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OAK RIDGE NATIONAL LABORATORY

MARTIN MARIETTA

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INDUSTRIAL SAFETY AND APPLIED HEALTH PHYSICS ANNUAL REPORT FOR 1979

J. A. Auxier, Director

D. M. Davis, Associate Director

Date Published: September 1980

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 describes and summarizes the activities of the Industrial Safety and Applied Health Physics Division. Information in this report was contributed by, and/or compiled by the following staff members of the Industrial Safety and Applied Health Physics Division.

Radiation Monitoring

E. D. Gupton

Environmental Surveillance and Evaluation

K. E. Shank
T. W. Oakes

Radiation and Safety Surveys

R. L. Clark

Industrial Safety and Special Projects

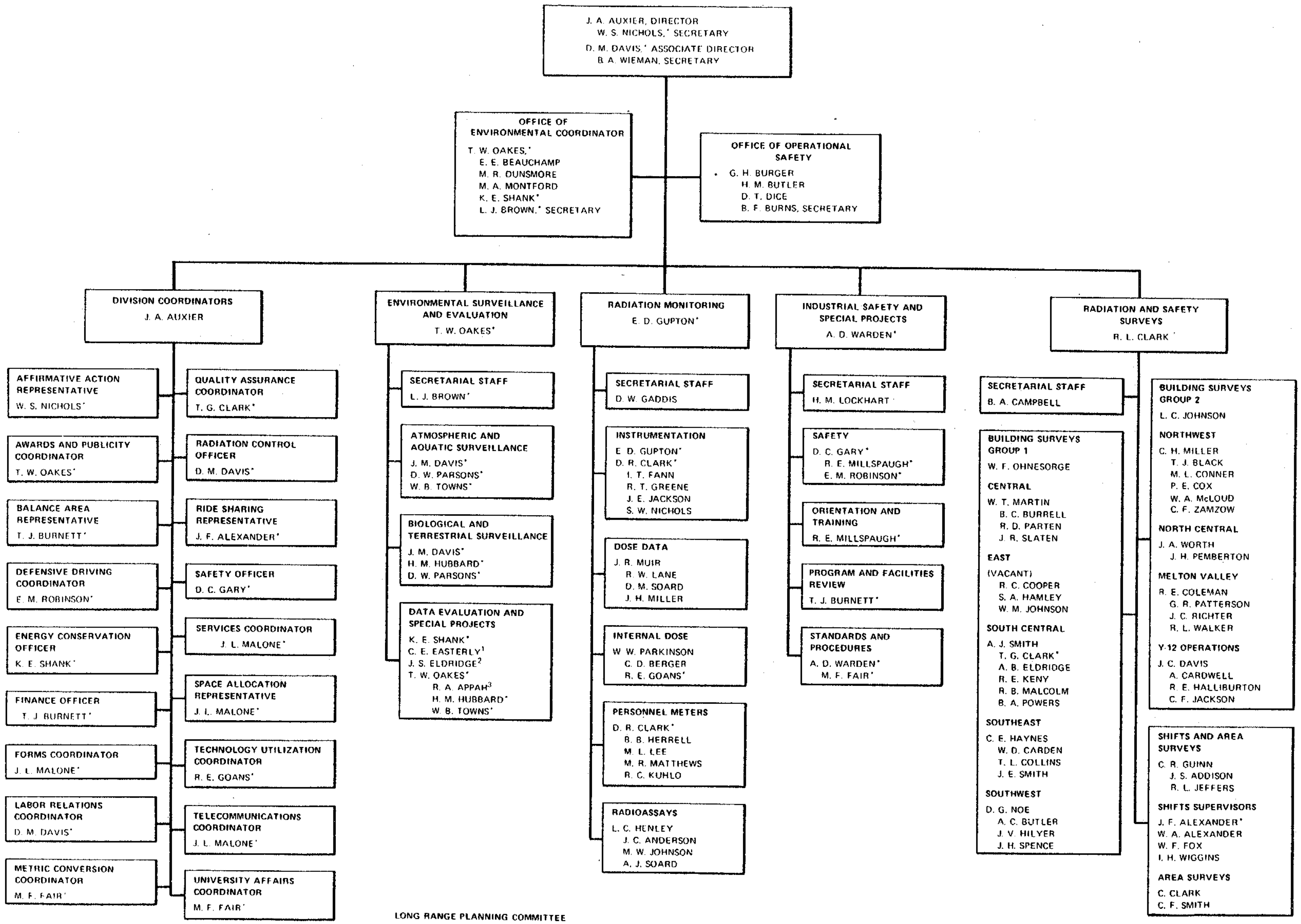
A. D. Warden

Office of Operational Safety

G. H. Burger

INDUSTRIAL SAFETY AND APPLIED HEALTH PHYSICS DIVISION

JANUARY 1, 1979



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D. T. DICE
R. E. GOANS
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K. E. SHANK

*DUAL CAPACITY
[1]HEALTH AND SAFETY RESEARCH DIVISION
[2]ANALYTICAL CHEMISTRY DIVISION
[3]IAEA FELLOW

2.0 SUMMARY

Radiation Quantities and Units

The four radiation quantities (and units) used in this report are: exposure (roentgen), absorbed dose (rad), dose equivalent (rem), 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 55 employees received whole body dose equivalents of one rem or greater. The highest whole body dose equivalent to an employee was 2.8 rem. The highest internal exposure was less than one-half of a maximum permissible dose for any calendar quarter.

Health Physics Instrumentation

During 1979, 57 portable instruments were added to the inventory and 75 retired. The total number in service on January 1, 1979, was 977. There were 5 facility radiation monitoring instruments installed and 7 retired during 1979. The total number in service on January 1, 1980, was 1,021.

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 incident 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 0.20 percent of the concentration guide.

Radiation Background Measurements

The average background level at the PAM stations during 1979 was 9.2 μR/hr, or 84 mR/yr.

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 0.01 pCi/g to 0.06 pCi/g, and the Uranium-235 content ranged from 0.01 pCi/g to 0.05 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 0.001 pCi/g to 0.010 pCi/g, and the Uranium-235 content ranged from 0.001 pCi/g to 0.010 pCi/g.

RADIATION AND SAFETY SURVEYS

Laboratory Operations Monitoring

During 1979, 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

Two radiation incidents involving radioactive materials were recorded during 1979. This compares with 14 incidents which occurred in 1978.

Laundry Monitoring

Of the 595,000 articles of wearing apparel and 209,000 articles, such as mops, laundry bags, towels, etc., monitored during 1979 about five percent were found to be contaminated.

INDUSTRIAL SAFETY AND SPECIAL PROJECTS

Accident Analysis

Three lost workday cases occurred at ORNL in 1979, an incidence rate of 0.07. The Recordable Injury and Illness frequency rate for 1979 was 1.05. The frequency rate for 1978 was 1.40.

Summary of Lost Workday Cases

A total of 69 days were lost or charged for the three lost workday cases in 1979. The days lost or charged in 1978 were 55 for three lost workday cases and 70 in 1977 for one lost workday case.

Safety Awards

The National Safety Council Award of Honor and the Union Carbide Corporation Award of Distinguished Safety Performance were earned by the Laboratory in 1979. This is the fifth consecutive year the Laboratory has earned these awards.

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, 1979

(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 2.8 rem or 56 percent of the applicable standard (5 rem). The range of doses to persons using ORNL badge-meters is shown in Table 3.1.1, page 9.

As of December 31, 1979, 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, page 9. No employee has an average annual dose that exceeds five rem per year of employment, Table 3.1.3, page 9. The greatest cumulative whole body dose received by an employee was approximately 111 rem. This was accrued over an employment period of about 35 years and represents an average of about 3.1 rem per year.

The greatest cumulative dose to the skin of the whole body received by an employee during 1979 was about 3.6 rem or 24 percent of the applicable standard (15 rem).

The maximum cumulative hand dose recorded during 1979 was about 12 rem or 16 percent of the applicable standard (75 rem).

The average of the 10 greatest whole body doses to ORNL employees for each of the years 1975 through 1979 is shown in Table 3.1.4, page 10.

(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.

Two employees had elevated excretion levels of tritium due to intermittent exposures to ^{3}H in the course of their work. At no time did the excretion reach a level corresponding to an MPBB and the whole body doses for each calendar quarter were less than 25% of doses permissible.

3.1.2 External Dose Techniques

(a) Badge-Meters - Photobadge meters are issued to all employees and to nonemployees who are authorized to have frequent access to ORNL facilities. Temporary meters are issued to casual visitors.

All badge-meters are equipped with nuclear accident metering devices and beta-gamma sensitive films. Various complements of TLDs, are included in photobadge meters according to the potential for radiation exposure. NTA films are included in the badges of those who are likely to be exposed to fast neutrons.

Badge-meters of employees are exchanged and processed routinely each calendar quarter, or more frequently if required for exposure control. Meters issued to visitors are processed as may be required for monitoring purposes.

(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 20 mrad or more exists during the work shift. Pocket meter pairs are processed each day by Health Physics technicians. Readings of 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 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, page 11, are the quantities of personnel metering devices used and processed during 1979. 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 body burden averaged over a calendar year may be exceeded.

The analyses performed by the Industrial Safety and Applied Health Physics radiochemical lab during 1979 are summarized in Table 3.1.6, page 12.

(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 460 whole body, chest, wound, and thyroid counts were performed by the Whole Body Counter facility during the year 1979. Most of the subjects counted had ^{137}Cs in the range 37 to 500 Bq. Most, if not all, of that cesium is from fallout from weapons testing. Trace amounts of activation products, fission products and ^{60}Co were found in or on a few subjects. In many of these cases it was determined from follow-up studies that the contamination was external rather than internal. No subject had an internal depositon of radioactivity, determinable by the whole body counter, that averaged more than 25 percent of a maximum permissible organ burden 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, page 12.

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 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, page 13, lists portable instruments assigned at the end of 1979; Table 3.2.2, page 13, lists stationary instruments in use at the end of 1979.

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, page 14.

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 1979 is shown in Table 3.2.4, page 15.

3.3 Developments

3.3.1 Hyperpure Germanium Array for Lung Counting

The ORNL Whole Body Counter began lung counting with an 80 cm^2 solid state (hyperpure germanium) array in January 1979. Computer programs for analysis of lung burdens of ^{239}Pu and ^{241}Am were developed, and prediction equations were derived based on data obtained from 30 uncontaminated adult males. The system performs better than the state-of-the-art phoswich system due to its superior energy resolution and greater sensitivity for photons of energy less than 16 fJ (100 keV). In one instance, a subject lung burden of 11 Bq of ^{241}Am was assessed with the solid state array, whereas no activity of that kind was observable with a phoswich detector.

Experiments are underway for improving the capability for detecting ^{239}Pu and ^{241}Am and other transuranic alpha emitters with the germanium array.

A study is being done to find if there is correlation between the amount of ^{210}Pb found in lungs of subjects and their smoking of cigarettes. No positive correlation has been found to date, but the investigation is continuing.

3.3.2 Sample Counting Standards

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

3.3.3 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 - 1979

Group	Dose Range (Rem)							Total
	0-0.1	0.1-1	1-2	2-3	3-4	4-5	5 up	
ORNL Employees	5,909	404	46	9	0	0	0	6,368
ORNL-Monitored Non-Employees	88	22	5	0	0	0	0	115
TOTAL	5,997	426	51	9	0	0	0	6,483

Table 3.1.2 Average Rem Per Year Since Age 18 - 1979

Group	Dose Range							Total
	0-0.1	0.1-1	1-2	2-3	3-4	4-5	5 up	
ORNL Employees	5,631	699	31	7	0	0	0	6,368

Table 3.1.3 Average Rem Per Year of Employment at ORNL - 1979

Group	Dose Range							Total
	0-0.1	0.1-1	1-2	2-3	3-4	4-5	5 up	
ORNL Employees	5,335	934	88	5	6	0	0	6,368

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 (Rem)	The Highest Dose (Rem)
1975	2.41	2.71
1976	2.68	3.49
1977	2.84	3.62
1978	2.39	3.34
1979	2.24	2.80

Table 3.1.5 Personnel Meters Services

	1977	1978	1979
A. Pocket Meter Usage			
1. Number of Pairs Used			
ORNL	92,352	70,512	70,238
CPFF*	17,836	20,748	8,022
Total	110,188	91,260	78,260
2. Average Number of Users Per Quarter			
ORNL	1,200	678	679
CPFF	351	399	174
Total	1,551	1,077	853
B. Meters Processed for Monitoring Data			
1. Beta-Gamma Badge-Meter	27,860	30,630	30,520
2. Neutron Badge-Meter	800	710	800
3. Hand Meter	700	670	720

*Cost Plus Fixed Fee Contractors - Rust Engineering.

Table 3.1.6 Radiochemical Lab Analyses - 1979

Radionuclide	Urine	Feces	Milk	Water	Controls
Plutonium, Alpha	390	1		64	67
Plutonium-241	3				
Transplutonium Alpha	302	1		64	56
Uranium, Alpha	322	2			25
Strontium, Beta	224		490	20	43
Tritium	401			120	10
Iodine-131			490		52
Other	16				8
Totals	1,658	4	980	268	261

Table 3.1.7 Counting Facility Analyses - 1979

Types of Samples	Number of Samples		Unit Total
	Alpha	Beta	
Facility Monitoring			
Smears	25,805	27,255	53,060
Air Filters	14,419	13,270	27,689
Environs Monitoring			
Air Filters	3,110	3,110	6,220
Fallout		3,060	3,060
Rainwater		833	833
Surface Water		298	298

Table 3.2.1 Portable Instrument Inventory - 1979

Instrument Type	Instruments Added 1979	Instruments Retired 1979	In Service Jan. 1, 1980
G-M Survey Meter	43	42	309
Cutie Pie	5	23	317
Alpha Survey Meter	3	6	241
Neutron Survey Meter	6	3	101
Miscellaneous	0	1	9
TOTAL	57	75	977

Table 3.2.2 Inventory of Facility Radiation Monitoring Instruments for the Year - 1979

Instrument Type	Installed During 1979	Retired During 1979	Total Jan. 1, 1980
Air Monitor, Alpha	0	1	107
Air Monitor, Beta	2	0	161
Lab Monitor, Alpha	0	1	187
Lab Monitor, Beta	1	0	218
Monitron	0	3	204
Other	2	2	144
TOTAL	5	7	1,021

Table 3.2.3 Health Physics Facility Monitoring Instruments
Divisional Allocation - 1979

ORNL Division	α Air Monitor	β Air Monitor	α Lab Monitor	β Lab Monitor	Monitron	Other	Total
Analytical Chemistry	8	10	16	18	14	5	71
Chemical Technology	50	40	76	46	42	35	289
Chemistry	7	1	13	14	3	4	42
Metals and Ceramics	15	15	22	12	8	17	89
Operations	15	83	38	85	109	44	374
All Others	12	12	22	43	28	39	156
TOTAL	107	161	187	218	204	144	1,021

Table 3.2.4 Calibrations Facility Resume - 1979

Item	Number of Calibrations
Beta-Gamma Survey Meters	2,546
Neutron Survey Meters	317
Alpha Survey Meters	890
Personal Dosimeters	3,420
Badge Dosimetry Components	4,300

4.0 ENVIRONMENTAL MANAGEMENT PROGRAM

During CY 1979 the Environmental Management Program consisted of the Office of Environmental Coordinator and the Environmental Surveillance and Evaluation Section.

4.1 Environmental Surveillance and Evaluation Section

The Environmental Surveillance and Evaluation Section 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 eight stations located outside the DOE-controlled area at distances of 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, and (4) radioiodine using charcoal cartridges.

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 Center's Ferry 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, ^{90}Sr, ^{3}H, ^{137}Cs, ^{60}Co, ^{106}Ru, 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 Center's Ferry near Kingston, Tennessee (CRM 4.5). 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 eluent is analyzed for gross activity and for individual radionuclides that may be present in significant amounts.

A "grab" sample is collected daily at the Center's Ferry sampling station which is located on the Clinch River at CRM 4.5. 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 14 sampling stations located within a radius of 50 miles from ORNL. Samples are taken on a weekly basis from eight 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 six 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 0.5 pCi/liter and 0.45 pCi/liter, 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 1979 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 1979, were as follows:

Network	Concentration (μCi/cc)
LAM	2.1×10^{-15}
PAM	1.2×10^{-15}
RAM	0.9×10^{-15}

All networks are less than ten percent of 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 1979, were as follows:

Network	Concentration (μCi/cc)
LAM	4.4×10^{-14}
PAM	2.7×10^{-14}
RAM	2.4×10^{-14}

The LAM network value of 4.4×10^{-14} μCi/cc is less than 0.002 percent of the $MPCU_a$ based on occupational exposure of 3×10^{-9} μCi/cc. Both the PAM and RAM network values represent < 0.03 percent of the $MPCU_a$ of 1×10^{-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.

[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 $MPCU_a$.

4.3.2 Fallout (Gummed Paper Technique)

The average activity per square foot on gummed paper for the three air monitoring networks are 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 1979 was as follows:

Network	Concentration (μCi/ml)
LAM	0.8×10^{-8}
PAM	1.0×10^{-8}
RAM	1.4×10^{-8}

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 0.4×10^{-14} μCi/cc during 1979. This average represents < 0.005 percent of the maximum permissible concentration of 1×10^{-10} μCi/cc applicable to inhalation of ^{131}I released to uncontrolled areas. The maximum concentration observed for one week was 3.4×10^{-14} μCi/cc.

The average radioiodine concentration at the local stations was 2.1×10^{-14} μCi/cc. This concentration is < 0.001 percent of the maximum permissible concentration for inhalation by occupational personnel. The maximum concentration for one week was 14.8×10^{-14} μCi/cc.

Table 4.3.7 presents the ^{131}I weekly average concentration data for both the local area (LAM) and the perimeter area (PAM) 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, 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 ^{131}I and ^{90}Sr 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 liter per 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 1979, 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. Maximum permissible concentration values in water (MPC_w) are presented in Table 4.4.3.

The annual average percent MPC_w of beta emitters, other than tritium in the Clinch River, 1968 through 1979, 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 1979.

