8 Tabulation of Injuries by UCC-ND Facility - 1980

Plant	Labor Hours (Millions)	Lost Workday Cases[a]				Recordable Injuries and Illnesses	
		Number of Injuries	Incidence Rate (LWCIR)	Days Lost or Charged	Severity Rate (LWIR)	Number of Injuries[b]	Incidence Rate
ORNL	8.5	2	0.05	147	3.45	41	0.96
ORGDP	11.3	2	0.04	348	6.18	55	0.96
Y-12	12.8	1	0.02	52	0.81	80	1.25
Paducah	3.7	2	0.11	180	9.68	25	1.34

[a] Starting with 1978 annual report the OSHA system (ANSI Z16.4-1977) is being used for measuring lost workday experience.

[b] Includes the number of Lost Workday Cases.

Table 6.1.9 Motor Vehicle Accidents (1976-1980)

Year	Number	Frequency Rate [a]	Damage
1976	14	6.42	$5,136
1977	12	5.05	$8,488
1978	29	13.49	$9,009
1979	17	8.39	$4,612
1980	6	3.31	$3,570

[a] $\text{Frequency} = \frac{\text{No. of Motor Vehicle Accidents} \times 1{,}000{,}000}{\text{No. of Miles Driven}}$

Table 6.1.10 Number of Fires (1976-1980)

Year	Number	Damage
1976	0	$ 0
1977	0	$ 0
1978	2	$16,095
1979	0	$ 0
1980	0	$ 0

Table 6.1.11 Number and Type of Off-The-Job Disabling Injuries (1976-1980)

	1976	1977	1978	1979	1980
Transportation	20	11	22	16	18
Home	17	11	28	34	24
Public	9	12	21	22	21
Total	46	34	71	72	63
Days Lost	1,251	765	1,055	1,499	992
Frequency Rate[a]	2.91	1.98	3.95	4.00	3.44
Fatalities	5	0	0	1	2

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[a] $$\text{Frequency} = \frac{\text{No. of Off-the-Job Disabling Injuries x 1,000,000}}{\text{Exposure Hours**}}$$

**Exposure Hours = 312 Hours/Employee Month.

7.0 OFFICE OF OPERATIONAL SAFETY

The Office of Operational Safety serves as the focal point for the operational safety activities (including reactor and criticality safety) of ORNL and provides liaison between ORNL, the UCC-ND Health, Safety, and Environmental Affairs Office, and the Department of Energy (DOE-ORO) on operational safety matters. A primary responsibility of the office is coordinating and monitoring the activities of the Division Safety Officers and Radiation Control Officers and the Laboratory Director's Review Committees, and ensuring follow-up of Committee recommendations. The staff of the office also participates in a wide variety of operational safety matters, including development of safety policies, procedures, practices, and guidelines for various Laboratory operations. Through review and approval functions, the office provides management assurance that Laboratory safety requirements are included in the design, modification, and construction of facilities and that all facilities are operated safely in accordance with ORNL and DOE requirements. The director of the office serves as the Laboratory's safety documentation and review coordinator in accordance with Standard Practice Procedure D-5-29. In fulfilling this responsibility, the director and office staff provide coordination, direction, and approval of safety documentation to assure compliance with Laboratory and DOE requirements. The office additionally provides coordination of safety activities in the decontamination and decommissioning program to assure that all environmental, safety and health physics concerns are included.

7.1 Laboratory Director's Review Committees

The Office of Operational Safety continued to coordinate the activities of the ORNL's Director's Review Committees during 1980. The Laboratory has eight standing committees whose work is coordinated by the OOS. These committees are responsible for review and recommendations for operations wherein significant or unique hazards exist.

In the coordinating role, the OOS is responsible for scheduling committee reviews, participating in reviews as ex-officio members of the committee, finalizing reports documenting the reviews, and seeing that recommendations formulated as a result of the reviews are either implemented or resolved in a manner satisfactory to management. The 1980 activities of the various review committees are shown in Table 7.1.1.

The OOS continued the practice started in 1979 of having each committee hold an annual meeting with Clyde C. Hopkins to discuss their work for the year and to raise any issues or concerns not covered in formal committee reports.

7.2 Implementation of DOE Manual Chapter 0531 and DOE Order 5481.1 Requirements

Enactment of DOE Manual Chapter 0531, "Safety of Nonreactor Nuclear Facilities," and subsequently DOE Order 5481.1, "Safety Analysis and Review System," significantly impacted on the documentation requirements of facilities identified as "nonreactor" nuclear facilities. This manual chapter and order specify requirements of S's (Safety Assessments), PSARs (Preliminary Safety Analysis Reports), FSARs (Final Safety Analysis Reports), and OSRs (Operating Safety Requirements) for all such facilities. (PSARs are required for new or major modified facilities only.) It is required that these documents be developed in sequence with various stages of completion of a facility or project so that upon completion of construction or commencement of a project, the documentation requirements are also completed. It also requires that documentation supporting the safe operation of existing facilities be produced or revised to conform to specific requirements and format.

DOE Order 5481.1 expands safety documentation requirements to operations having hazards of a type and magnitude not routinely encountered and/or accepted by the public.

While there were a limited number of new facilities or projects requiring such documentation, there are numerous existing nonreactor nuclear facilities which have not completed development of the required documents. Initially (during 1978) there were 33 existing facilities which were identified as being in this category. During 1979 a schedule of implementation of the MC 0531 document requirements for these existing facilities (modified to include 28 facilities) was developed and was shown in Table 7.2.1 in ORNL 5663. An updated schedule is shown in Table 7.2.1. The schedule will be revised as necessary to include any additional facilities which require safety documentation in accordance with Order 5481.1.

During 1980 safety analysis documentation continued on the 7920 TRU Facility; 3019 Pilot Plant and 3100 Vault; a site generic document; Solid Waste Storage Facility; the Tritium Target Facility, 7205, and the 5505 TRL Facility with scheduled completion dates for Safety Analysis Reports and Operating Safety Requirements revised to accommodate completion in mid 1981. The Intermediate Level Waste Operating Safety Requirements document was completed and final drafts of FSARs for the Building 3027 Vault and Holified Heavy Ion Research Facility were submitted to DOE for approval.

7.3 RCO-DSO Activities

Operating and research divisions at the Laboratory have appointed Radiation Control and Division Safety Officers who are responsible for coordinating radiation safety and other safety matters, respectively with the divisions they represent. Shown in Table 7.3.1 is a list of RCOs and DSOs and the divisions they represent.

The OOS conducts quarterly meetings for the purpose of disseminating information of interest and importance to the safety officers. During 1980 the meetings were conducted on January 22, April 15, July 23, and October 14. The meetings are documented in ORNL/CF-80/39, ORNL/CF-80/86, ORNL/CF-80/261, and ORNL/CF-80/344. The OOS also reviews and comments on safety analysis reports, project safety summaries, safety inspections, and reports of accidents submitted by the safety officers. It also reviews operations for recommendation and approval; the requirements of which are not specifically covered in manuals.

7.4 Staff Consultation, Review, and Other Activities

In order to assure continuance of and promote safety in operation of Laboratory facilities, the OOS engages in activities in addition to those previously described.

The staff engaged in numerous consultations with members of operating facility staffs and performed reviews and audits of both routine and requested operations and facilities. Numerous requests were received for approval of proposed experiments or operations, including disposal of radioactive wastes, handling and processing special radioactive materials, and transportation of nuclear materials.

Other staff activities included participating in all accident or "near miss" investigations and assisting or observing emergency drill performance. The staff also participates in and develops procedures for the Health Physics and Safety Manuals. Charters for the Director's Electrical Safety and Transportation Committees were completed.

Assistance was given to several groups in the design and procurement of glove boxes. Additionally, the staff assisted in the review of decontamination and decommissioning criteria, determination of appropriate site boundaries for safety analysis documentation, proposed Laboratory facility siting, and seismic and wind criteria for the ORNL area.

Considerable staff effort was required in particpating in and answering questions raised as a result of review of the HFIR by DOE's Nuclear Facility Personnel Qualification and Training Committee (Crawford Committee).

As part of the responsibility for providing liaison between management and DOE on safety matters, many meetings were held with DOE safety staff. These included participation in the following:

DOE Occupational Safety and Health Program Audit - April 8

DOE Industrial and Construction Safety Audit - July 21-25

DOE Nuclear and Criticality and Transportation Safety Audit - September 15-22

Crawford Committee (NFPQT) - October 20-24

DOE Environmental Management Appraisal - October 21-23

DOE Annual Health Physics Appraisal - December 1-12

DOE Appraisal of ORNL Emergency Preparedness Program - July 29-31

DOE Reactor Safety Appraisal (not complete)

DOE Nulcear Facility Safety Appraisal (MC 0531) - March 3-7

OOS responsibilites in audits also include ensuring follow-up of audit recommendations and providing implementation progress reports when required.

The office also participated in the UCC-ND Safety and Health Audit.

7.5 Summary

During 1980 there were no facility or nuclear reactor accidents or incidents of an operational nature which resulted in injury to personnel or which were reportable to DOE.

The OOS continued to review and ensure review of operations and facilities by appropriate Director's Committees to assure management of continued safe operation of all Laboratory facilities. Work continued on implementation of MC 0531 and DOE Order 5481.1 by allocation of funds and revision of schedules and programs for completion of safety analysis reports for existing facilities. A greater effort in the development of criteria for decontamination and decommissioning continued.