Trends in radionuclide discharges and MPC_w levels are presented in Figs. 4.4.1 through 4.4.3. Discharges of ^{90}Sr and ^{3}H 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.

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

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, 4.4.7, and 4.4.8. The average concentrations of all substances analyzed were in compliance with Tennessee guidelines. Table 4.4.8 is data collected during 1979 at the locations shown in Fig. 4.4.4. The National Pollutant Discharge Elimination System compliance on water quality is presented in Table 4.4.9.

4.4.2 Potable Water

The average quarterly concentrations of ^{90}Sr in potable water at ORNL during 1979 were as follows:

Quarter Number	Concentration of ^{90}Sr (μCi/ml)
1	155.0×10^{-11}
2	5.0×10^{-11}
3	5.0×10^{-11}
4	18.0×10^{-11}
Average for Year	46.0×10^{-11}

The average value of 46.0×10^{-11} represents < 0.2 percent 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 pCi/kg of wet weight (Table 4.4.10) 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 37 pounds. 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]

[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.

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. Twenty-three road-killed deer and one poacher-killed deer were analyzed during 1979 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 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

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[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 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 240 mrem/yr was calculated for this location assuming that an individual remained at this point for 24 hours/day for the entire year. The calculated maximum potential exposure is 48 percent 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 hours/yr. The calculated dose under these conditions was 6.6 mrem/yr which is 1.3 percent of the allowable standard and represents what is considered a probable upper limit of exposure.

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 2×10^4 liters/day. The calculated dose commitments at this location

[6]DOE Manual Chapter 0524.

were 5.1 ± 300% mrem to the lung (the critical organ) and 0.5 ± 300% mrem to the total body; uranium-234 is the important radionuclide contributing to this dose. These levels are 0.34 percent and 0.1 percent, 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 one liter of milk per day is 0.1 mrem to the thyroid and 7.3 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 16 miles downstream at Kingston, Tennessee. The intake to the water filtration plant is located on the Tennessee River approximately one-half mile upstream from the confluence of the Clinch and Tennessee Rivers. Normally, Tennessee River water is used for the Kingston water supply but under certain conditions of power generation, backflow can occur. Under backflow conditions, Clinch River water may move upstream in the Tennessee River and be used as the source of water for the Kingston filtration plant. It is estimated that these conditions would prevail a maximum of 20 percent of the time.

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 percent of the daily adult requirement (about two liters per day) is 2.3 mrem to the bone, and 0.05 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 37 pounds of fish per year from the Clinch River. The consumption of 37 pounds 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 4.4.10), the maximum organ dose commitment to an individual from the bluegill samples taken from CRM 20.8 is estimated to be 118 mrem to the bone from ^{90}Sr. The maximum total body dose to an individual was calculated to be 2.4 mrem. These doses are eight percent and 0.5 percent, 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 0.02 ± 300% mrem as compared to approximately 100 mrem from natural background radiation; the average dose commitment to the lung of an Oak Ridge resident was 0.4 ± 150% mrem. The maximum potential dose commitment to an Oak Ridge resident was calculated to be 5.1 ± 300% mrem to the lung. This calculated dose is 0.3 percent 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 1979 plant effluents was calculated to be 5.3 ± 300% 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 percent 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 of Other Major Activities of the Environmental Management Program

4.10.1 Environmental Protection Awareness Seminars

Over 100 seminars were given to 6,000 ORNL and UCC-ND general staff employees. The purpose of these seminars was intended to inform employees of new environmental regulations, the EPA and State enforcement of these regulations, and penalties for failure to comply.

4.10.2 Environmental Protection Manual

The ORNL Environmental Protection Manual was prepared to provide employees with procedures for assisting in protecting the environment and obeying environmental law with the least impact on the research programs at the Laboratory. At present the manual contains procedures on the following: (1) Asbestos, (2) Oils (Non-PCB), (3) Mercury, (4) PCBs, (5) Cooling Tower Sludge, and (6) Substantial Risk Notification Under the Toxic Substances Control Act. Procedures under review are: (1) Air Emission Permits, (2) Environmental Assessments, (3) Disposal of Unrequired or Excess Chemicals, and (4) Carcinogenic Materials. Procedures will be added as needed.

4.10.3 Waste Oil Investigation Committee

Repeated occurrences at ORNL of improper discharges of oil, resulted in the formation of the ORNL Waste Oil Investigation Committee on March 14, 1979. Memberss of the Committee are: T. W. Oakes (Chairman), Jo Brown (Secretary), W. C. Cox, G. J. Dixon, C. L. Fox, M. J. Hickey, J. R. Jones, J. B. Ruch, K. E. Shank, H. M. Shearin, and K. W. Tidwell. Advisors to the Committee are: W. B. Hood, W. S. Hornbaker, L. C. Lasher, G. K. Oppegard, and A. H. Petree.

The major results of the Committee's studies and recommendations were: (a) identification and review of all sumps at ORNL which may be a source of oil discharge and establishment of a quarterly inspection program; (b) inspection of elevator shafts for oil leakage and establishment of a quarterly inspection program; (c) discontinuation of the use of bladder bags for oil storage at the Steam Plant; (d) review of diking for integrity; (e) identification and documentation of locations of equipment containing oil; (f) inventory of the quantity of oil on the ORNL site; (g) review of purchase versus use and disposal of oil on an annual basis; (h) identification of effluent discharge points to creeks; (i) determination of the drainage areas serving each discharge point; (j) identification and documentation of locations of building drains; and (h) "fingerprinting" (by analysis) types of oil used at ORNL.

The final Committee report is scheduled for completion by October 1, 1980.

4.10.4 Committee for the Establishment of Environmental Guidelines

In June 1979, a committee was established to address three issues on the disposal of radioactive waste: (1) to develop upper and lower limits on the amount of activity that can be disposed of underground; (2) to compile selection criteria for new underground radioactive waste disposal areas; and (3) to prepare guidelines for aboveground storage of radioactive waste. The committee was made up of eleven people from four different divisions: Industrial Safety and Applied Health Physics Division - T. W. Oakes, Chairman, K. E. Shank, C. H. Miller, C. R. Guinn, and B. A. Kelly, Secretary; Engineering - H. D. MacNary and T. W. Thompson, Jr.; Operations - E. M. King and R. E. Helms; and Environmental Sciences - T. Tamura and M. S. Moran.

The committee met through Augusut 1979. A final report will be prepared during 1980.

4.10.5 ORNL Environmental Impact Statement

The preparatory work for the ORNL Environmental Impact Statement (EIS) was a major effort during CY 1979. Scoping meetings were held with State, DOE, and EPA personnel; this resulted in the completed scoping document in November 1979. A detailed work plan for various aspects of the project was also completed during 1979. An exhaustive surface water and biological sampling program has been conducted by IS&AHP and ESD personnel and various milestones have been established for the EIS for 1980 and 1981.

4.10.6 Environmental Assessments

Sixteen environmental assessments were completed during 1980. The projects for which environmental assessments were written are: Upgrade Laboratories to Handle Hazardous Materials, Solid Waste Handling and Decontamination Facility, Improvements to Fusion Energy Facilities, Energy Systems Research Laboratory, Upgrade of ORNL Primary Substation, Toxic Substances Laboratory and Animal Facility, High Temperature Materials Laboratory, Water Pollution Control - ORNL, Modernization of Laboratories for Study of Environmental Pollutants, Holifield Heavy Ion Research Facility, Phase II, Accelerator Improvement Project - en-Tandem, Accelerator Improvement Project - HHIRF, and Improvements to Radioactive Waste Facilities: Off-Gas and Cell Ventilation Improvement, Streamflow Monitoring and Control System Improvements, and Waste Operations Control Center.

4.10.7 ORNL National Pollutant Discharge Elimination System (NPDES) Program

During 1979 ORNL continued to conduct the extensive water monitoring program set forth in its NPDES permit. This permit, issued by the Environmental Protection Agency, calls for monitoring at four locations: (1) White Oak Creek, (2) Melton Branch of White Oak Creek, (3) ORNL's Main Sanitary Treatment Plant, and (4) the Sanitary Treatment Plant at the HFIR facility.

An application for a new NPDES permit was also submitted to DOE in August 1979, since ORNL's current permit expires in February 1980. This new permit, when issued, will call for monitoring at six locations (1) White Oak Creek, (2) Melton Branch of White Oak Creek, (3) ORNL's Main Sanitary Treatment Facility, (4) the Coal Pile Runoff Basin behind ORNL's Steam Plant, (5) the discharges from the Environmental Sciences Building, and (6) Fifth Street Branch of White Oak Creek.

ORNL-DWG. 66-2218

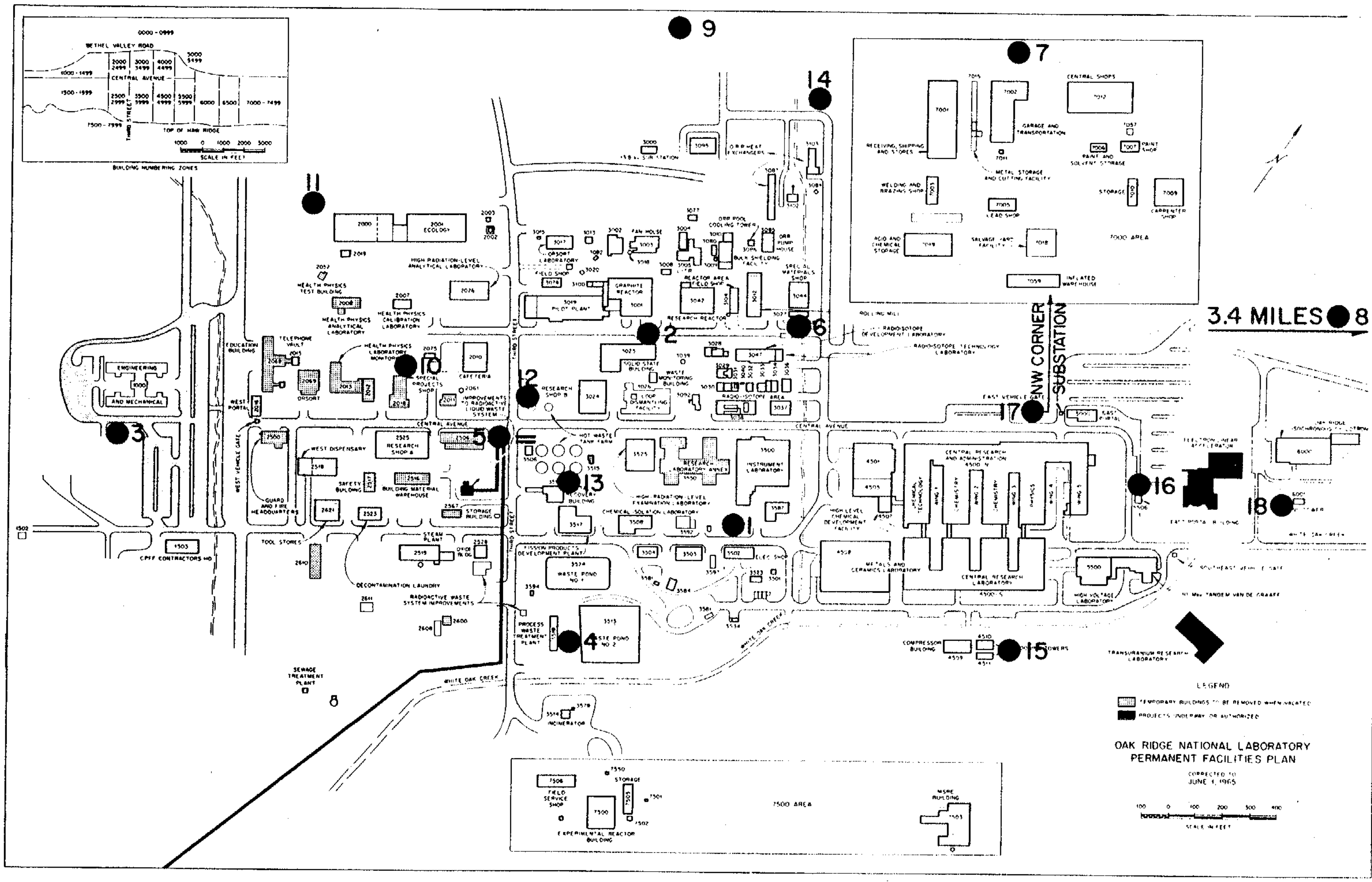

Fig. 4.1.1 Local Air Monitoring (LAM) Network - Bethel Valley

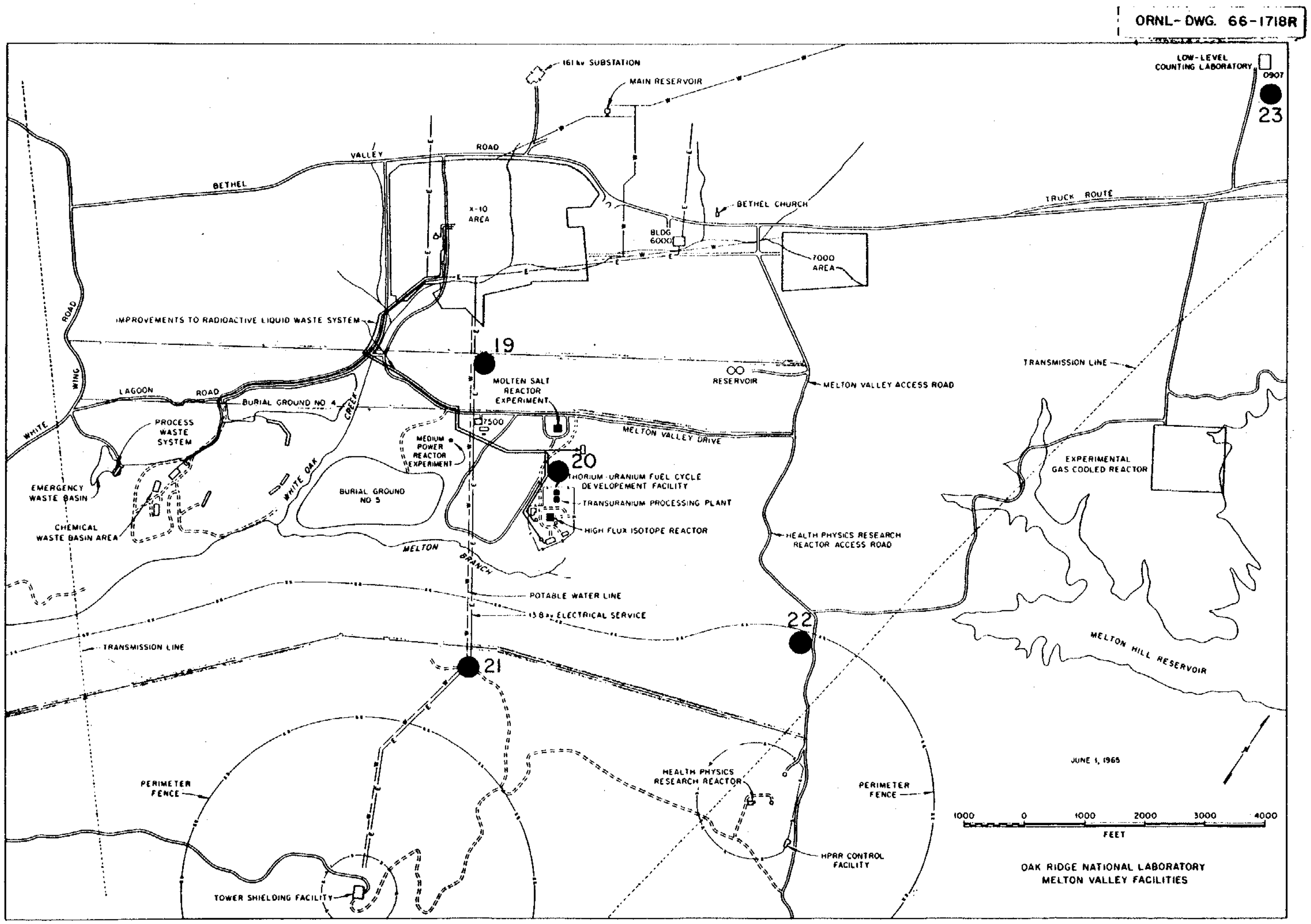

Fig. 4.1.2 Local Air Monitoring (LAM) Network - Outlying Stations

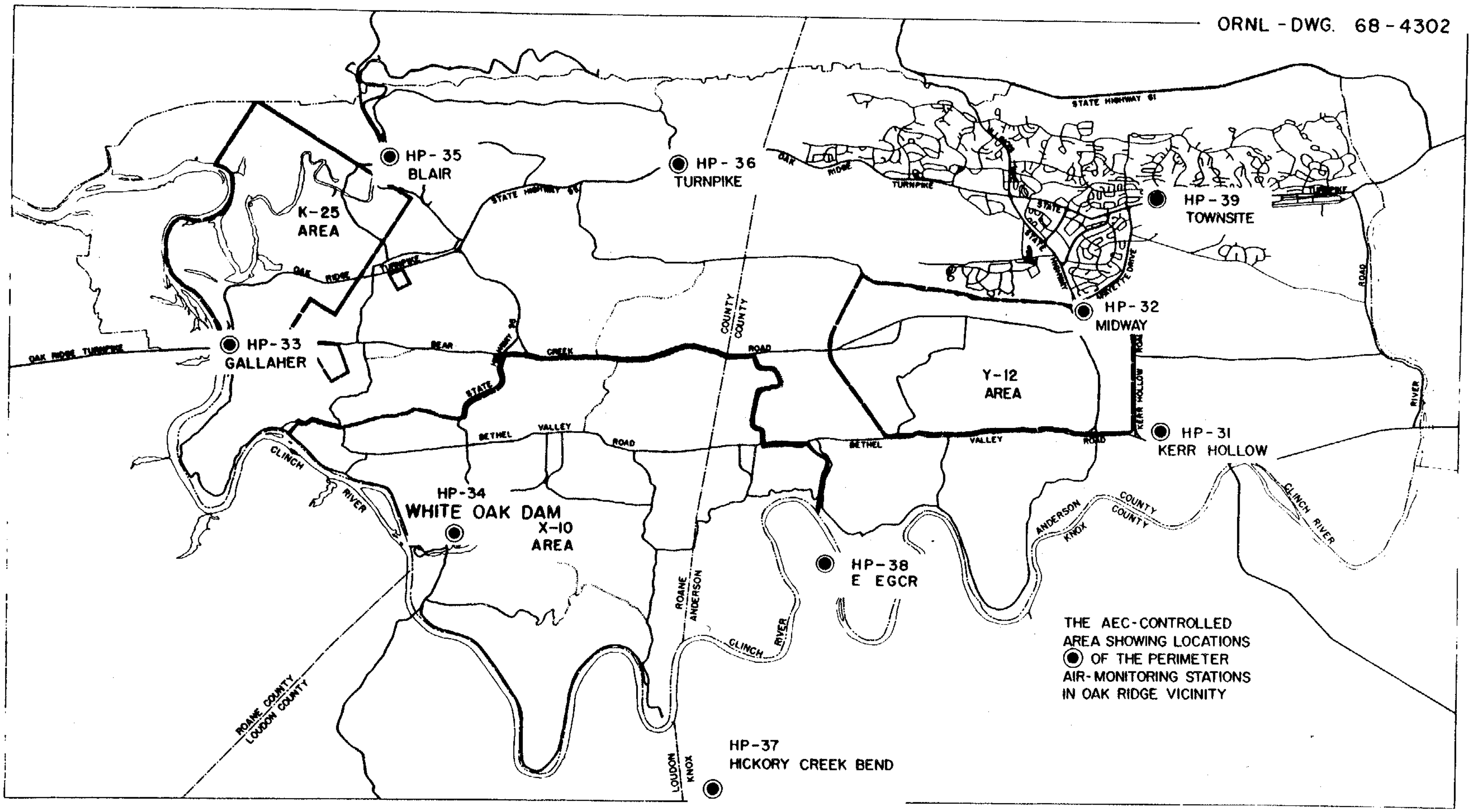

Fig. 4.1.3 Perimeter Air Monitoring (PAM) Network

ORNL-DWG 66-1719

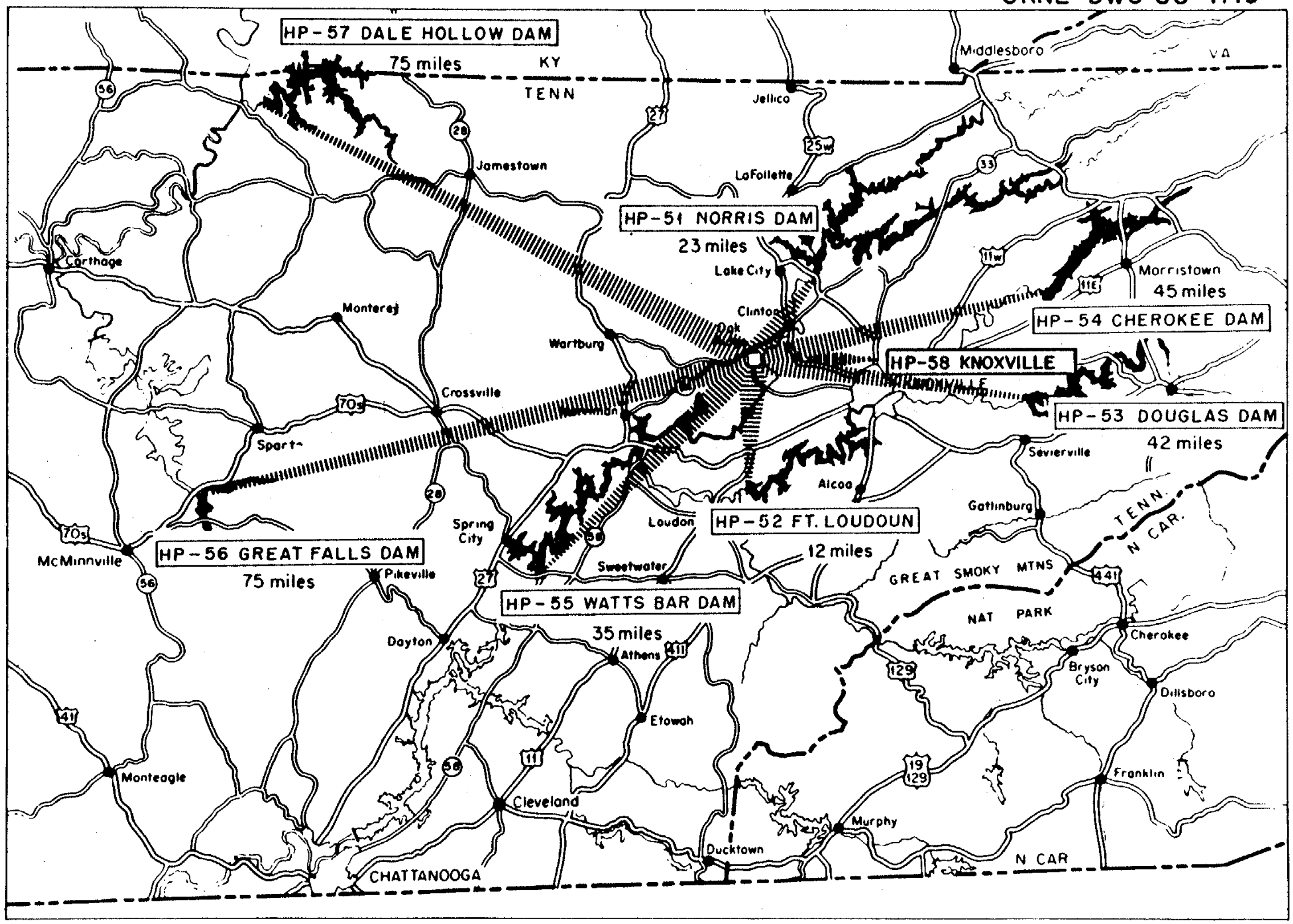

Fig. 4.1.4 Remote Air Monitoring (RAM) Network

ORNL-DWG. 66-2216R

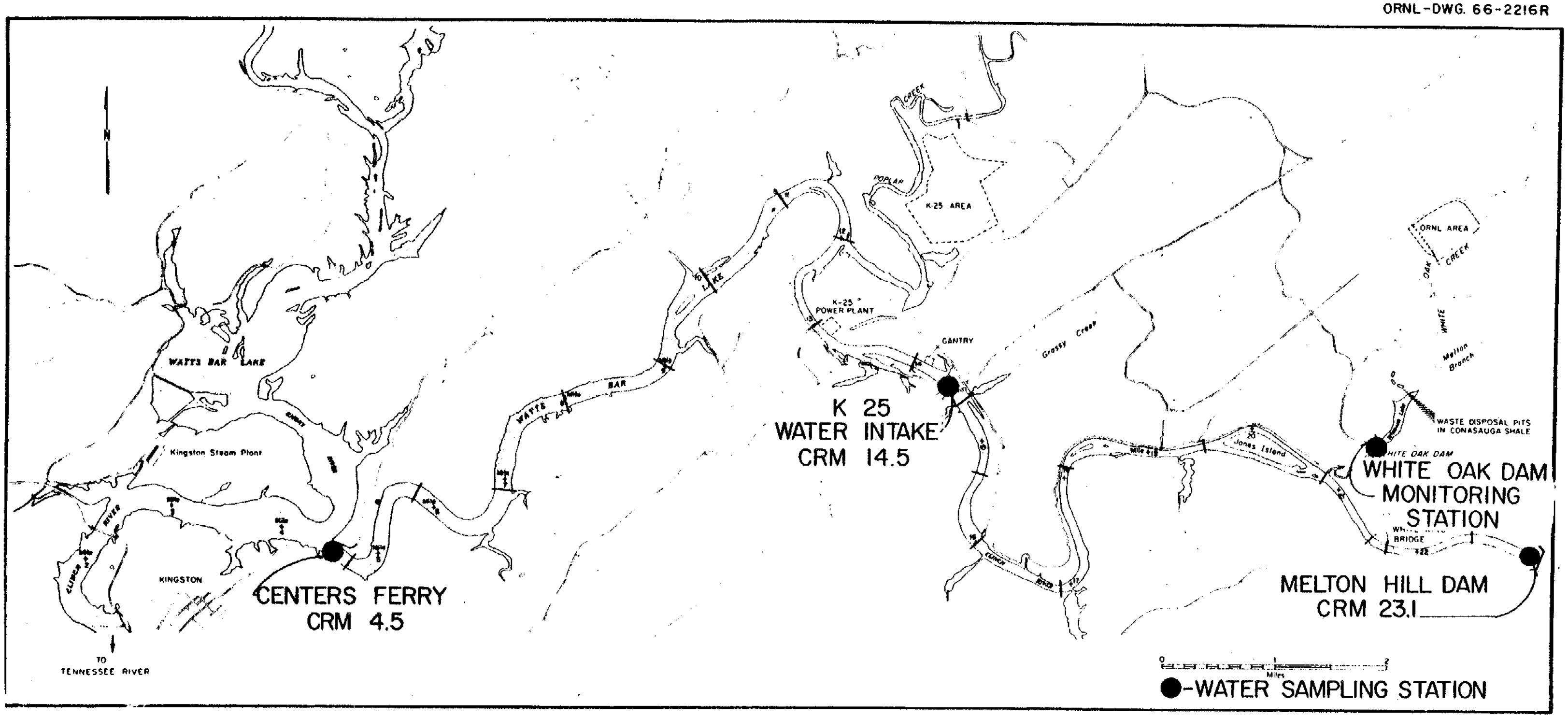

Fig. 4.1.5 Map Showing Water Sampling Locations in the East Tennessee Area

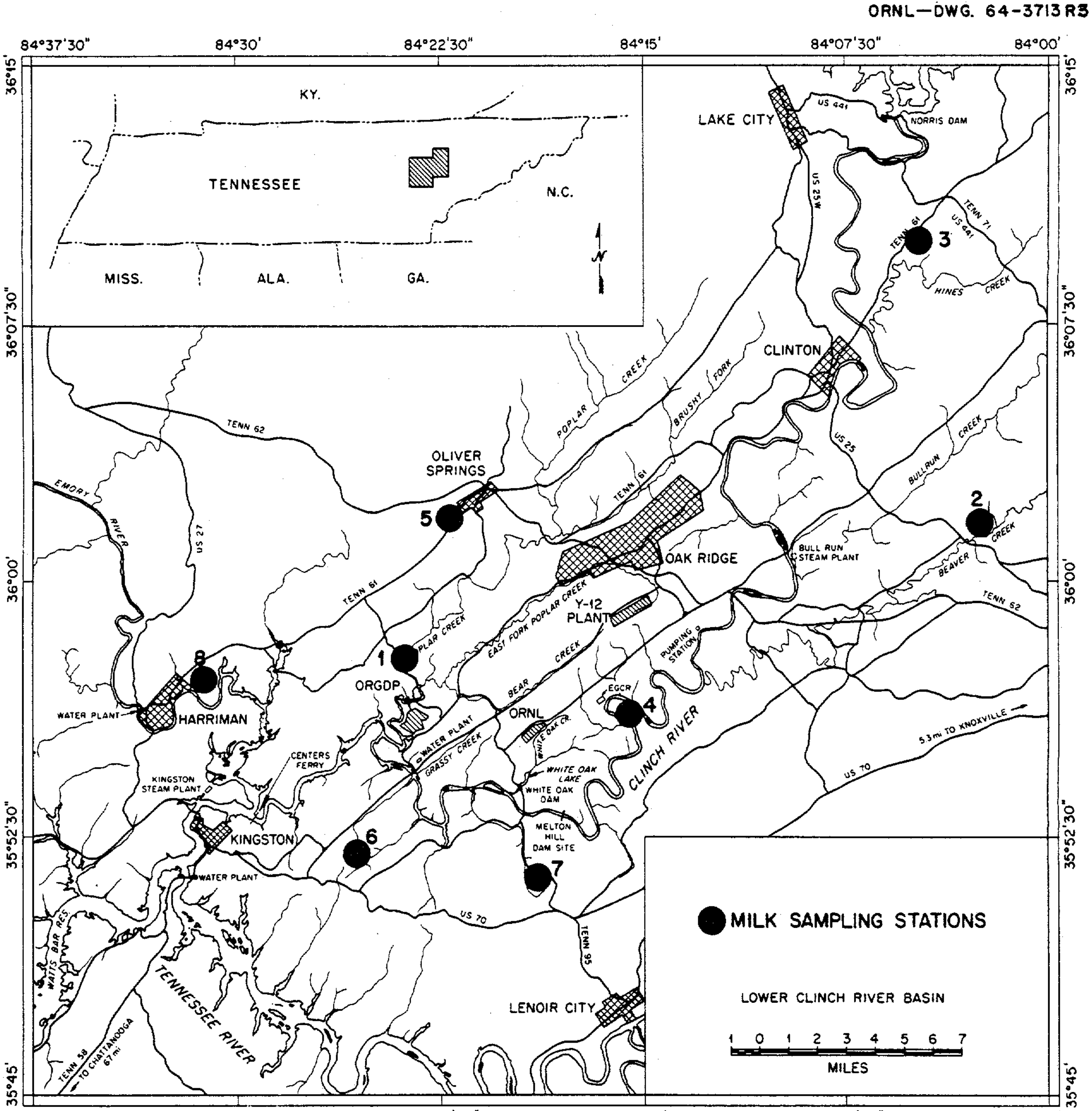

Fig. 4.1.6 Location of Milk Sampling Stations (Within 20-Mile Radius of ORNL)