Table 7.1.1 Summary of Meetings Held in 1980 by Laboratory Director's Review Committees

Date	Subject	ORNL Report No.
	Radioactive Operations Committee	
2/25	Review of Isotopes Research Materials Laboratory, Building 3038 East End	CF 80/50
3/17	Review of Chemical Technology Alpha Isolation Laboratory Building 3508	CF 80/93
3/26	Building 3027 Vault SAR	---
4/22	Review of High Level Radiochemical Laboratory, Building 4501	CF 80/92
5/30	Review of ORNL Transuranium Research Laboratory, Building 5505	CF 80/219
6/3	US/UK Higher Actinide Experiment	Internal Memo
6/25	Review of Buildings 3028 and 3029	CF 80/282
7/17	Completed Review of ILW System	---
7/29	Review of Building 3026-C, Thermal Diffusion Enrichment Facility	CF 80/283
7/29	Review of Dismantling and Examination Hot Cells-Building 3026-D	CF 80/284
8/28	Radioactive Operations Committee Review of Building 3019-A	CF 80/285
10/8	Review of TRU Facility - Building 7920	CF 80/317
10/21	Annual Meeting with C. C. Hopkins	---
11/20	Review Radioisotope Development Laboratory, Building 3027	CF 80/360
11/24	FSAR for Buildings 3019 and 3100	---

Table 7.1.1 Summary of Meetings Held in 1980 by Laboratory Director's Review Committees

Date	Subject	ORNL Report No.
	Accelerators and Radiation Sources Review Committee	
1/31 2/7-8 5/14	Review SAR for Heavy Ion Facility	---
3/4	Review J. L. Shepherd & Associates ^{60}Co Irradiation in BG-71, Building 4501	CF 80/75
6/12	Review of Source Group C	CF 80-245
9/24	Review ORELA in Building 6010	CF 80/312
10/16	Annual meeting with C. C. Hopkins	---
	Reactor Operations Review Committee	
1/24, 31 & 5/22	1979 Annual Review of HFIR	CF 80/218
1/24, 1/31	1979 Annual Review of TSF	---
2/26	Finalize 1979 Reports on TSF, ORR, HPRR, BSR	HPRR CF 80/20 ORR CF 80/51 TSF CF 80/52
3/20 4/16	1979 Annual Review of BSF	CF 80/52
3/25 4/2	Special meeting to discuss hypothetical cooling system failure at ORR	---
6/10	Quarterly Meeting	---
10/29	Quarterly Meeting	---
10/29	Annual meeting with C. C. Hopkins	---

Table 7.1.1. Summary of Meetings Held in 1980 by Laboratory Director's Review Committees

Date	Subject	ORNL Report No.
	Electrical Safety Committee	
7/29	Electrical Safety of Purchased Items Ground Fault Interrupter Seminar planning Committee Charter	---
7/29	ORIC Electrical Safety Review	CF 80/361
7/31	Ground Fault Interrupter Seminar	---
7/31	Electrical Safety Review of Health and Safety Research Division	CF 80/343
10/13	Annual meeting with C. C. Hopkins	---
October	Review Solid State Division Activities in Isotope Materials Research Laboratory	Internal Memo
	Transportation Committee	
7/19	Annual meeting with C. C. Hopkins	---
	Criticality Committee	
Nov.-Dec.	1980 Criticality Audit of ORNL	To be written
10/17	Annual meeting with C. C. Hopkins	---

As in past years, the majority of operations of the committee were executed by the Committee Chairman through the Office of Operational Safety. Numerous NSRs were granted extensions in cases where operations are continuing and five new NSRs were processed.

Table 7.1.1 Summary of Meetings Held in 1980 by Laboratory Director's Review Committees

Date	Subject	ORNL Report No.
	Reactor Experiments Review Committee	
1/8 3/19-24	TRIGA-LEU Experiment in ORR	Approved in Memo from G. H. Jenks to C. C. Hopkins January 8, 1980
2/28	Periodic Review of HSST BSR Experiment	---
4/10	ORR Poolside Facility (PVS)	Memo Jenks to Hopkins 4/15/80
4/24	HFED-1-D2 Experiment in ORR	Memo Jenks to Hopkins May 15 & 27, 1980
5/8 5/26	ORR Experiment MFE 4	Memo Jenks to Hopkins 6/10/80
7/11	Gamma Thermometer Experiment in ORR	Memo Jenks to Hopkins 7/31/80
7/15	HFED Experiment in ORR	Memo Jenks to Hopkins 7/16/80
9/18	MFE^3 Experiment in ORR (Preliminary Review)	Not Complete
7/10 10/2	MFE^5 Experiment in ORR	Memo Jenks to Hopkins 10/14/80
10/9	Annual meeting with C. C. Hopkins	---

Table 7.1.1 Summary of Meetings Held in 1980 by Laboratory Director's Review Committees

Date	Subject	ORNL Report No.
	High Pressure Equipment Review Committee	
3/21 4/9	Gold-Cell Hydrothermal Equipment F-255, Building 4500S	Internal memo 5/16/80
4/9	High Pressure, High Temperature System BG-72, 4501	Internal memo 5/16/80
5/22	Autoclave Installation, Building 3592	---
6/12 7/25	High Pressure Experiment on Alpha-Uranium, HFIR	Internal memo 7/28/80
8/1	New Hydrofracture Project	Internal memo 8/5/80
9/10	High Pressure, High Temperature System BG-72, 4501	Internal memo 9/10/80
10/12	High Pressure, High Temperature System BG-72, 4501	---
12/2	Annual meeting with C. C. Hopkins	---

The Committee reported they conducted 15 other inspections of high pressure equipment at ORNL during 1980

Table 7.2.1 Implementation Schedule and Cost for Compliance With DOE Manual Chapter 0531, Safety of Nonreactor Nuclear Facilities (Safety Analysis Reports, SARs; and Operations Safety Requirements, OSRs)

Facility	Bldg.	Cost (SAR/OSR)
FY 1980		
Transuranium Processing Plant	7920	$ 37,000
Radiochemical Processing Pilot Plant	3019	37,000
Transuranium Research Laboratory	5505	55,000
Tritium Target Facility	7025	28,000
Site Generic Document		37,000
Solid Waste Storage		55,000
	Total	$ 250,000
FY 1981*		
Transuranium Processing Plant	7920	30,000
Radiochemical Processing Pilot Plant	3019	20,000
Transuranium Research Laboratory	5505	20,000
Tritium Target Facility	7025	30,300
Site Generic Document		10,000
Solid Waste Storage		20,000
Electromagnetic Separation of Heavy Elements (86" Cyclotron)	9204-3	30,000
High Level Analytical Laboratory	2026	60,600
Radiation Gas Handling - Operations	3033W	30,300
Alpha Isolation Laboratory	3508	60,600
Room 136 - Ceramic Fuels Alpha Technology	4508	60,600
	Total	$ 352,000
FY 1982		
Alpha Handling Facility	3038	$ 64,150
Radioisotope Development Lab	3047	64,150
Alpha Isolation Labs	3508	64,150
Gaseous Waste	3039	64,150
Electromagnetic Separation of Heavy Elements	9204-3	64,150
	Total	$ 320,750
FY 1983		
High Radiation Level Examination Lab	3525	$ 69,300
Radioisotope Packaging	3038M	69,300
Radioisotopes Lab	3038	69,300
Thorium-Uranium Recycle Facility	7930	69,300
	Total	$ 277,200
FY 1984		
Radioisotope Production Development Lab	3028	$ 74,830
Segmenting Cells	30260	74,830
Source Development Lab	3029	74,830
Low Level Alpha Facility	4501	74,830
Isotopes Research Materials Lab	3033	74,830
	Total	$374,200
FY 1985		
^{85}Kr Enrichment	3026	$ 80,810
Fission Production Development Lab	3517	80,810
Hot Cells	3025	80,810
Rolling Mill	3012	80,810
Machine Shop	3044	80,810
	Total	$404,000
	TOTAL	$1,978,150

*Includes documentation begun in FY 1980

Table 7.3.1 Radiation Control Officers and Division Safety Officers

Division	DSO	RCO
Analytical Chemistry	G. R. Wilson	G. R. Wilson
Biology	D. G. Doherty	D. G. Doherty
Chemical Technology	J. B. Ruch	J. B. Ruch
Chemistry	C. E. Haynes	C. E. Haynes
Computer Sciences	N. A. Betz	N. A. Betz
Central Management	G. C. Cain	G. C. Cain
Employee Relations	J. A. Holloway, Jr.	
Energy	R. C. DeVault	R. C. DeVault
Engineering	H. D. MacNary	H. D. MacNary
Engineering Technology	C. A. Mills	A. W. Longest
Engineering Physics	G. T. Chapman	G. T. Chapman
Environmental Sciences	M. H. Shanks	M. H. Shanks
Finance & Materials	G. E. Testerman	
Fusion Energy	R. S. Edwards	R. S. Edwards
Health Division	J. A. Ealy	J. A. Ealy
Health & Safety Research	J. P. Judish	J. P. Judish
Industrial Safety & Appl. Health Physics	D. C. Gary	D. M. Davis
Information	E. J. Howard, Sr.	
Instrumentation & Controls	R. A. Crowell	M. M. Chiles
Laboratory Protection	R. L. Atchley	H. C. Austin
Metals & Ceramics	W. H. Miller, Jr.	W. H. Miller, Jr.
MIT School of Engr. Practice	K. J. Fallon	K. J. Fallon
Operations	J. R. Gissel	J. R. Gissel
Physics	R. L. Auble	R. L. Auble
Plant & Equipment	R. H. Winget	R. H. Winget
Quality Assurance & Inspection	J. L. Holbrook	J. L. Holbrook
Solid State	J. A. Setaro	J. A. Setaro