ORNL DWG 76-12775RA

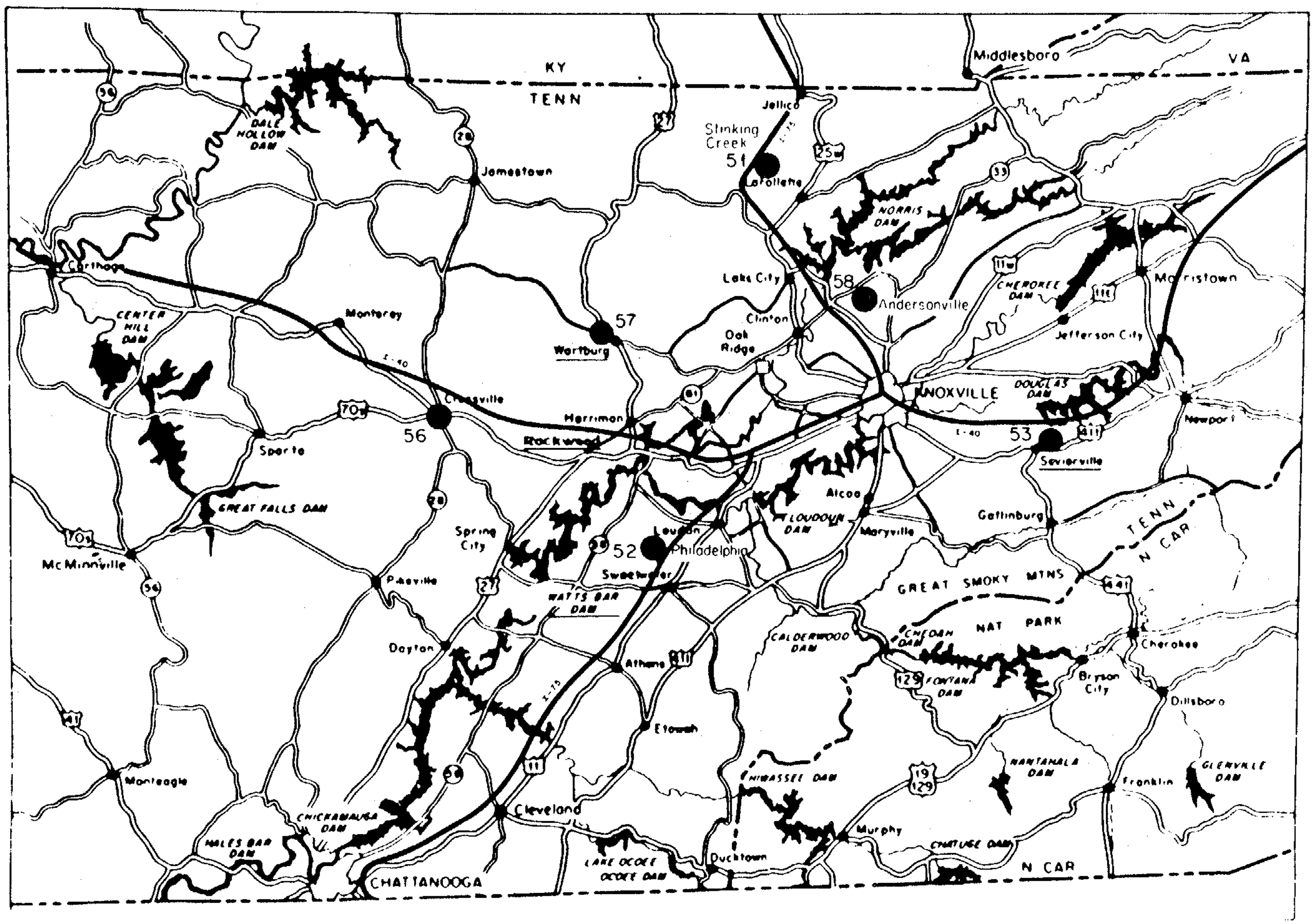

Fig. 4.1.7 Remote Environs Milk Sampling Locations

ORNL DWG 76-12776

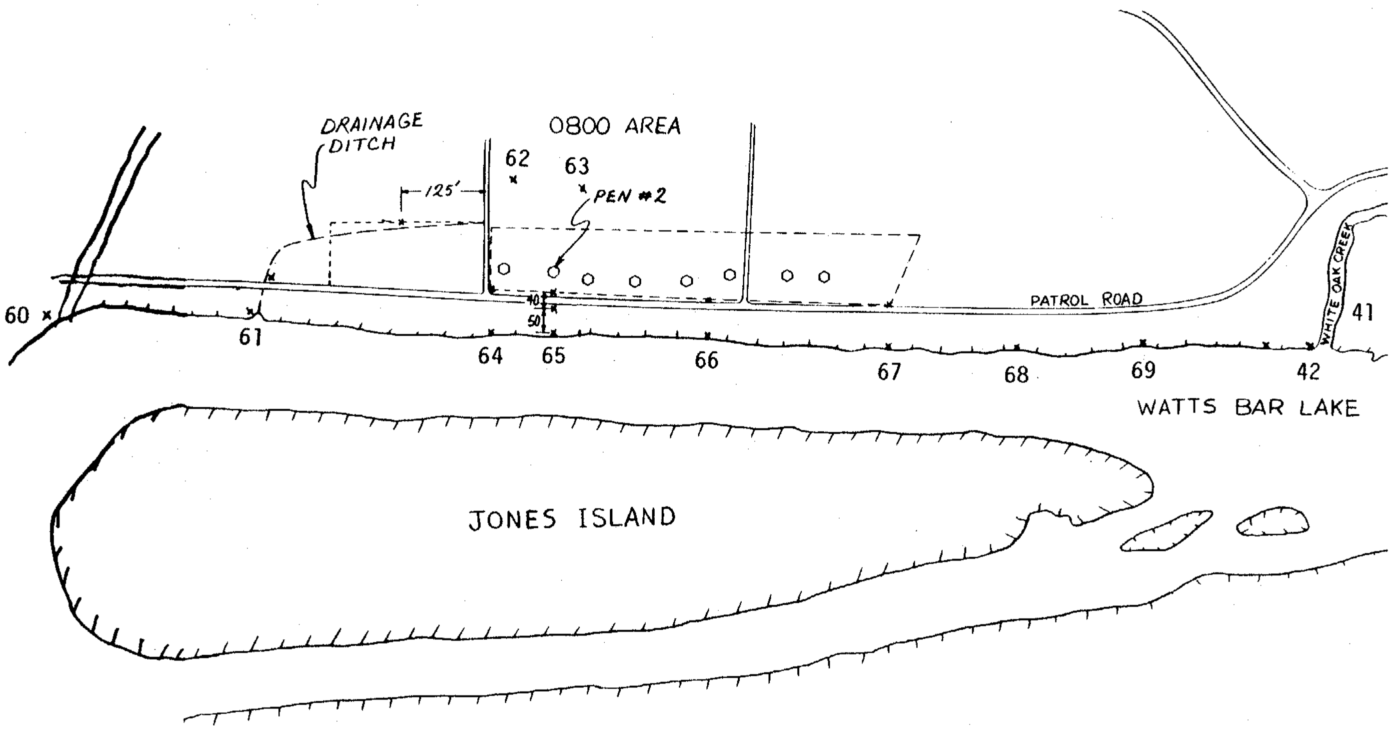

Fig. 4.1.8 Thermoluminescent Dosimeter Locations Along Perimeter of the DOE-Oak Ridge Controlled Area

Table 4.3.1 Concentration of Alpha Radioactivity in Air - 1979
(Filter Paper Data - Yearly Average)

Station Number	Location	Long-Lived Activity 10^{-15} μCi/cc
	Laboratory Area	
HP-1	S 3587	1.6
HP-2	NE 3025	1.8
HP-3	SW 1000	2.1
HP-4	W Settling Basin	1.6
HP-5	E 2506	2.3
HP-6	SW 3027	1.5
HP-7	W 7001	1.8
HP-8	Rock Quarry	1.8
HP-9	N Bethel Valley Road	2.0
HP-10	W 2075	5.6
HP-16	E 4500	1.9
HP-20	HFIR	1.5
HP-23	Walker Branch	1.6
Average		2.1
	Perimeter Area	
HP-31	Kerr Hollow Gate	1.1
HP-32	Midway Gate	1.4
HP-33	Gallaher Gate	1.2
HP-34	White Oak Dam	1.2
HP-35	Blair Gate	1.5
HP-36	Turnpike Gate	1.1
HP-37	Hickory Creek Bend	0.9
HP-38	E EGCR	1.4
HP-39	Townsite	1.2
Average		1.2
	Remote Area	
HP-51	Norris Dam	1.0
HP-52	Loudoun Dam	0.9
HP-53	Douglas Dam	0.9
HP-54	Cherokee Dam	0.9
HP-55	Watts Bar Dam	0.7
HP-56	Great Falls Dam	1.0
HP-57	Dale Hollow Dam	1.0
HP-58	Knoxville	0.9
Average		0.9

Table 4.3.2 Concentration of Beta Radioactivity in Air - 1979 (Filter Paper Data - Yearly Average)

Station Number	Location	Long-Lived Activity 10^{-14} μCi/cc
	Laboratory Area	
HP-1	S 3587	3.6
HP-2	NE 3025	4.9
HP-3	SW 1000	3.7
HP-4	W Settling Basin	4.6
HP-5	E 2506	3.4
HP-6	SW 3027	4.1
HP-7	W 7001	3.2
HP-8	Rock Quarry	3.7
HP-9	N Bethel Valley Road	3.5
HP-10	W 2075	13.0
HP-16	E 4500	3.1
HP-20	HFIR	3.2
HP-23	Walker Branch	3.3
Average		4.4
	Perimeter Area	
HP-31	Kerr Hollow Gate	2.5
HP-32	Midway Gate	3.1
HP-33	Gallaher Gate	2.7
HP-34	White Oak Dam	2.8
HP-35	Blair Gate	2.7
HP-36	Turnpike Gate	2.3
HP-37	Hickory Creek Bend	3.5
HP-38	E EGCR	2.6
HP-39	Townsite	2.5
Average		2.7
	Remote Area	
HP-51	Norris Dam	2.6
HP-52	Loudoun Dam	2.5
HP-53	Douglas Dam	2.4
HP-54	Cherokee Dam	2.0
HP-55	Watts Bar Dam	1.3
HP-56	Great Falls Dam	2.7
HP-57	Dale Hollow Dam	3.4
HP-58	Knoxville	2.2
Average		2.4

Table 4.3.3 Concentration of Beta Radioactivity in Air as Determined from Filter Paper Data - 1979 (System Average - by Weeks)

Week Number	Units of 10^{-14} µCi/cc LAM's	PAM's	RAM's	Week Number	Units of 10^{-14} µCi/cc LAM's	PAM's	RAM's
1	3.5	3.2	3.0	29	4.3	2.7	2.6
2	4.0	4.1	3.5	30	3.2	2.4	2.0
3	5.4	3.4	2.7	31	5.5	3.7	2.6
4	4.5	2.5	2.6	32	6.4	4.0	2.7
5	7.2	2.2	2.0	33	5.0	3.3	2.6
6	4.4	3.6	4.9	34	4.3	2.8	1.8
7	3.4	2.7	3.2	35	3.4	2.5	1.5
8	2.8	1.5	2.8	36	4.4	3.1	1.7
9	5.8	2.2	1.9	37	4.1	2.5	2.1
10	7.6	3.1	2.5	38	3.5	2.3	1.9
11	4.7	2.7	3.1	39	3.2	1.8	1.4
12	6.2	2.3	1.8	40	3.8	2.3	1.8
13	7.6	3.3	3.0	41	4.2	2.1	2.2
14	6.5	2.3	2.0	42	4.4	3.0	2.3
15	5.9	2.1	1.9	43	4.5	2.4	2.4
16	8.3	4.0	3.0	44	4.0	2.4	1.9
17	5.5	2.6	2.1	45	3.9	2.8	3.0
18	3.3	3.3	2.1	46	5.2	4.7	3.1
19	3.0	1.9	2.5	47	4.1	2.9	1.9
20	4.5	3.1	2.9	48	3.6	2.2	2.0
21	2.8	2.1	1.9	49	3.0	3.2	2.5
22	2.8	2.1	2.8	50	3.3	2.4	2.2
23	3.4	2.5	2.0	51	2.7	2.1	2.0
24	3.8	3.4	2.8	52	3.4	2.5	2.2
25	3.0	2.4	2.3				
26	3.5	2.6	1.9				
27	4.4	2.4	2.3				
28	3.1	1.5	1.5	Average	4.4	2.7	2.4

Table 4.3.4 Radioparticulate Fallout - 1979
(Gummed Paper Data - Station Yearly Average)

Station Number	Location	Long-Lived Beta Activity 10^{-4} μCi/ft^2
	Laboratory Area	
HP-1	S 3587	0.04
HP-2	NE 3025	0.03
HP-3	SW 1000	0.03
HP-4	W Settling Basin	0.03
HP-5	E 2506	0.03
HP-6	SW 3027	0.03
HP-7	W 7001	0.03
HP-8	Rock Quarry	0.03
HP-9	N Bethel Valley Road	0.03
HP-10	W 2075	0.03
HP-16	E 4500	0.03
HP-20	HFIR	0.03
HP-23	Walker Branch	0.03
Average		0.03
	Perimeter Area	
HP-31	Kerr Hollow Gate	0.03
HP-32	Midway Gate	0.03
HP-33	Gallaher Gate	0.03
HP-34	White Oak Dam	0.03
HP-35	Blair Gate	0.03
HP-36	Turnpike Gate	0.03
HP-37	Hickory Creek Bend	0.03
HP-38	E EGCR	0.03
HP-39	Townsite	0.03
Average		0.03
	Remote Area	
HP-51	Norris Dam	0.03
HP-52	Loudoun Dam	0.03
HP-53	Douglas Dam	0.03
HP-54	Cherokee Dam	0.03
HP-55	Watts Bar Dam	0.03
HP-56	Great Falls Dam	0.03
HP-57	Dale Hollow Dam	0.04
HP-58	Knoxville	0.03
Average		0.03

Table 4.3.5 Concentration of Beta Radioactivity in Rainwater - 1979
(Yearly Average by Stations)

Station Number	Location	Activity in Collected Rainwater 10^{-8} μCi/ml
	Laboratory Area	
HP-7	West 7001	0.8
HP-23	Walker Branch	0.9
Average		0.8
	Perimeter Area	
HP-31	Kerr Hollow Gate	0.9
HP-32	Midway Gate	0.7
HP-33	Gallaher Gate	1.1
HP-34	White Oak Dam	1.0
HP-35	Blair Gate	1.0
HP-36	Turnpike Gate	1.0
HP-37	Hickory Creek Bend	1.0
HP-38	E EGCR	1.1
HP-39	Townsite	0.8
Average		1.0
	Remote Area	
HP-51	Norris Dam	1.2
HP-52	Loudoun Dam	1.4
HP-53	Douglas Dam	1.4
HP-54	Cherokee Dam	1.5
HP-55	Watts Bar Dam	1.2
HP-56	Great Falls Dam	1.7
HP-57	Dale Hollow Dam	1.3
HP-58	Knoxville	1.1
Average		1.4

Table 4.3.6 Weekly Average Concentration of Beta Radioactivity in Rainwater - 1979 (Units of 10^{-8} μCi/ml)

Week Number	LAM's	PAM's	RAM's	Week Number	LAM's	PAM's	RAM's
1	NS*	1.4	1.6	27	0.7	0.2	1.0
2	0.6	NS	2.0	28	0.3	0.2	0.0
3	0.3	0.7	0.6	29	0.8	0.4	0.7
4	1.2	1.9	2.8	30	0.0	0.6	0.2
5	1.6	2.3	4.4	31	0.6	0.7	NS
6	0.8	1.7	3.0	32	0.5	0.5	0.0
7	1.1	1.3	2.9	33	NS	NS	NS
8	0.7	1.6	1.5	34	0.0	0.3	1.2
9	0.4	0.3	0.3	35	0.9	0.3	0.9
10	6.6	2.3	3.1	36	NS	NS	NS
11	1.8	1.9	2.7	37	0.9	0.4	0.8
12	0.0	0.2	0.7	38	0.2	0.2	0.8
13	0.0	0.1	0.1	39	0.1	0.1	0.2
14	0.5	0.9	0.7	40	0.3	0.1	0.3
15	0.9	1.0	0.8	41	1.2	0.5	0.2
16	NS	NS	3.4	42	1.1	1.0	0.2
17	1.1	0.5	1.5	43	NS	NS	NS
18	1.0	1.2	0.9	44	1.2	0.6	0.6
19	0.6	1.1	1.0	45	1.2	0.8	0.6
20	1.4	1.6	1.2	46	0.3	0.4	0.2
21	1.1	0.6	1.3	47	0.3	0.4	0.2
22	0.5	1.1	1.0	48	NS	NS	0.0
23	0.4	0.0	0.4	49	NS	NS	2.8
24	0.0	0.6	0.8	50	0.5	0.2	1.6
25	1.1	0.9	1.4	51	0.3	0.5	1.2
26	0.9	0.7	0.8	52	1.4	1.0	1.6
				Average	0.8	0.8	1.2

* No rainfall.

Table 4.3.7 Weekly Concentration of ^{131}I in Air - 1979
(Units of 10^{-14} μCi/cc)

Week Number	LAM's	PAM's	Week Number	LAM's	PAM's
1	1.1	0.6	27	1.0	0.4
2	0.9	0.4	28	0.9	0.4
3	1.6	0.4	29	0.8	0.3
4	3.4	0.5	30	0.8	0.4
5	0.8	0.3	31	1.1	0.4
6	4.2	0.6	32	2.9	0.3
7	14.8	3.4	33	1.2	0.4
8	7.1	0.6	34	0.9	0.4
9	2.8	0.5	35	0.9	0.3
10	4.3	0.6	36	0.7	0.4
11	3.7	0.4	37	0.7	0.3
12	3.6	0.4	38	1.0	0.3
13	3.4	0.5	39	1.0	0.5
14	4.2	0.4	40	1.9	0.2
15	11.5	1.1	41	1.5	0.1
16	3.6	0.5	42	0.3	0.1
17	1.3	0.6	43	0.4	0.1
18	1.0	0.4	44	0.3	0.1
19	2.1	0.6	45	0.8	0.2
20	1.1	0.5	46	0.4	0.2
21	1.8	0.3	47	0.7	0.1
22	1.5	0.3	48	0.9	0.1
23	1.2	0.3	49	0.5	0.1
24	0.7	0.4	50	0.3	0.2
25	0.9	0.4	51	0.2	0.1
26	0.7	0.4	52	0.4	0.2
			Average	2.0	0.4

Table 4.3.8 Concentration of ^{131}I in Air - 1979
(Weekly Average by Stations)

Station Number	Location	Activity in Air 10^{-14} µCi/cc
	Laboratory Area	
HP-3	SW 1000	2.1
HP-4	W Settling Basin	1.7
HP-6	SW 3027	3.8
HP-7	W 7001	1.7
HP-8	Rock Quarry	1.0
HP-9	N Bethel Valley Road	1.4
HP-10	W 2075	4.9
HP-16	E 4500	2.4
HP-20	HFIR	0.8
HP-23	Walker Branch	0.7
Average		2.1
	Perimeter Area	
HP-31	Kerr Hollow Gate	0.5
HP-32	Midway Gate	0.4
HP-33	Gallaher Gate	0.5
HP-34	White Oak Dam	0.5
HP-35	Blair Gate	0.3
HP-36	Turnpike Gate	0.3
HP-37	Hickory Creek Bend	0.4
HP-38	E EGCR	0.4
HP-39	Townsite	0.4
Average		0.4

Table 4.3.9 Continuous Air Monitoring Data Specific Radionuclides in Air - 1979
(Composite Samples)
Units of 10^{-15} μCi/cc

Radionuclides	Yearly Average		
	Local Stations	Perimeter Stations	Remote Stations
^{7}Be	104	106	95
^{90}Sr	0.23	0.15	0.19
^{106}Ru	1.4	1.56	1.36
^{125}Sb	0.32	0.37	0.33
^{137}Cs	0.96	0.67	0.61
^{144}Ce	1.52	1.85	1.10
^{228}Th	0.01	0.01	0.002
^{230}Th	0.01	0.02	0.01
^{232}Th	0.02	0.01	0.01
^{234}U	0.33	0.44	0.01
^{235}U	0.01	0.03	0.01
^{238}U	0.08	0.26	0.02
^{238}Pu	0.0001	0.002	0.0007
^{239}Pu	0.01	0.04	0.01

*Not detectable.

Table 4.3.10 Air Monitoring Data - Suspended Particulates
1979

Location[a]	Number of Samples	Concentration ($\mu g/m^3$)			
		Maximum	Minimum	Average	% Std.[b]
LAM-1	4	29	21	26	34
LAM-3	4	21	12	16	21
LAM-6	4	31	17	23	31
LAM-15	4	29	13	22	29

[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 Concentration of ^{131}I in Milk[a] - 1979

Station Number	Number of Samples	Units of 10^{-9} μCi/ml Maximum	Minimum[b]	Average	Comparison with Standard[c]
		Immediate Environs[d]			
1	45	0.45	< 0.45	< 0.45	Range I
2	48	1.20	< 0.45	< 0.47	Range I
3	46	0.45	< 0.45	< 0.45	Range I
4	45	0.45	< 0.45	< 0.45	Range I
5	48	8.00	< 0.45	< 0.61	Range I
6	46	1.40	< 0.45	< 0.50	Range I
7	46	7.00	< 0.45	< 0.60	Range I
8	45	8.00	< 0.45	< 0.61	Range I
Average				< 0.52	
		Remote Environs[e]			
51	8	< 0.45	< 0.45	< 0.45	Range I
52	8	< 0.45	< 0.45	< 0.45	Range I
53	7	< 0.45	< 0.45	< 0.45	Range I
56	3	< 0.45	< 0.45	< 0.45	Range I
57	10	< 0.45	< 0.45	< 0.45	Range I
58	8	< 0.45	< 0.45	< 0.45	Range I
Average				< 0.45	

[a] Raw milk samples, except for Station 2 which is a dairy.

[b] Minimum detectable concentration of ^{131}I is 0.45×10^{-9} μCi/ml.

[c] Applicable FRC Standard, assuming 1 liter per day intake:

Range I	0 to 1×10^{-8} μCi/ml	- Adequate surveillance required to confirm calculated intakes.
Range II	1×10^{-8} μCi/ml to 1×10^{-7} μCi/ml	- Active surveillance required.
Range III	1×10^{-7} μCi/ml to 1×10^{-6} μCi/ml	- Positive control action required.