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T. W. Oakes, K. E. Shank, J. A. Auxier, J. S. Eldridge, P. Jenkins, G. L. Love, S. G. Oberg, V. Panesko, B. Selby, W. D. Travers, W. R. Strodl, Environmental Radiological Surveillance: Mechanisms for Information Exchange " *Upgrading Environmental Radiation Data*, EPA 520/1-80-012 (August 1980).

J. S. Eldridge, B. Balba, T. W. Oakes, and D. W. Parsons, "Use of Bio-Indicators for Environmental Surveillance," *Analytical Chemistry Division Summary Report*, ORNL/CF-80/286 (September 1980).

K. E. Shank and T. W. Oakes, "Environmental Surveillance and Evaluation," *Industrial Safety and Applied Health Physics Annual Report for 1979*, ORNL-5543 (September 1980).

F. F. Haywood, D. G. Jacobs, H. M. Hubbard, Jr., B. S. Ellis and W. H. Shinpaugh, *Radiological Survey of the Inactive Uranium-Mill Tailings at Gunnison, Colorado*, ORNL-5453 (1980).

F. F. Haywood, W. A. Goldsmith, B. S. Ellis, H. M. Hubbard, Jr., W. F. Fox and W. H. Shinpaugh, *Assessment of the Radiological Impact of the Inactive Uranium-Mill Tailings at Mexican Hat, Utah*, ORNL-5448 (1980).

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F. F. Haywood, T. D. Jones, H. M. Hubbard, Jr., B. S. Ellis and W. H. Shinpaugh, *Radiological Survey of the Inactive Uranium-Mill Tailings at Tuba City, Arizona*, ORNL-5450 (1980).

K. E. Shank, T. W. Oakes, J. S. Eldridge and M. A. Montford, *Quality Assurance Procedures for Environmental Surveillance Activities at Oak Ridge National Laboratory*, ORNL/TM-7213 (1980).

F. S. Tsakeres, K. E. Shank, M. Y. Chaudhry, S. A. Ahmad, P. M. Dizillo-Benoit and T. W. Oakes, *Radiological Assessment of Residences in the Oak Ridge Area*, ORNL/TM-7392/V-1 (October 1980).

L. C. Henley, W. W. Parkinson, Jr. and C. W. Nestor, Jr., "Urinary Excretion of Curium by Two Cases Sustaining a Subcutaneous Intake of $Cm(NO_3)_3$," *Health Phys.* 39, pp. 977-980, (December 1980).

C. S. Sims and H. W. Dickson, "Health Physics Research Reactor Spectrum Measurements with Threshold Detector Units," *Health Phys.* 38, 76 (1980).

P. T. Perdue, H. W. Dickson, and F. F. Haywood, "Radon Monitoring Instrumentation," *Health Phys.* 39, 85 (1980).

PRESENTATIONS

J. A. Auxier, "Low-Level Effects of Radiation on Humans," Vanderbilt University, Nashville, Tennesse, March 5, 1980.

J. A. Auxier, "Health Effects of Low-Level Radiation," 1980 UCC-ND and Goodyear Atomic Corporation Waste Management Seminar, April 22, 1980.

J. A. Auxier, "The Accident at Three Mile Island," Twenty-fifth Annual Meeting, Health Physics Society, Seattle, Washington, July 25, 1980.

J. A. Auxier, "Occupational Exposure: Expected Health Effects," 1980 Scientific Assembly of the Medical Society of the District of Columbia, White Sulphur Springs, West Virginia, October 25, 1980.

J. A. Auxier, "Low-Level Effects of Radiation: Model Based Upon Ichiban (Japanese) Data," Fall Meeting of Bluegrass Chapter, Health Physics Society, Louisville, Kentucky, November 14, 1980.

J. T. Blackmon and W. J. Huffman, "The Design of Fire Safe Buildings," presented at the Fall Conference of National Fire Protection Association, Phoenix, Arizona, November 1980.

J. T. Blackmon, "Impact of Regulations on Fire Protection Engineering and Design," KD/5077, presented to the Society of Fire Protection Engineers, WATTAC Conference, Knoxville, Tennessee, February 20, 1980.

J. T. Blackmon, "The Changing Requirements of Safety/Health Education in Industry," KD/5075, presented to the Council of Safety and Health Educators, Nashville, Tennessee, March 1, 1980.

H. W. Dickson, "Planning for Decommissioning Action," U.S. Department of Energy Decommissioning Criteria Workshop, Kansas City, Missouri, April 15-16, 1980 as an invited paper.

E. L. Keller and W. A. Goldsmith, "Proposed Relationship Between FUSRAP Radiological Monitoring and Certification Contractors," U.S. Department of Energy Decommissioning Critera Workshop, Kansas City, Missouri, April 15-16, 1980 (presented by H. W. Dickson).

H. W. Dickson and C. S. Sims, "Adequacy of Personnel Dosimetry in Mixed Neutron and Gamma Radiation Fields," 25th Annual Meeting of the Health Physics Society, Seattle, Washington, July 20-25, 1980.

H. W. Dickson, "Contingency Planning at Multipurpose Nuclear Facilities," Meeting of North Carolina Chapter Health Physics Society, Boone, North Carolina, October 10, 1980.

B. M. Eisenhower and E. E. Ketchen, "Introduction to the Hazardous Materials Management and Control Program at ORNL," presented to the following ORNL Divisions during 1980: Chemical Technology, Chemistry, Engineering, Engineering Physics, Finance and Materials, Information, Operations, Physics, and Plant and Equipment.

J. S. Eldridge and T. W. Oakes, "Radionuclide Transport in a Liquid Waste System," presented at the 179th National ACS Meeting, Houston, Texas, March 23-28, 1980.

J. S. Eldridge, T. W. Oakes, and K. E. Shank, "Radionuclide Concentrations in White-Tailed Deer on the Department of Energy's Oak Ridge Reservation," presented at the Health Physics Society Annual Meeting, Seattle, Washington, July 20-25, 1980

E. S. Hougland, T. W. Oakes, and K. E. Shank, "Design of the Sulfur Dioxide and Particulate Air Monitoring Network for the ORNL Steam Plant," presented at the 1980 UCC-ND and GAT Waste Management Seminar, Friendship, Ohio, April 22-23, 1980.

E. S. Hougland, T. W. Oakes, and K. E. Shank, "The Use of an Idoine-131 Data Base for Model Validation in the Design of the ORNL Steam Plant Air Quality Monitor Network," presented at the Symposium on Intermediate Range Atmospheric Transport Processes and Technology Assessment, Gatlinburg, Tennessee, October 1-3, 1980.

M. A. Montford, K. E. Shank, C. Hendricks, and T. W. Oakes, "Concentration of Radionuclides and Stable Elements in Food Products," presented at the 14th Annual Conference on Trace Substances in Environmental Health, University of Missouri, Columbia, Missouri, June 3-6, 1980.

T. W. Oakes and B. A. Kelly, "Environmental Regulations - Past, Present, and Future," presented at the 1980 UCC-ND and GAT Waste Management Seminar, Friendship, Ohio, April 22-23, 1980.

T. W. Oakes, J. C. Bird, K. E. Shank, B. A. Kelly, L. L. Harrison, B. R. Clark, and F. Rogers, "Waste Oil Management at ORNL," presented at the 1980 UCC-ND and GAT Waste Management Seminar, Friendship, Ohio, April 22-23, 1980.

T. W. Oakes, K. E. Shank, J. S. Eldridge, D. W. Parsons, J. L. Malone, and H. M. Hubbard, "Distribution of Radionuclides in White Oak Creek and Lake Sediment," presented at the Health Physics Society Annual Meeting, Seattle, Washington, July 20-25, 1980.

T. W. Oakes, "Analytical Requirements to Meet Environmental Regulations," presented at the 24th Conference on Analytical Chemistry in Energy Technology, Gatlinburg, Tennessee, October 7-9, 1980.

T. W. Oakes, "Needs for Better ^{99}TC Analysis for Environmental Samples," presented at the 24th Conference on Analytical Chemistry in Energy Technology, Gatlinburg, Tennessee, October 7-9, 1980.

T. W. Oakes, "Filtration in Environmental Protection," presented at the Dixie Chapter of the Filtration Society, Atlanta, Georgia, October 1980.

K. E. Shank, T. W. Oakes, and J. S. Eldridge. "Quality Assurance Applied to Environmental Surveillance," presented at the 1980 UCC-ND and GAT Waste Management Seminar, Friendship, Ohio, April 22-23, 1980.

K. E. Shank, T. W. Oakes, J. C. Bird, and F. S. Tsakeres, "An Assessment of Aquatic Data at Oak Ridge National Laboratory," presented at the Health Physics Society Annual Meeting, Seattle, Washington, July 20-25, 1980.