Note: Upper limit of Range II can be considered the concentration guide.

[d] See Fig. 4.1.6.

[e] See Fig. 4.1.7.

Table 4.3.12 Concentration of ^{90}Sr in Milk[a] - 1979

Station Number	Number of Samples	Units of 10^{-9} µCi/ml Maximum	Minimum[b]	Average	Comparison with Standard[c]
		Immediate Environs[d]			
1	41	3.7	0.9	2.6	Range I
2	46	3.0	0.7	1.8	Range I
3	44	3.4	0.7	1.7	Range I
4	40	3.1	0.9	1.9	Range I
5	45	4.1	0.7	2.1	Range I
6	45	8.9	1.8	4.3	Range I
7	44	4.1	0.9	2.2	Range I
8	43	4.0	1.2	3.1	Range I
Average				2.5	
		Remote Environs[e]			
51	8	3.4	1.4	2.8	Range I
52	7	2.3	0.9	1.5	Range I
53	7	2.1	0.9	1.3	Range I
56	3	1.8	1.4	1.6	Range I
57	10	4.1	1.6	2.6	Range I
58	8	1.8	0.9	1.4	Range I
Average				1.9	

[a] Raw milk samples, except for Station 2 which is a dairy.

[b] Minimum detectable concentration of ^{90}Sr is 0.5×10^{-9} µCi/ml.

[c] Applicable FRC Standard, assuming 1 liter per day intake:

Range I	0 to 2×10^{-8} µCi/ml	- Adequate surveillance required to confirm calculated intakes.
Range II	2×10^{-8} µCi/ml to 2×10^{-7} µCi/ml	- Active surveillance required.
Range III	2×10^{-7} µCi/ml to 2×10^{-6} µCi/ml	- Positive control action required.

Note: Upper limit of Range II can be considered the concentration guide.

[d] See Fig. 4.1.6.

[e] See Fig. 4.1.7.

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

Stack Number	^{3}H	^{85}Kr	^{131}I	^{133}Xe	Unidentified Alpha
3039	5,000	<8,700	0.18	<42,300	
7025	109				
7911		<1,800	0.12	< 8,890	
Bldg. 9204-3 Stack (Y-12)					4.4×10^{-6}
Trans Lab					$< 3.36 \times 10^{-7}$
4509					$< 1.87 \times 10^{-8}$
Total	5,109	<10,500	0.30	<51,190	$< 4.8 \times 10^{-6}$

[a]Data furnished by Operations Division.

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

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

Table 4.4.2 Concentration of Radionuclides in the Clinch River - 1979

(Units of 10^{-9} μCi/ml)

Locations	Number of Samples	Range	^{90}Sr	^{137}Cs	^{106}Ru	^{60}Co	^{3}H	% CG[a]
CRM 23.1	4	Max.	0.16	0.02	0.09	0.01	721	
		Min.	0.05	0.01	0.02	0.01	586	0.06
		Avg.	0.01	0.01	0.05	0.01	646	
CRM 20.8[b]	12	Max.	72.8	13.7	13.7	31.9	267,995	
		Min.	9.1	1.8	4.6	2.7	25,025	16.1
		Avg.	33.4	5.1	6.4	13.9	136,538	
CRM 14.5	4	Max.	0.68	0.5	0.14	0.11	1,036	
		Min.	0.16	0.01	0.03	0.01	2,207	0.15
		Avg.	0.40	0.02	0.08	0.05	1,351	
CRM 4.5	4	Max.	0.5	0.05	0.23	0.05	1,802	
		Min.	0.14	0.01	0.02	0.02	1,396	0.21
		Avg.	0.33	0.02	0.11	0.04	1,592	
CRM Dilution[c]	12	Max.	1.4	0.29	0.03	NA	3,477	
		Min.	0.15	0.01	0.01	NA	409	0.20
		Avg.	0.43	0.05	0.02	NA	1,244	

[a] Percent of concentration guide calculated as shown in DOE Manual, Appendix 0524, Annex A.

[b] Intersection of White Oak Creek and the Clinch River.

[c] Values given for this location are calculated based on the concentrations measured at White Oak Dam and the dilution afforded by the Clinch River.

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 - 1979

Month	WOD	Intersection of WOC & CR	Calculated Value for C. R.*
January	47	14	0.1
February	60	31	0.2
March	74	35	0.1
April	65	19	0.2
May	61	6	0.6
June	74	19	0.1
July	59	7	0.4
August	75	9	0.1
September	72	19	0.1
October	93	11	0.1
November	61	10	0.2
December	97	18	0.2
AVERAGE	70	17	0.2

*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	0.53	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

[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

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

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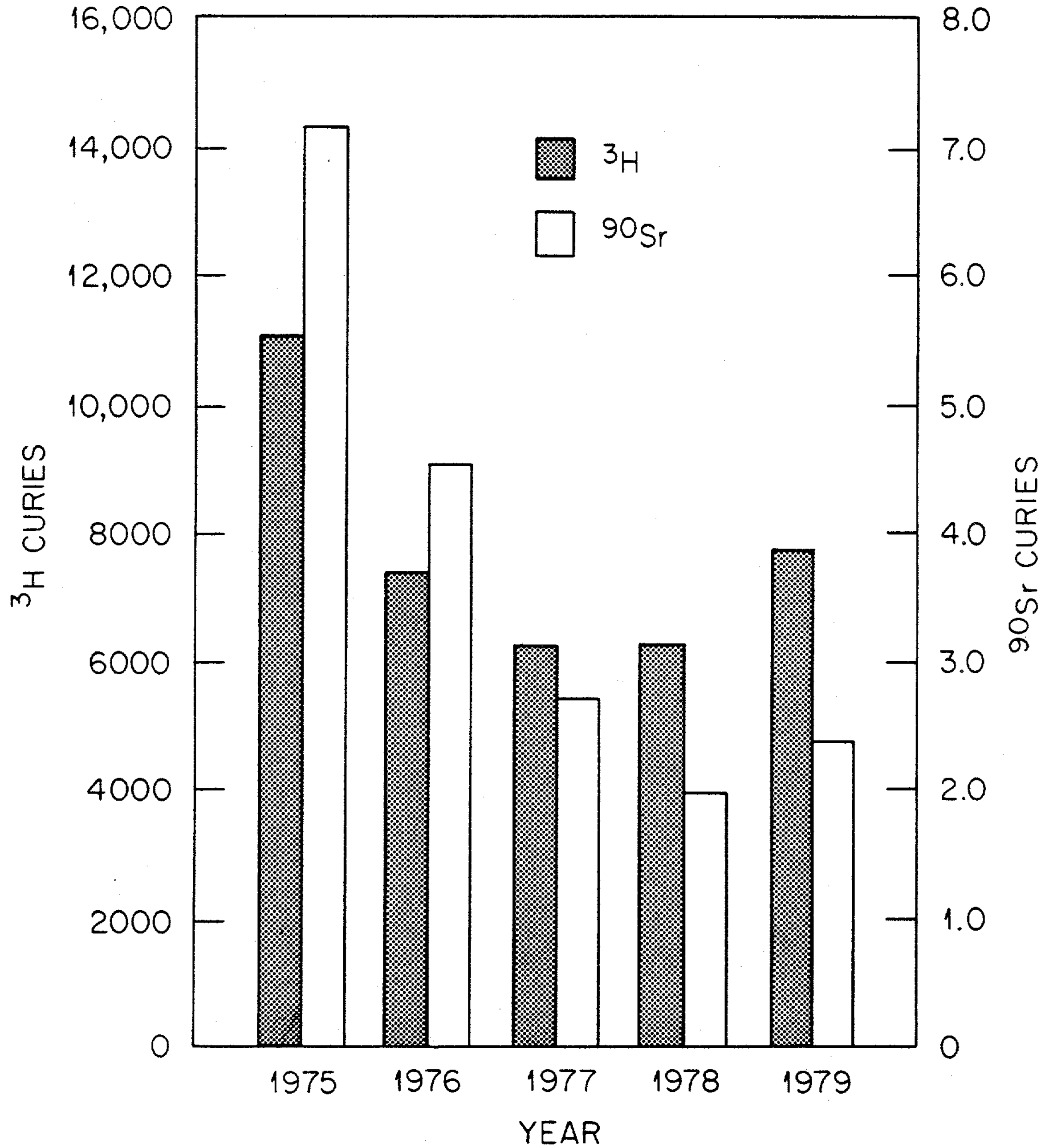

Fig. 4.4.1 Curies Discharged Over White Oak Dam

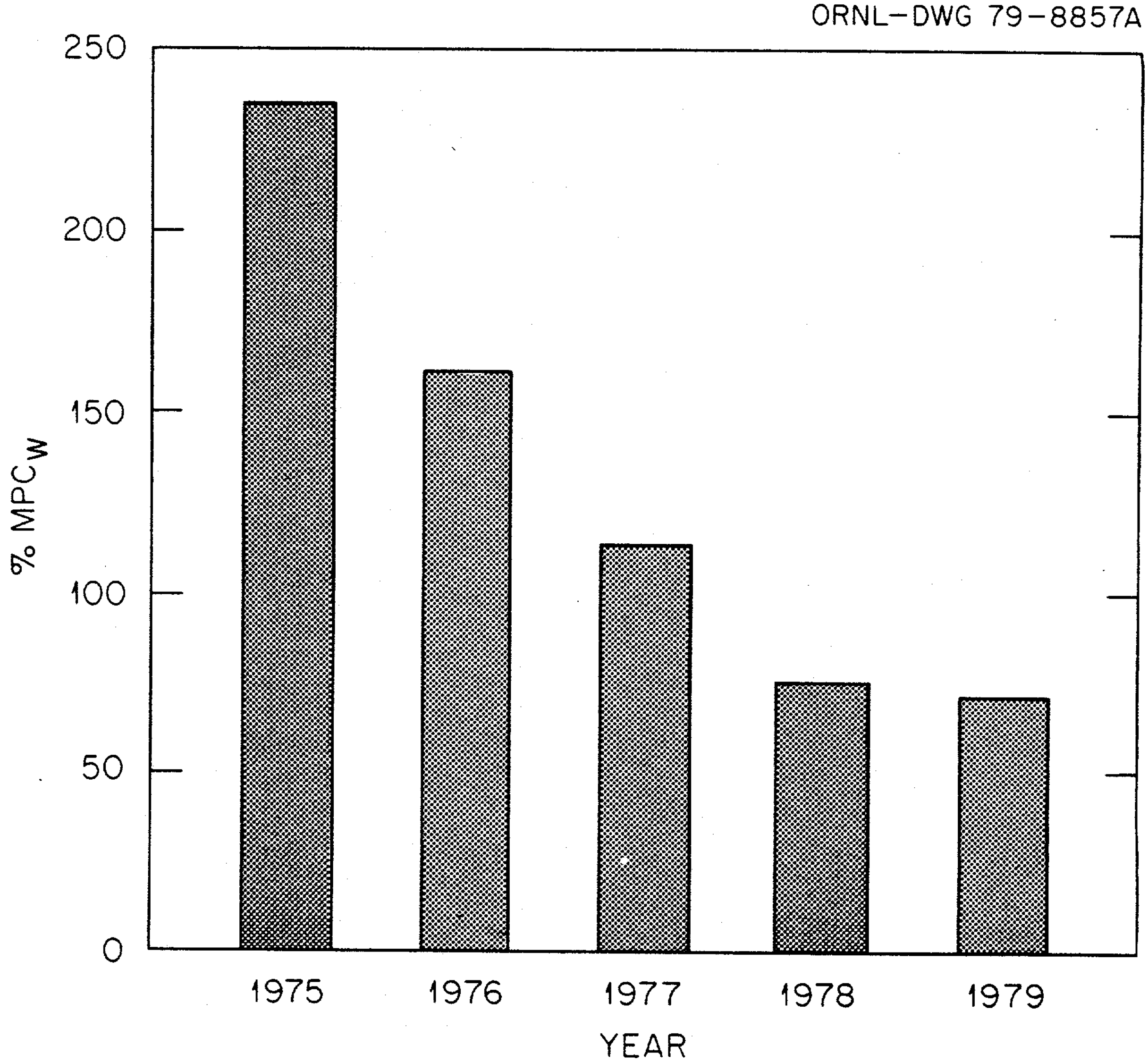

Fig. 4.4.2 Total MPC_w Levels Discharged Over White Oak Dam

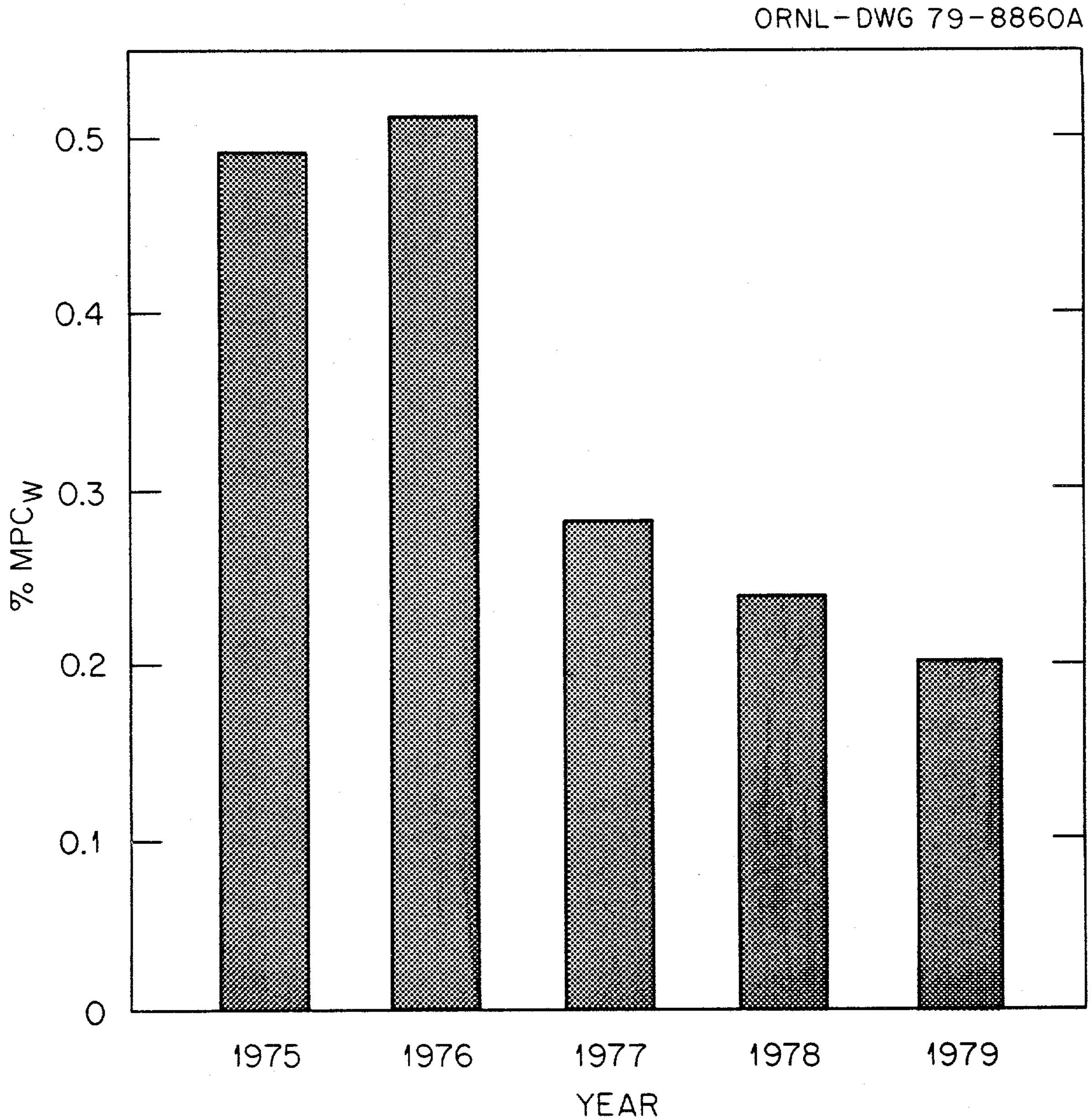

Fig. 4.4.3 Total MPC_w Levels in the Clinch River (Values given are Calculated Values Based on Those Concentrations Measured at White Oak Dam and Dilution Afforded by the Clinch River)

Table 4.4.6 Chemical Water Quality Data
White Oak Dam - 1979

Substance	Number of Samples	Concentration (μg/1)				% Std.
		Maximum	Minimum	Average	Std.[a]	
Cr	11	3.8	1.3	2.5 ± 0.5	50	5
Zn	11	43	2.4	13 ± 8	100	13
$NO_3(N)$	11	4,300	240	2700 ± 800	10,000	27
Hg	12	.37	.001	0.1 ± 0.06	5	2

[a]Tennessee Stream Guidelines.

Table 4.4.7 Chemical Water Quality Data
Melton Hill Dam - 1979

Substance	Number of Samples	Concentration (μg/1)				% Std.
		Maximum	Minimum	Average	Std.[a]	
Cr	11	0.6	0.05	0.05 ± 0.2	50	1
Zn	11	2.0	0.1	0.7 ± 0.4	100	0.7
NO_3(N)	11	2,460	7	360 ± 430	10,000	3.6
Hg	12	0.09	0.001	0.03 ± 0.02	5	0.6

[a]Tennessee Stream Guidelines.