D. O. Stroud, J. R. Jones, M. E. Mitchell, T. W. Oakes, M. Sanders, and M. B. Tate, "Waste Oil Disposal at the DOE-Oak Ridge Plants," presented at the 1980 UCC-ND and GAT Waste Management Seminar, Friendship, Ohio, April 22-23, 1980

LECTURES

J. A. Auxier

"Health Physics Challenges," ORAU-NRC Health Physics and Radiation Protection Training Course, February 1980.

"Low-Level Effects of Radiation on Humans," University of Tennessee, Knoxville, Tennessee, April 1980.

"The Effects of Low-Level Radiation," Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee, June 1980.

"Nuclear Power and Public Concern," ORAU Traveling Lecture, Bethel College, North Newton, Kansas, November 1980.

"Hiroshima to Three-Mile Island: Where Do We Go From Here," Wright H. Langham Memorial Lecture, University of Kentucky, Lexington, Kentucky, November 1980.

C. D. Berger

"ORNL Participation in Knoxville Academy of Medicine Mass Casualty Simulation," IS&AHP Division Seminar, January 1980.

"Health Physics and Dosimetry at TMI," ORAU Medical and Health Sciences Division Seminar, ORAU, April 1980.

"The Role of a Whole Body Counter in a Post-Reactor Accident Situation," Health Physics Society Annual Meeting, Seattle, Washington, July 1980.

"What's So Good About the ORNL Whole Body Counter," IS&AHP Division Seminar, December 1980.

"Operational Status of ORNL Whole Body Counter Instrumentation: Comparisons Between a Hyperpure Germanium Array and a Phoswich Detector," LASL/DOE Instrumentation Workshop for Low-Level Transuranic Measurements Applied in In-Vivo and Environmental Monitoring, March 1980.

G. H. Burger

"Presentation of ORNL Supplement to Standard Practice Procedure D-5-29 - Safety Review and Documentation Program," presented to an ad-hoc committee established to assist in preparation and review of the proposed SPP Supplement, November 1980.

H. W. Dickson

"Criticality Dosimetry,' ORAU, Health Physics in Radiation Accidents Seminar, January 1980.

"Risk from Nuclear Power," Powell High School Senior Science Class, Powell, Tennessee, March 1980.

"Neutron Activation Foils," ORAU, Health Physics and Radiation Protection Course, April 1980.

"Basis for Decommissioning Criteria," University of Tennesee, Knoxville, Radiation Biology Seminar, May 1980.

"Reactors," ORAU, Applied Health Physics Course, June 1980.

"Mammary Tumorogenesis in the Sprague Dawley Rat," University of Tennessee, Comparative Animal Research Laboratory, August 1980.

"Criticality and Associated Dose Estimates," ORAU REAC/TS Training Course: Health Physics in Radiation Accidents, September 1980.

"Decommissioning of Nuclear Facilities - The Health Physics Role," Luncheon Seminar Series, IS&AHP Division, November 1980.

"Principles of Reactors," ORAU, Applied Health Physics Course, November 1980.

C. E. Haynes

"Transuranium Health Physics," ORAU-NRC Health Physics and Radiation Protection Course, April 1980.

"ORNL Radiation Safety Practices," "Radioactivity Decontamination at ORNL," and "Emergency Drill Involving Radioactive Material," ORAU, Radiation Safety Training Program for Chemical Technology Division personnel, September 1980.

C. H. Miller

"Protective Clothing," ORAU-NRC Health Physics and Radiation Protection Course, March 1980.

T. W. Oakes

"Environmental Surveillance," Chattanooga State Technical Community College, February 1980.

"Environmental Monitoring," REAC/TS Training Course, Medical Planning and Care in Radiation Accidents, ORAU, March 1980.

"Environmental Problems," Junior Science and Humanities Symposium, Oak Ridge National Laboratory, March 1980.

"Environmental Problems," Middle Tennessee State University, March 1980.

"Water Sampling: Spot Samples," ORAU-NRC Health Physics and Radiation Protection Course, April 1980.

"Water Sampling: Continuous Samples," ORAU-NRC Health Physics and Radiation Protection Course, April 1980.

"White Oak Lake and Dam: A Review and Status Report - 1979," IS&AHP Luncheon Seminar, February 1980.

"Environmental Monitoring," REAC/TS Training Course on Medical Planning and Care in Radiation Accidents, ORAU, March 1980.

"Water Sampling," ORAU, Applied Health Physics Course, June 1980.

"ORNL Environmental Activities of Interest to ADBES Divisions," Oak Ridge National Laboratory, June 1980.

"Problems with Implementing ORNL Hazardous Materials Program," Joint Meeting UCC-ND Environmental Monitoring and Protection Committee and GAT Environmental Control Representatives, Y-12 Plant, Oak Ridge, Tennessee, August 1980.