Table 4.4.8 Chemical Water Quality - 1979

Parameter (Units)	Location[a] P-1	P-2	P-6	T-1
COD (mg/l)	8.3 ± 0.3	10 ± 0.3	5.8 ± 0.3	8.8 ± 0.3
BOD (mg/l)	< 5 ± 0.0	< 5 ± 0.0	< 5 ± 0.0	< 5 ± 0.0
TSS (mg/l)	25 ± 3.4	12 ± 0.6	7.2 ± 0.3	26 ± 1.6
TDS (mg/l)	151 ± 1.2	198 ± 2.2	101 ± 1.7	146 ± 2.7
PCB (μg/ml)	<.005 ± 0.0	<.005 ± 0.0	<.005 ± 0.0	<.005 ± 0.0
TOC (μg/ml)	2.4 ± 0.04	3.0 ± 0.03	1.1 ± 0.03	2.1 ± 0.10
Alkalinity (ppm)	106 ± 1.0	113 ± 0.7	102 ± 1.4	128 ± 2.0
Oil & Grease (mg/l)	< 2 ± 0.0	< 2 ± 0.0	< 2 ± 0.0	< 2 ± 0.0
Nitrate (μg/ml)	0.03 ± 0.01	0.04 ± 0.02	0.01 ± 0.01	0.02 ± 0.01
Kjeldahl-N (mg/l)	0.24 ± 0.05	0.29 ± 0.09	0.21 ± 0.02	0.21 ± 0.02
Organic Nitrogen (mg/ml)	0.24 ± 0.05	0.29 ± 0.09	0.21 ± 0.02	0.21 ± 0.02
Hardness (ppm)	122 ± 0.6	144 ± 1.2	100 ± 1.5	136 ± 1.7
Chlorine (mg/ml)	4.0 ± 0.13	8.0 ± 0.24	1.0 ± 0.03	3.0 ± 0.05
Potassium (mg/ml)	1.7 ± 0.02	2.0 ± 0.04	1.0 ± 0.01	1.4 ± 0.06
Mercury (ng/ml)	0.04 ± 0.03	0.09 ± 0.05	0.02 ± 0.04	0.02 ± 0.01
Phenols (ng/ml)	2 ± 1.0	2 ± 1.0	2 ± 1.0	2 ± 1.0
Turbidity (ntu)	9.0 ± 0.3	8.0 ± 0.1	4.4 ± 0.2	16.0 ± 1.2
NH_3 (mg/l)	<.2 ± 0.0	< 2 ± 0.0	<.2 ± 0.0	<.2 ± 0.0
NO_3 (μg/l)	1.8 ± 0.04	2.4 ± 0.09	.28 ± .01	2.0 ± .05
Total PO_4 (μg/ml)	0.08 ± 0.003	0.24 ± 0.005	0.01 ± 0.006	0.02 ± .007
Sodium (mg/ml)	6.0 ± 0.31	16.0 ± 0.71	0.44 ± 0.06	2.8 ± 0.07
Sulfate (mg/ml)	27.4 ± 0.78	56.0 ± 1.8	3.1 ± 0.07	16.0 ± 0.47
Chromium (ng/ml)	1.4 ± 0.12	3.0 ± 0.21	0.47 ± 0.02	0.46 ± 0.02
Manganese (ng/ml)	43.4 ± 1.5	0.12 ± 0.01	12.0 ± 1.0	41.2 ± 1.8
Copper (ng/ml)	3.0 ± 0.11	4.0 ± 0.07	1.0 ± 0.07	2.0 ± 0.13
Iron (ng/ml)	73.1 ± 5.0	112 ± 5.0	58.0 ± 2.4	125 ± 6.3
Nickle (ng/ml)	4.1 ± 0.27	8.0 ± 0.43	4.4 ± 0.29	5.1 ± 0.32
Lead (ng/ml)	2.1 ± 0.27	1.3 ± 0.05	1.0 ± 0.05	1.3 ± 0.08
Phosphorus (μg/ml)	0.067 ± 0.003	0.200 ± 0.004	0.007 ± 0.003	0.012 ± 0.004
Zinc (ng/ml)	37.0 ± 3.3	12.4 ± 0.6	2.1 ± 0.3	6.0 ± 1.1
Cadmium (ng/ml)	0.23 ± 0.02	.16 ± 0.01	0.54 ± 0.16	0.13 ± 0.01

[a]See Fig.

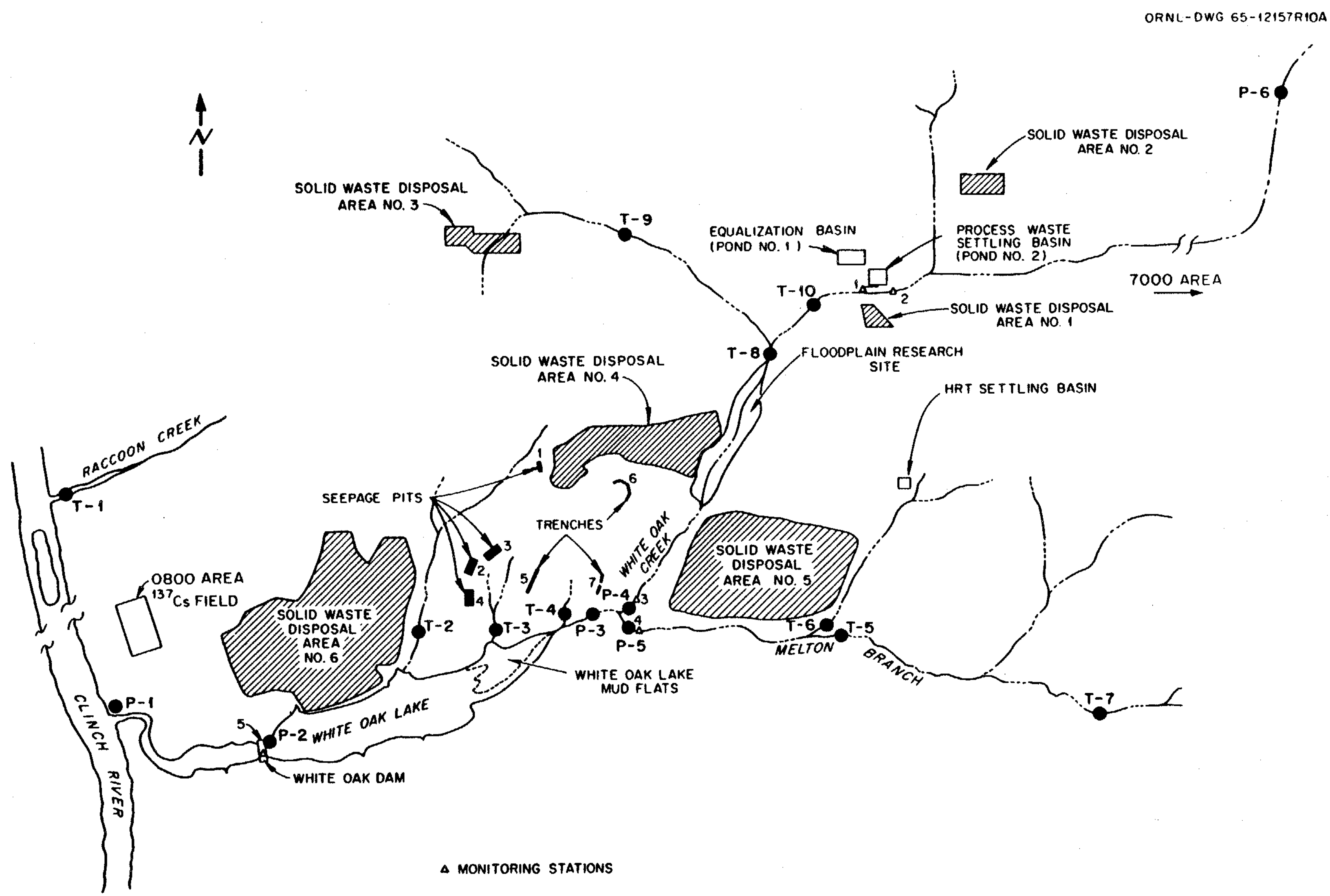

Fig. 4.4.4 Chemical Water Sampling Locations

Table 4.4.9 National Pollutant Discharge Elimination System (NPDES) Experience - 1979

Discharge Point	Effluent Parameters	Daily Effluent Limits[a] (mg/l) Average	Maximum	% of Measurments in Compliance
ORNL 001 White Oak Creek	Dissolved Oxygen (min.)	5	--	100
	Dissolved Solids	--	2000	100
	Oil and Grease	10	15	89
	Chromium (Total)	--	0.05	100
	pH (pH units)	--	6.0-9.0	100
002 Melton Branch	Chromium (Total)	--	0.05	100
	Dissolved Solids	--	2000	100
	Oil and Grease	10	15	100
	pH (pH units)	--	6.0-9.0	100
003 Main Sanitary Treatment Facility	Ammonia (N)	--	5	56
	BOD	--	20	85
	Chlorine Residual	--	0.5-2.0	99
	Fecal Coliform Bact. (No./100 ml)	200[b]	400[c]	100
	pH (pH units)	--	6.0-9.0	100
	Suspended Solids	--	30	92
	Settleable Solids (ml/l)	--	0.5	94

[a]Limit applicable only during normal operations. Not applicable during periods of increased discharge due to surface run-off resulting from precipitation.

[b]Monthly average.

[c]Weekly average.

Table 4.4.10 Radionuclide Content in Clinch River Fish - 1979

pCi/kg Wet Weight

Location	Species[a]	^{90}Sr	^{239}Pu	^{238}Pu	^{238}U	^{235}U	^{234}U	^{137}Cs	^{60}Co	^{40}K	%MPI[b]	Hg(ng/g)	%A.L.[c]
CRM 5.0	Bass	2.1	0.03	0.02	0.35	0.03	0.49	151	6.1	327	0.03	2.6	0.5
	Blue Gill	6.3	0.05	0.02	0.72	0.16	1.15	77	3.9	4137	0.05	3.1	0.6
	Carp	4.9	0.01	0.02	0.63	0.08	0.84	59	3.1	3525	0.04	5.6	1.1
	Shad	8.8	0.05	0.02	6.20	0.34	9.24	66	4.8	2508	0.07	0.7	0.1
	Crappie	4.9	0.02	0.02	0.42	0.04	0.80	56	3.8	2819	0.11	2.0	0.4
CRM 12.0	Bass	8.9	0.06	0.03	1.20	0.23	2.32	1649	12.7	16177	0.21	5.2	1.0
	Blue Gill	21.1	0.88	0.88	9.40	2.31	11.70	120	14.6	12870	0.16	5.9	1.2
	Carp	17.6	0.23	0.17	8.10	0.68	13.0	406	15.9	1896	0.17	20.0	4.0
	Shad	46.9	0.26	0.03	10.40	0.79	13.50	416	19.5	7288	0.38	1.7	0.3
	Crappie	13.7	0.03	0.10	1.30	8.50	3.10	683	13.6	1808	0.17	4.2	6.8
CRM 20.8[d]	Bass	10.6	0.01	0.01	0.21	0.06	0.44	1352	9.4	275	0.51	3.1	0.3
	Blue Gill	255.4	0.03	0.08	0.70	0.08	1.25	3955	91.9	3159	2.20	3.7	0.7
	Carp	56.7	0.02	0.03	0.29	0.08	0.56	502	16.6	3314	0.45	2.6	0.5
	Shad	23.4	0.06	0.09	2.04	0.27	3.28	513	82.0	2668	0.23	0.5	0.1
	Crappie	14.0	0.01	0.15	0.71	0.09	1.85	393	10.8	4021	0.14	3.2	0.6
CRM 25.0	Bass	6.9	0.04	0.08	1.20	0.23	1.69	219	11.6	23870	0.07	1.2	0.2
	Blue Gill	6.9	0.07	0.70	1.90	1.40	5.21	153	20.8	20126	0.07	0.7	0.1
	Carp	3.8	0.08	0.08	1.10	0.56	1.8	29	18.0	13875	0.03	1.4	0.3
	Shad	6.6	0.07	0.07	3.40	0.33	3.29	32	16.6	10528	0.07	0.2	0.1

[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 37 lb/yr of the species in question. Only man-made radionuclides were used in the calculation.

[c] Percent of proposed FDA action level of 500 ng/g.

[d] Average of quarterly samples.

Table 4.5.1 External Gamma Radiation Measurements at Local Air Monitoring Stations - 1979

Station Number	μR/hr[a]	mR/yr[b]
HP-1	24	212
HP-2	67	585
HP-3	9	76
HP-4	229	2015
HP-5	23	284
HP-6	45	396
HP-7	6	54
HP-8	8	73
HP-9	9	75
HP-10	7	59
HP-11	10	84
HP-12	43	374
HP-13	160	1406
HP-14	11	98
HP-15	17	148
HP-16	8	70
HP-17	10	88
HP-18	8	68
HP-19	11	97
HP-20	10	89
HP-21	8	74
HP-22	11	93
Average	34	296

[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 - 1979

Station Number	Location	Number of Measurements Taken	Background μR/hr	Background mR/yr
Perimeter Stations[a]				
HP-23	Walker Branch	12	7.5	66
HP-31	Kerr Hollow Gate	12	9.9	87
HP-32	Midway Gate	10	9.8	86
HP-33	Gallaher Gate	12	9.3	82
HP-34	White Oak Dam	11	11.4	100
HP-35	Blair Gate	12	9.9	87
HP-36	Turnpike Gate	11	8.7	76
HP-37	Hickory Creek Bend	12	8.5	75
HP-38	East of EGCR	12	8.6	76
HP-39	Townsite	12	8.2	72
Average			9.2	84
Remote Stations[b]				
HP-51	Norris Dam	2	5.6	49
HP-52	Loudoun Dam	2	7.1	62
HP-53	Douglas Dam	2	5.7	50
HP-54	Cherokee Dam	2	5.4	47
HP-55	Watts Bar Dam	2	6.1	54
HP-56	Great Falls Dam	2	6.0	53
HP-57	Dale Hollow Dam	2	10.3	91
HP-58	Knoxville	2	11.0	97
Average			7.2	63

[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 - 1979

Location[a]	μR/hr	mR/yr[b]
HP-60	11.8	104
HP-61	17.3	152
HP-62	31.2	274
HP-63	58.6	515
HP-64	27.2	239
HP-65	34.2	303
HP-66	29.1	256
HP-67	22.4	197
HP-68	13.1	115
HP-69	12.5	110

[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 - 1979 (pCi/g-Dry Weight)

Sampling Location[a]	^{90}Sr	^{137}Cs	^{226}Ra	^{234}U	^{235}U	^{238}U	^{238}Pu	^{239}Pu
				Perimeter				
HP-31	.3	1.0	1.5	0.4	.01	.23	.003	.02
HP-32	.3	1.5	0.9	1.4	.05	.86	.002	.02
HP-33	.4	1.8	0.9	0.3	.02	.21	.001	.01
HP-34	.5	2.6	0.9	0.3	.01	.21	.001	.06
HP-35	.1	2.0	1.2	0.5	.03	.37	.001	.04
HP-36	.2	1.8	1.1	0.4	.02	.31	.001	.03
HP-37	.2	0.7	0.7	0.4	.02	.27	.010	.01
HP-38	.3	1.4	0.6	0.3	.01	.24	.003	.02
HP-39	.4	2.4	1.1	1.1	.03	.90	.002	.03
Average	.4	1.5	1.0	0.6	.02	.38	.003	.03
				Remote				
HP-51	.12	0.9	1.0	.30	.01	.25	.002	.01
HP-52	.38	1.7	1.4	.62	.02	.49	.001	.02
HP-53	.30	1.5	2.1	.89	.04	.76	.001	.04
HP-54	.17	2.8	1.5	.57	.02	.54	.001	.05
HP-55	.43	1.5	1.1	.43	.03	.32	.002	.02
HP-56	.21	1.6	1.1	.32	.02	.26	.002	.03
HP-57	.20	2.3	1.4	.62	.02	.49	.001	.04
HP-58	.24	1.4	1.0	.38	.02	.30	.001	.02
Average	.29	1.7	1.3	.52	.02	.43	.001	.03

[a] See Figs. 4.1.3 and 4.1.4.

Table 4.6.2 Radioactivity in Grass Samples from Perimeter and Remote Monitoring Stations - 1979 (pCi/g-Dry Weight)

Sampling Location[a]	^{7}Be	^{90}Sr	^{137}Cs	^{239}Pu	^{238}Pu	^{238}U	^{235}U	^{234}U
				Perimeter				
HP-31	13	.6	.2	.002	.001	.04	.010	.08
HP-32	10	.6	ND	.010	.010	.01	.010	.36
HP-33	10	.5	ND	.001	.001	.02	.004	.03
HP-34	8	.6	.3	.001	.001	.03	.004	.03
HP-35	4	.1	.1	.002	.002	.03	.001	.04
HP-36	10	.6	.1	.003	.003	.03	.004	.05
HP-37	10	.4	ND	.001	.003	.02	.002	.03
HP-38	6	.3	ND	.004	.004	.03	.004	.04
HP-39	19	.5	.2	.002	.001	.04	.002	.03
Average	11	.5	.1	.003	.003	.03	.005	.03
				Remote				
HP-51	14	.6	.1	.001	.0014	.08	.008	.09
HP-52	14	.1	.1	.001	.0022	.02	.004	.01
HP-53	13	.3	.1	.001	.0005	.09	.010	.10
HP-54	12	.4	.1	.001	.0003	.01	.003	.01
HP-55	12	.4	.2	.002	.0005	.06	.006	.08
HP-56	20	.2	.3	.002	.0003	.02	.005	.03
HP-57	26	.3	.1	.002	.0005	.03	.005	.05
HP-58	16	.4	.1	.001	.0003	.04	.004	.06
Average	16	.3	.1	.001	.0008	.04	.010	.05

[a] See Figs. 4.1.3 and 4.1.4.