"Disposal of Potentially Explosive Materials," Joint Meeting UCC-ND Environmental Monitoring and Protection Committee and GAT Environmental Control Representatives, Y-12 Plant, Oak Ridge, Tennessee, August 1980.

"ORNL Committee for the Establishment of Environmental Guidelines for Radioactive Waste Disposal," UCC-ND Workshop on Radioactive Waste Criteria for Engineering Planning and Design, Oak Ridge National Laboratory, August 1980.

"Potential Impact of Environmental Regulations on Teaching and Research Chemical Laboratories," Wake Forest University, October 1980.

"Natural Radioactivity," Physics Department, Clemson University, October 1980.

"Environmental Monitoring," ORAU, Oak Ridge, Tennessee, November 1980.

"Environmental Protection Surveillance and Nuclear Power Plants," Department of Entomology, VPI&SU, Blacksburg, VA, December 1980.

TRAINING COURSES

Presented

C. D. Berger

"Bioassay and Whole Body Counting," NRRPT Certification Course, ORAU, April 1980.

"Radiation Release and Health Effects Lessons from the TMI Incident--Assessment of Objective Risks for Emergency Preparedness Planning," Kentucky Special Advisory Committee on Nuclear Issues, Northern Kentucky University, Highland Heights, Kentucky, November 1980.

"Health Physics and Radiation Accidents," and "Bioassay," REAC/TS Training Course, ORAU, September 1980.

"Laboratory Assessment of Body Burden," REAC/TS Training Course, ORAU, November 1980.

"Whole Body Counting," Applied Health Physics Course, ORAU, November 1980.

"Health Physics and Dosimetry at Three-Mile Island," CARL, March 1980.

J. R. Muir

"Personnel Monitoring," NRRPT Certification Course, ORAU, March 1980.

Attended

H. M. Butler

Refresher courses for continuing education credit presented by the Health Physics Society, Annual Meeting, Seattle, Washington, July 1980.

G. H. Burger

Three-day seminar "The Effective Manager," sponsored by ORNL and presented by the University of Tennessee, November 1980.

T. J. Burnett

"Mobile Crane and Rigging Fundamentals," Oak Ridge, Tennessee, March 1980.

"Supervisors Development Program," ORNL, April 1980.

M. F. Fair

"Supervisors Development Program," ORNL, April 1980.

"Jr. Science and Humanities Symposium, State of Tennesse, ORNL, May 1980.

D. C. Gary

"Supervisors Development Program," ORNL, April 1980.

"Accident Investigation Refresher Course (MORT), Lake Buena Vista, Florida, September 1980.

M. W. Knazovich

"UCMS Principles and Practices, ORNL, May 1980.

R. E. Millspaugh

Taught "Supervisors Development Program,"ORNL, April 1980.

"National Safety Congress," Chicago, Illinois, October 1980.

A. D. Warden

"Supervisors Development Program," ORNL, April 1980.

PROFESSIONAL ACTIVITIES AND ASSOCIATIONS

J. A. Auxier

Consultant to Radiation Effects Research Foundation, Japan; Member of Dose Assessment Steering Group, U.S. Department of Energy; Advisor to U.S. Department of Justice on Health Physics and Radiation Dosimetry; Member of National Academy of Sciences Panel on Hiroshima/Nagasaki Occupation Forces; Member of Subcommittee on Exposure at Tests of Nuclear Weapons, National Academy of Science; Member of Subcommittee on Radiation Research National Institute of Health; Member, National Council on Radiation Protection and Measurements; Member, Awards Committee, Health Physics Society; Member, Ad Hoc Committee on Scientific and Public Issues, Health Physics Society; Member, NCRP Scientific Committee 34 on Maximum Permissible Concentrations for Occupational and Non-Occupational Exposure, NCRP Scientific Committee 57 on Internal Emitter Standards, NCRP Scientific Committee 63 on Radiation Exposure Control in Peacetime and Wartime; Delivered Eighth Wright H. Langham Memorial Lecture, University of Kentucky; Received Meritorious Public Service Medal, Defense Nuclear Agency.

C. D. Berger

Participation and Critique, Knoxville Academy of Medicine Mass Casualty Simulation, Knoxville, Tennessee; Member Health Physics Society.

G. H. Burger

Member of Instrument Society of America and American Association for the Advancement of Science.

H. M. Butler

President, East Tennessee Chapter HPS: Member Advisory Committee on Nuclear Technology, Chattanooga State Community College; Member, Admissions Committee, Health Physics Society.

D. T. Dice

Attended ANS Committee 15.14 on Physical Security of Research Reactors, Chicago, May 1980.

H. W. Dickson

Member, Health Physics Society, International Radiation Protection Association; Member, East Tennesse Chapter HPS; Member, HPS Standards Committee.

J. R. Muir

Member, Health Physics Society, Rules Committee.

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