Table 4.7.1 Radionuclide Concentration in Deer Samples - 1979
(pCi/kg Wet Weight)

Sample No.	Location	Sex	Organ	^{137}Cs	^{40}K
1	Bear Creek Road 0.8 km South of Highway 58	M	L[a]	19	2238
			M[b]	43	2808
2	Bethal Valley Road 0.4 km East of Building 7000	M	L	19	1958
			M	81	2862
3	Waste Pit 4 (found dead)	M	M	38	1215
4	Bear Creek Road at K-25 Target Range	M	L	ND*	2309
			M	27	2479
5	Bear Creek Road 0.8 km West of K-25 Target Range	M	L	ND	2128
			M	41	2823
6	Bear Creek Road 1.7 km East of Highway 95	F	L	49	2109
			M	49	2649
7	Bear Creek Road at Highway 95	M	M	24	2889
			S[c]	ND	6453
8	Melton Valley Drive 0.8 km East of 7900 Area	M	L	16	2298
			M	43	2808
			S	24	2198
9	New Zion Road at Highway 95	F	L	ND	1742
			M	30	2066
			S	24	7965
10	Bethal Valley Road at Building 0903	M	L	57	2338
			M	51	2489
			S	ND	2338
11	Highway 95 0.8 km South of Highway 58	F	L	19	2479
			M	70	2754
			S	ND	5454
12	Interstate 75 2 km North of Clinton Exit	F	L	35	3051
			M	95	3105
			S	ND	4590
13	Norris Dam	M	L	46	2787
			M	149	2787
			S	375	6453
14	Scarboro Road at Entrance to Y-12 East Portal	F	L	95	2117
			M	119	2498
			S	589	4455
15	Blair Road Near K-25 Portal 6	M	L	ND	1898
			M	27	2357
			S	11	2616
16	Bear Creek Road 0.3 km West of County Line	F	L	46	2406
			M	100	2317
			S	16	2579
17	Highway 58 Between K-25 Overlook and Clinch River	M	L	11	1877
			M	24	2657
			S	16	1647
18	K-25 North Perimeter Road Near Top of East Side of Ridge	M	S	203	2238
19	Highway 95 0.2 km North of Highway 58/95 Intersection	M	L	143	1717
			B[d]	162	2187
20	Highway 95 0.8 km South of Highway 58	F	L	65	2149
			M	170	1949
21	Highway 95 0.1 km South of Midway Turnpike	M	M	119	2049
			S	62	2527
22	Highway 58 0.4 km South of Clinch River at Gallaher Bridge	F	L	208	2117
			M	589	2787
23	Highway 58 Halfway Between Blair Road and K-25 Portal 3	F	L	105	2516
			M	140	2238
24	Poacher (U.T. Arboretum)	M	M	548	2627

*ND - Not Detectable
a - Liver
b - Muscle
c - Stomach
d - Blood

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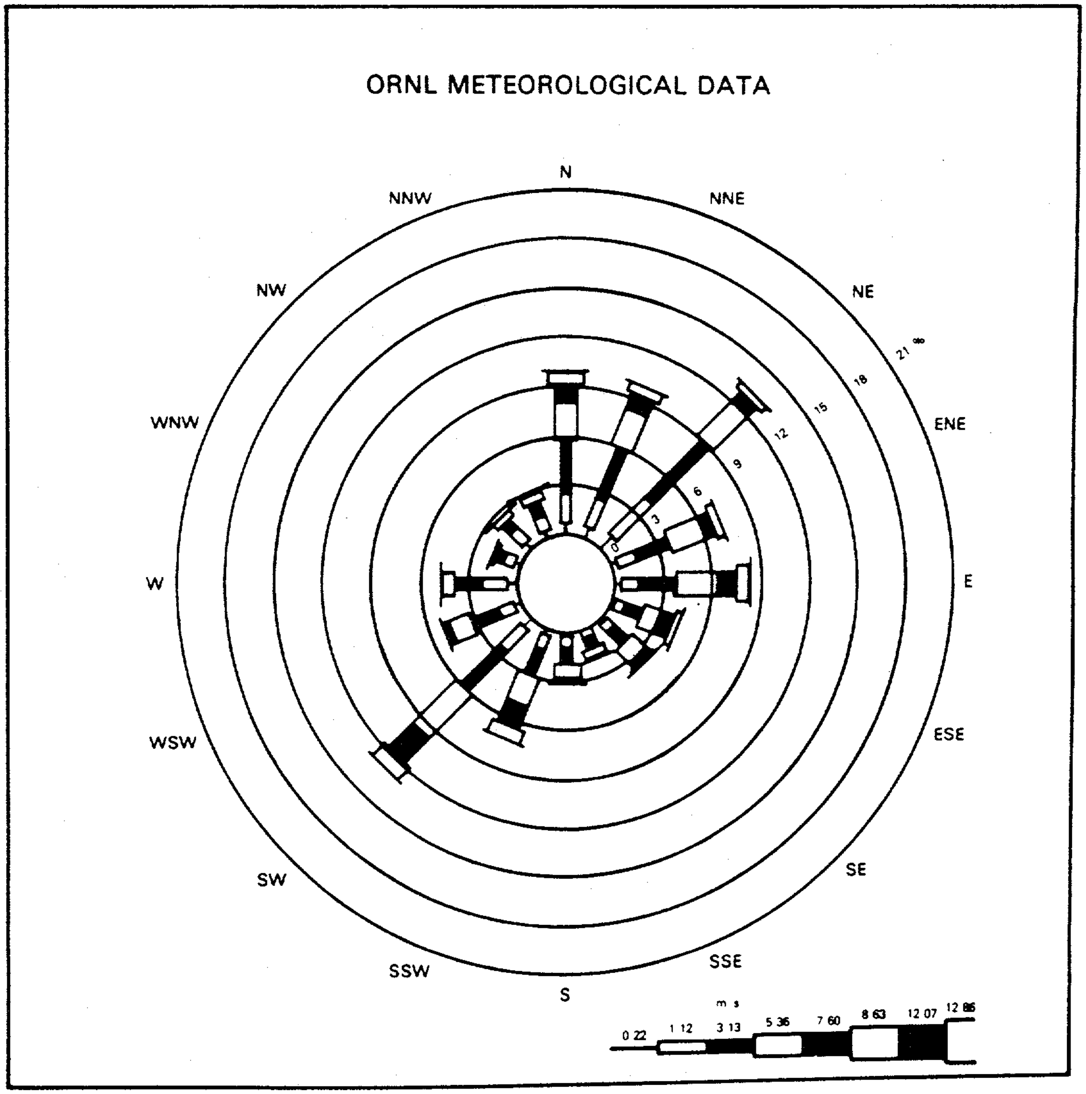

Fig. 4.8.1 Meteorological Data for the Oak Ridge Reservation

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 1979 at Locations of Maximum Exposure

Pathway	Location	Dose (millirem)	
		Total Body	Critical Organ
Gaseous Effluents			
Inhalation plus direct radiation from air and ground	Nearest resident to site boundary	0.5 ± 300%	5.1 ± 300% (lung)
Terrestrial food chains	Milk sampling stations (^{90}Sr)	0.20	7.3
Liquid Effluents			
Aquatic food chains	Clinch-Tennesse River System (^{90}Sr)	2.4	118 (bone)
Drinking water[a]	Kingston, Tennessee (^{90}Sr)	0.05	2.3 (bone)
Direct radiation along water, shores, and mud flats[b]	Downstream from White Oak Creek near experiment CS field plots	6.6	6.6 (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 - 1979

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	979
Fish	Radiochemical, Gamma Spectrometry	38 Groups
Rainwater	Gross Beta	979
Raw Milk	^{131}I, ^{90}Sr	457
White Oak Dam Effluent	Gross Beta, Radiochemical, Gamma Spectrometry	415
White Oak Creek	Gross Beta, Radiochemical Gamma Spectrometry	240
Clinch River Water	Radiochemical, Gamma Spectrometry	55
Potable Water	Radiochemical, Gamma Spectrometry	8
Soil Samples	Gamma Spectrometry, Wet-Chemistry	26
Grass Samples	Gamma Spectrometry, Wet-Chemistry	26
Deer Samples	Gamma Spectrometry	24

5.0 RADIATION AND SAFETY SURVEYS

5.1 Laboratory Operations Monitoring

During 1979 personnel of the Radation and Safety Surveys Section provided guidance information and recommendations to the research and operating groups in support of the 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 Pool Critical Assembly, Building 3010

The Pressure Vessel Surveillance Dosimetry Study, begun in 1978, was continued through 1979. This program, of international significance, is designed to measure the radiation doses at varying depths in the walls of reactor pressure vessels as an indication of the radiation effects to be expected. It involved the use of a multiplicity of dosimetric devices - fissile foils, solid state track recorders, gamma and neutron spectrometers, fission chambers - each of which required radiation surveillance monitoring after irradiation in the assembly.

Exposures to personnel were held to a small percentage of permissible levels, and contamination was successfully contained within the established zones.

5.1.2 Radiochemical Pilot Plant Operations, Building 3019

One of the major programs in the Radiochemical Pilot Plant, operated by the Chemical Technology Division, was the loading of 57 kg of $^{233}U_3O_8$ into 1,743 stainless steel packets for criticality studies in the Argonne National Laboratory's Zero Power Reactor. Purified feed solution for the Oxide Conversion Facility was produced in the remotely operated, directly maintained Solvent Extraction and Ion Exchange Systems in Cells 5, 6 and 7. Extensive monitoring and decontamination efforts were necessary in order to meet the surface alpha contamination limits specified by ANL for the loaded packets. Containment of hazardous alpha emitters and control of personnel exposures to β-γ radiation from the ^{232}U decay products were satisfactory throughout the program.

5.1.3 Hot Cell Operations, Buildings 3026-D and 3525

The work of the Hot Cell Operations Group at the High Level Segmenting Cell Facility and the High Radiation Level Examination Laboratory is primarily concerned with experiments or materials which have been irradiated in various reactors across the country and are intensely radioactive. The demand for these services is shown by the fact that over 240 shipments (in and out) of shielded carriers containing such materials were processed during the year. Some 40 loads of scrap material were generated in these operations and sent to the Solid Waste Disposal Facilities. Each of these package shipments required careful monitoring by Radiation and Safety Surveys personnel to ensure that the radiation shielding and contamination containment provisions conformed to Laboratory standards. Personnel exposures were well within permissible levels, and contamination problems were confined to zoned areas where controls were adequate.

5.1.4 Isotope Area Operations, Building 3038, et al

Work in this area, principally the production, packaging, and shipping of radioisotopes continued at about the same level as in the previous year. Medical research isotopes processed included ^{33}P, ^{43}K, ^{57}Co, ^{60}Co, ^{75}Se, ^{153}Gd, and ^{195m}Pt. Industrial and experimental users required supplies of ^{3}H, ^{37}Ar, ^{56}Co, ^{57}Co, ^{60}Co, ^{131}I, ^{153}Gd, ^{192}Ir, ^{237}U, ^{237}Np, ^{236}Pu, ^{237}Pu, and ^{242}Pu. The Research Materials Laboratory continued to supply customer needs for dosimeters fabricated from various isotopes of thorium, uranium, neptunium and plutonium. In all, over 2,600 packages of radioactive materials were shipped from the Laboratory during the year. The monitoring services provided assured that each package was in compliance with applicable DOT regulations.

Two major operations (both involving window replacements in hot cell facilities) were completed in Building 3028. Extensive decontamination plus local shielding with lead and plywood sheets enabled the replacement of the windows in the Iodine Cell to be done in working backgrounds of 200 to 1500 mR/hr.

The decontamination effort in Cell 2 was not quite so successful due to the presence of a number of loose metallic wafers of ^{192}Ir, very small but intensely radioactive. In addition to lead sheets placed on the cell floor, a concrete pad ($\sim$ 1.2 meters thick) was poured in from the back door, and covered by a stainless steel pan. The working background in the cell remained in the 2 to 5 R/hr range while the window replacement was completed. Close surveillance monitoring by Health Physics personnel succeeded in keeping dose equivalents to all those involved within permissible limits.

5.1.5 Oak Ridge Research Reactor, Building 3042

Surveillance monitoring services were provided for completion of the modifications and installations necessary for the initial operations of the Neutron Diffraction Program being implemented by Ames National Laboratory personnel at four horizontal beam facilities (HB-1, HB-2, HB-4, HB-5). Despite occasionally excessive dose rates, the dose equivalents to involved personnel were maintained within acceptable limits.

5.1.6 Fission Product Development Laboratory, Building 3517

The first step toward decontamination and decommissioning of this building was taken during 1979. Cell 19, a small manipulator cell which had been used for separation and processing of ^{144}Ce and ^{147}Pm, was dismantled and removed from the building. Decontamination, following removal of manipulators and equipment, was only partially successful. Radiation levels up to 2 R/hr and a working background of 200 mR/hr existed during removal of the stainless steel liner and dismantling of the walls. Surveillance monitoring of these operations was effective in controlling personnel exposures and preventing any significant release of contamination.

5.1.7 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 fuction as building operators in charge of all aspects of the TRL ventilation and containment system.

5.1.8 Nuclear Safety Pilot Plant Operations, Building 7500

The Nuclear Safety Pilot Plant conducted several experiments in which uranium was converted to UO_2 by burning in order to simulate fuel aerosol particles which might be found in the unlikely event of an accident involving the fuel in fast reactors. Sample studies were made of the resultant fall-out 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 were provided during these experiments which were made without incident.

5.1.9 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 intercomparison studies, both international in scope of participation, were conducted during the year. One was related to personnel dosimetry; the other to nuclear accident dosimetry.

During the months of February, March, and April, Building 7712, which formerly housed the Dosar Linear Accelerator, was decontaminated and decommissioned. The operation entailed the processing of approximately 1,200 smears for evaluation of ^3H contamination and others for more usual beta, gamma and/or alpha contamination. Many valuable items of material or equipment were cleaned and released for use by other experimenters or sent to salvage or idle equipment storage. The building was released for use as a document storage and experiment preparation area.

Health Physics coverage was provided for employees improving reactor controls and contractor personnel working on improving reactor and material surveillance and security systems.

Special assistance was provided for a radiation biology experiment in which 150 rats (3 groups of 50 rats each) were irradiated at very low dose rates for up to 15 hours per day, 5 days per week for four weeks.

5.1.10 High Flux Isotope Reactor, Building 7900

Although this reactor has an outstanding record in terms of percent of time at full power operation, a number of shutdowns are still necessary. During 1979, in fact, the reactor was shut down 16 times for replacement of fuel and some of the target rods. These "down" intervals are also utilized as optimum times for component inspection, testing, and replacement. These operations require close health physics surveillance due to the levels of radioactivity associated with such components, and the resultant potential for personnel exposures and contamination releases. All operations requiring lowered pool levels for in-pool work, or in the sub-pile room where water leaks from the reactor vessel, must be stringently controlled and diligently monitored because of the contamination levels involved.

Two other especially hazardous operations took place during this period. One involved replacing the cation resin from one of the primary coolant demineralizer units by pumping this highly radioactive material (as a slurry) from a shielded cell into shielded transfer casks in a normally clean area. The other involved removal and replacement of the filters from the Hot Off-Gas System. Some of these were grossly contaminated with ^{244}Cm. In both operations, contamination was confined to zoned areas and dose equivalents to personnel were well within approved limits.

5.1.11 Chemical Technology Operations, Building 7920

Application of the ALARA concept in a review of process operations at the TRU Facility, with particular emphasis on glove box work and waste handling, has produced encouraging results. Special tools for remote handling of materials in the boxes were developed, and shielding added to the boxes in several cases.

Dose equivalents resulting from waste handling operations have been improved by a more refined partitioning of the wastes and a more equitable distribution of the work load among available personnel.

Maintenance work on process equipment in Cell Pit 5 and the pipe tunnel was completed without significant incident. This was quite an accomplishment in view of the facts that transplutonium nuclide contamination levels exceeded 10^6 d/m/100 cm^2 and that gamma and neutron dose rates required limited work times for each individual. Precision planning, cautious execution, and continuous monitoring were key points in the success of this work.

5.1.12 Fusion Energy Operations, Building 9204-1

A large ($\sim$ 11 meters diameter by 11 meters high) stainless steel tank was assembled in the building for magnetic coil testing. The tank was brought in in several segments which were then welded together. All welds were given full radiographic inspection with x-ray equipment. Health physics surveillance monitoring was provided for these operations.

5.1.13 Chemical Technology Operations, Building 9204-3

The electromagnetic separation was put in operation to produce 250 grams of 99.9^{+}% pure ^{242}Pu. Each step in this operation was closely monitored for airborne activity and contamination releases. Enhanced internal dosimetry procedures were imposed on operating personnel. There were no detectable problems during the preparation of this highly hazardous material.

5.1.14 Tank Farm Area Operations

Close surveillance was provided during the cutting of old intermediate level liquid waste lines and the "tie-ins" of new lines in the tank farm area, all in conjunction with the upgrading of the liquid waste system. Exposures were kept well below maximum permissible levels and contamination control was adequate.

5.1.15 Shale Fracturing Facility Operations

Continuous surveillance was provided in May during the injection of approximately 83,000 gallons of intermediate level liquid waste containing about 13,973 curies of activity. All personnel exposures were kept below maximum permissible levels and contamination control was maintained.

5.1.16 Contaminated Above Ground Equipment Storage Area

Close surveillance was provided during the removal and disposal of contaminated equipment from the "above ground" storage area. Although many radiation and contamination problems were encountered during this work, contamination of personnel was prevented and personnel exposures were kept well below maximum permissible levels.

5.1.17 New ORNL Telephone Network

Close surveillance was provided in certain areas throughout the Laboratory during excavation work for the installation of underground telephone cables and manholes. Only minor contamination problems were encountered, but by early detection of the contaminated areas it was possible to prevent contamination of personnel and equipment.

5.2 X Ray and Microwave Safety Programs

5.2.1 X Ray Program

Two new x-ray units were put into service during the year. The safety systems were checked and found to comply with ORNL standards. Radiation surveys of these units indicated satisfactory shielding. Routine safety reviews were conducted for 28 of the older x-ray units.

A detailed review of the medical unit was conducted. The review included dosimetric studies utilizing TLD dosimeters and a Rando phantom. Patient exposures were measured for seven of the most common diagnostic procedures. These exposures were compared to those given at other federal facilities and found to be approximately the same as the average exposures for comparable procedures at those facilities.

5.2.2 Microwave Program

Seven new microwave cooking ovens were checked for microwave leakage and interlock integrity. Approximately 25 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 Operations

Approximately 595,000 articles of wearing apparel and 209,000 articles such as mops, laundry bags, towels, etc. were monitored at the Laundry during 1979. Approximately five percent were found contaminated. Of 453,345 khaki garments monitored during the year, only 86 were found contaminated.

A total of 4,867 full face respirators and 5,609 canisters were monitored during the year. Of these numbers, 175 masks and 188 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 two such occurrences in 1979 (may be compared to 15 which occurred in 1978). All were of minor significance.

6.0 INDUSTRIAL SAFETY AND SPECIAL PROJECTS

During 1979 the Laboratory completed the fifth consecutive year in which the goals set by UCC-ND Management for prevention of injuries were met or improved upon. Three disabling injuries or lost workday cases occurred during the year.

For the fifth straight year, the Laboratory earned the highest award of both the Union Carbide Corporation and the National Safety Council: the Award of Distinguished Safety Performance and the Award of Honor.

6.1 Accident Analysis

The injury statistics for ORNL for the period 1970-1979 are shown in Table 6.1.1, page 82. 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, page 83; 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, page 84.

Thirteen ORNL divisions did not have a recordable injury or illness in 1979. Injury statistics by divisions are shown in Table 6.1.4, page 85.

Disabling injury accident-free periods for ORNL are shown in Table 6.1.5, page 86. From March 26, 1979, through September 14, 1979, the Laboratory accumulated over 4 million workhours without a disabling injury.

Table 6.1.6, Figure 6.1.1, and Table 6.1.7, pages 87, 88, and 89, 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 page 90.

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, pages 91 and 92. There was a significant decrease in the number of vehicle accidents during 1979, from 29 in 1978 to 17 in 1979. 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 1979 remained about the same as the number reported for 1978. 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 one off-the-job fatality that occurred during the year was the result of a one car vehicle accident.

6.2 Summary of Disabling Injuries

The following are summaries of three disabling injuries experienced at ORNL in 1979.

Date of Injury - March 23, 1979

A welder apprentice suffered a severed tendon of the right index finger as he was helping to lower a tool chest from the back of a pickup truck. During the unloading process, the chest started slipping out of the grasp of the two men; and in the scramble to remove his hand, the employee cut the tendon on the raw sheet metal chest. Time loss: 20 days

Date of Injury - September 14, 1979

A pipefitter received fractures of the 2nd and 3rd fingers of the left hand while grinding the jaws of an adjustable wrench using a pedestal grinder. The jaws of the wrench seized the grinding wheel catching the employee's fingers between the wrench and the work rest, resulting in the fractures of the two fingers. Time loss: 5 days

Date of Injury - October 24, 1979

A staff member of the I&C Division suffered a broken leg while making a turn on a moped. During the turning maneuver, the front wheel of the moped struck the curb and he was thrown off the machine, breaking his right leg. Time loss: 52 days

6.3 Safety Awards

Each Laboratory employee at the X-10 site and on the payroll as of December 31, 1979, earned a $13.00 safety award. Samples of the awards were placed on display and each employee had the opportunity to view the samples and fill in a card indicating their award choice. The items chosen were mailed directly to the homes of the employees.

Table 6.1.1 ORNL Injury Statistics (1970-1979)

	Disabling Injuries (DI)			Lost Workday Cases (LWC)		Recordable Injuries and Illnesses (RII)	
	Number	Frequency Rate[1]	Severity Rate[2]	LWCIR	LWIR	Number	Incidence Rate[3]
1970	5	0.76	88	-	-	49	7.5
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

*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) are being based on the OSHA system ANSI (Z16.4-1977) for measuring lost workday experience:

$$\text{LWCIR} = \frac{\text{No. Lost Workday Cases X 200,000}}{\text{Exposure or Employee-hours}}$$

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

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

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

[3]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 (1975-1979)[1]

	1975	1976	1977	1978	1979
Number of Injuries	2	1	1	3	3
Labor Hours (Millions)	7.3	7.6	8.0	8.4	8.4
Incidence Rate	0.05	0.03	0.02	0.07	0.07
Days Lost or Charged	173	106	70	55	69
Severity Rate	4.8	2.8	1.8	1.30	1.64

[1]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	----	0.67
1978	0.07*	----	----	0.75
1979	0.07	----	----	0.17

*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 - 1979

Division	Medical Reports Received	Recordable Injuries and Illnesses		Lost Workday Cases (LWC)*			Exposure Hours (In Millions)
		Number	Incidence Rate	Number	Incidence Rate (LWCIR)	Severity Rate (LWIR)	
Analytical Chemistry	5	1	0.84				.239
Chemistry	14	0	0				.213
Central Management	2	0	0				.135
Computer Sciences	6	0	0				.446
Chemical Technology	12	2	0.62				.643
Engineering	8	0	0				.454
Energy	0	0	0				.246
Engineering Physics	1	0	0				.142
Employee Relations	7	0	0				.171
Environmental Sciences	4	2	1.31				.306
Finance & Materials	15	0	0				.334
Health	1	0	0				.063
H & S Research	3	0	0				.231
Information	16	3	1.41				.526
Instr. and Controls	34	2	1.03	1	0.52	22.7	.388
Ind. Safety & AHP	2	0	0				.184
Laboratory Protection	14	1	1.06				.189
Metals & Ceramics	13	3	1.10				.545
Operations	24	3	1.14				.525
Physics	1	0	0				.207
Plant & Equipment	190	26	2.66	2	0.20	2.56	1.954
QA & Inspection	8	1	3.06				.065
Solid State	2	0	0				.195
PLANT TOTAL	382	44	1.05	3	0.07	1.64	8.401

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

Table 6.1.5 Disabling Injury Accident (Lost Workday Cases) Free Periods - ORNL (1972-1979)

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
Best Accident-Free Period	
July 4, 1968 - August 20, 1969	8,529,750

Table 6.1.6 Number and Percent of Accidents by Type - 1979

Type of Accident	Number	Percent
Struck Against	132	34.6
Struck By	116	30.4
Slip, Twist	26	6.8
Caught In, On, Between	53	13.9
Contact with Temp. Extremes	15	3.9
Fall, Same Level	28	7.3
Inhalation, Absp., Ingestion	0	0
Fall, Different Level	5	1.3
Other	7	1.8
TOTAL	382	100.0

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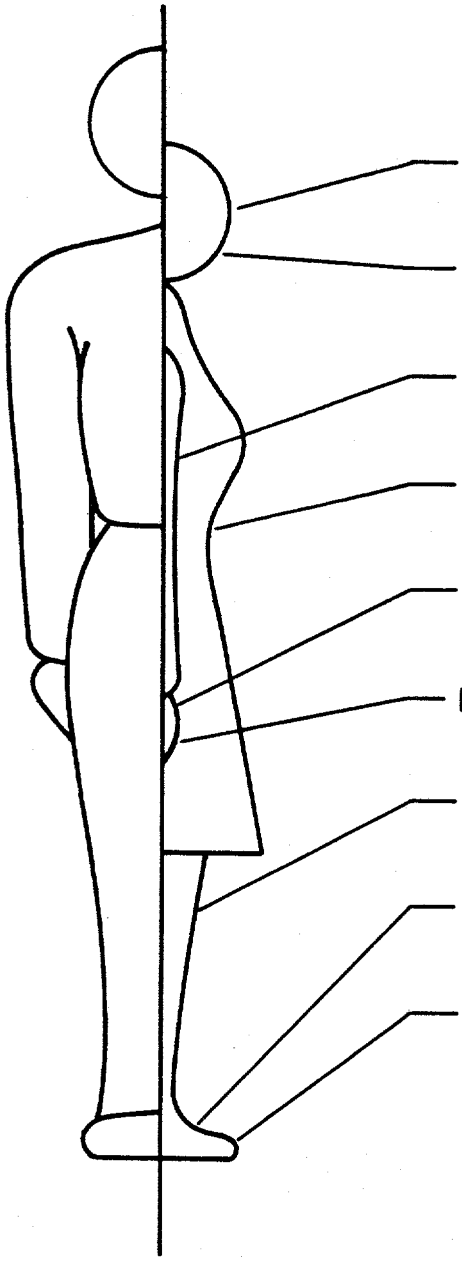

BODY AREA	%	TOTAL INJURIES
EYES	7.6	29
HEAD	10.7	41
ARMS	11.3	43
TRUNK	2.1	8
HANDS	7.3	28
FINGERS	37.4	143
LEGS	8.9	34
FEET	6.8	26
TOES	0.6	2
GENERAL	7.3	28

Fig. 6.1.1 Part of Body Injured

Table 6.1.7 Number and Percent of Accidents by Nature of Injury - 1979

Nature of Injury	Number	Percent
Laceration, Puncture	158	41.4
Contusion, Abrasion	100	26.2
Strain	24	6.3
Burn, Temperature	29	7.6
Sprain	21	5.5
Conjunctivitis	23	6.0
Burn, Chemical	7	1.8
Other	20	5.2
TOTAL	382	100.0

Table 6.1.8 Tabulation of Injuries by UCC-ND Facility - 1979

Plant	Labor Hours (Millions)	Lost Workday Cases*				Recordable Injuries and Illnesses	
		Number of Injuries	Incidence Rate (LWCIR)	Days Lost or Charged	Severity Rate (LWIR)	Number of Injuries**	Incidence Rate
ORNL	8.4	3	0.07	69	1.64	44	1.05
ORGDP	11.5	0	0	0	0	72	1.25
Y-12	12.3	2	0.03	94	1.50	55	0.89
Paducah	4.1	1	0.05	15	0.73	36	1.75

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

**Includes the number of Lost Workday Cases.

Table 6.1.9 Motor Vehicle Accidents (1975-1979)

Year	Number	Frequency Rate[1]	Damage
1975	7	3.33	$2,567
1976	14	6.42	$5,136
1977	12	5.05	$8,488
1978	29	13.49	$9,009
1979	17	8.39	$4,612

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

Table 6.1.10 Number of Fires (1975-1979)

Year	Number	Damage
1975	8	$16,493
1976	0	$ 0
1977	0	$ 0
1978	2	$16,095
1979	0	$ 0

Table 6.1.11 Number and Type of Off-The-Job Disabling Injuries (1975-1979)

	1975	1976	1977	1978	1979
Transportation	14	20	11	22	16
Home	16	17	11	28	34
Public	6	9	12	21	22
Total	36	46	34	71	72
Days Lost	1,724	1,251	765	1,055	1,499
Frequency Rate*	2.33	2.91	1.98	3.95	4.00
Fatalities	1	5	0	0	1

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

**Exposure Hours = 312 Hours/Employee Month.

7.0 OFFICE OF OPERATIONAL SAFETY

The Office of Operational Safety (OOS) serves as the focal point for operational safety activities of ORNL, providing management assurance that Laboratory safety requirements are included in the design, modification, and construction of facilities and that all facilities, including nuclear reactors, are operated safely. To discharge this responsibility, the office serves primarily as a liaison office, functioning between management and the operating and research divisions at the Laboratory and the Department of Energy. In this role, the Office coordinates (a) the activities of the Division Radiation Control Officers (RCOs) and Division Safety Officers (DSOs); (b) the activities of the Laboratory Director's Review Committees; and (c) the development of documentation required in the implementation of the DOE Manual Chapter 0531. The OOS also advises on safety-related matters requiring approval beyond the division level as well as initiates and assists in accident investigations. The OOS engages in numerous other activities not specifically categorized above, but listed in Procedure 1.1A of the Health Physics Procedures Manual and in the ORNL Safety and Loss Control Manual.

7.1 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 within the divisions they represent. Shown in Table 7.1.1 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 1979 the meetings were conducted on January 16, April 10, July 17, and October 23. The meetings are documented in ORNL/CF-79/83, ORNL/CF-79/139, ORNL/CF-79/252, and ORNL/CF-79/317. 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.

7.2 Implementation of the DOE Manual Chapter 0531 Requirements

Enactment of DOE Manual Chapter 0531, Safety of Nonreactor Nuclear Facilities, significantly impacted on the documentation requirements of facilities identified as "nonreactor" nuclear facilities. This manual Chapter specifies the requirements of SADs (Safety Assessment Document), PSARs (Preliminary Safety Analysis Report), FSARs (Final Safety Analysis Report) 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.

While there were a limited number of new facilities or projects requiring such documentation during 1979, 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 is shown in Table 7.2.1.

During 1979 safety analysis documentation was begun on the 7920 TRU Facility; 3019 Pilot Plant and 3100 Vault; a site generic document; Solid Waste Storage Facility; and the 5505 TRL Facility with scheduled completion dates for Safety Analysis Reports and Operating Safety Requirements in July, August, and September 1980. The Intermediate Level Waste Safety Analysis Report was completed; and the Intermediate Level Waste Operating Safety Requirements document final draft has been submitted to DOE for approval.

7.3 Laboratory Director's Review Committees

The Office of Operational Safety continued to coordinate the activities of ORNL's Director's Review Committees during 1979. The Laboratory currently has eight standing committees whose work is coordinated by the OOS, which are responsible for review and recommendations for approval of operation 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 the 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 1979 activities of the various review committees are shown in Tables 7.3.1 and 7.3.2.

7.4 Staff Consultation, Review, and Other Activities

In order to assure continuance of and promote safety in opera tion 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. Safety Manual procedures were completed for steam pit work and for assuring ASME code stamping of all pressure-containing equipment at the Laboratory. Charters for the Radioactive Operations Committee and Reactor Experiments Review Committee were completed. A new procedure for the design and use of glove boxes was issued. Assistance was given to several groups in 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, seismic and wind criteria for the ORNL area, review of the SF_6 system of the Holifield Heavy Ion Facility, and design criteria for a new Laboratory Emergency Control Center.

As part of the responsibility for providing liaison between management and DOE on safety matters, many meetings were held with DOE safety staff. The OOS staff participated in DOE audits of ORNL nuclear reactors, criticality and transporation, and preoperational audit of the Intermediate Level Waste System Evaporator. OOS responsibilities in DOE audits also include ensuring follow-up of audit recommendations and providing implementation progress reports when required.

The Office also assisted in establishing annual meetings of the Director's Committees with the Laboratory Executive Director and assisted in arranging the coordinating triennial internal audits of the Laboratory's Criticality Committee, Reactor Operations Review Committee, and Reactor Experiments Review Committee in conformance with DOE requirements.

7.5 Summary

During 1979 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 Office of Operational Safety staff continued to review and ensure review of operations and facilities by the appropriate Director's Committees to assure management of the continued safe operation of all Laboratory facilities. A program was instituted for the implementation of Manual Chapter 0531 by allocation of funds and the establishment of a schedule and program for revision of safety analysis reports for existing facilities.

Table 7.1.1 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	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

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		
Tritium Target Facility	7025	$ 29,700
High Level Analytical Lab	2026	59,400
Radioisotope Production Laboratory/ Gas Handling	3033	59,400
High Level Chemical Development Lab	4507	59,400
Ceramic Fuels Alpha Technology	4508	59,400
	Total	$267,300
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	3026D	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		
85Kr 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	$1,893,500

*To complete work started in FY 1979

Table 7.3.1 Reviews and Reports by Laboratory Director's Review Committees

Facility	Review Date	ORNL Rpt.
Reactor Operations Review Committee		
High-Flux Isotope Reactor	2/8/79	CF 79/135
Health Physics Research Reactor	2/26/79	CF 79/170
Bulk Shielding Facility	3/1/79	CF 79/136
Oak Ridge Research Reactor	3/1/79	CF 79/137
Tower Shielding Facility	3/28/79	CF 79/138
Radioactive Operations Committee		
Radioactive Materials Analytical Laboratory	2/9/79	CF 79/54
Metal Recovery Facility	3/29/79	CF 79/188
Fisson Products Development Laboratory	3/29/79	CF 79/189
Radioisotope Production Laboratory F	4/11/79	CF 79/245
Radioisotope Production Laboratory, Annex	4/11/79	CF 79/288
Alpha Handling Facility	6/6/79	CF 80/26
Solid Waste Storage Area	6/19/79	CF 79/276
Physical Examination Hot Cells	9/11/79	CF 79/302
High Radiation Level Alpha Facility	10/17/79	CF 80/36
Tritium Target Facility	11/2/79	CF 79/327
High Level Chemical Development Laboratory	11/8/79	CF 79/315
Intermediate-Level Liquid Waste Evaporator System	12/5/79	CF 79/338

Facility	Review Date	Memo Date
Transportation Committee		
Shipment/Container		
French Iridium-192 Shipping Container	5/8/79	5/8/79*
Amendment to Certificate of Compliance 5507, HFIR Cask TC 7903	7/17/79	7/17/79*
Safety Analysis Report for Packaging the Unirradiated Fuel Shipping Container	2/79	2/28/79*
Technical Operations Proposed Iridium-192 Shipment	12/79	12/13/79*

*Memos prepared by Committee Chairman, E. M. King

Table 7.3.1 Reviews and Reports by Laboratory Director's Review Committees (con't.)

Facility	Review Date	Memo Date
Reactor Experiments Review Committee		
Installations/Operations		
Installation and Operation of Engineering Technology Gamma Heating Measuring Assembly in ORR Poolside	3/19,21/79	4/4/79
Production of Fission Mo-99 in ORR	9/20/79	10/5/79
Pressure Vessel Simulator at ORR	10/11/79	10/29/79
TRIGA-LEU Fuel Element Experiment in ORR	11/30/79	1/8/80
Facility		
High-Flux Isotope Reactor Experiments	Report-ORNL CF 79/61	
High Pressure Equipment Committee		
Equipment/Systems		
High Pressure, High Temperature Phase Equilibrium & Crystallization Studies of Model Magma Systems	3/29/79	5/16/79
High Pressure, High Temperature System, Building 4501	4/14/79	
Coal Liquefaction Material Test Facility, Building 4500S	4/17, 6/7/79	
High Pressure Equipment for Geochemical Research	8/2/79	
Electrical Safety Committee		
Discussions/Reviews	Date	
Double Insulated Tools	3/8/79	
Buildings Located Under Power Lines	3/8/79	
Coding of Defective Electrical Cords	3/8/79	
Insulated Electrical Hand Tools, with Purchasing Staff	3/26/79	
Comparison of Double Insulated and Three-Wire Hand Tools with Black & Decker Safety Assurance Manager	7/17/79	

Table 7.3.2 Summary of Meetings Held in 1979 by Laboratory Director's Review Committees

Date	Subject	Action
	Reactor Operations Review Committee	
2/8	The 1978 Reactor Operations Review Committee (RORC) Review of the HFIR	ORNL/CF-79/135
2/26	The 1978 Review of the Health Physics Research Reactor by the RORC	ORNL/CF-79/170
3/1	The 1978 Reactor Operations Review Committee Review of the Bulk Shielding Facility (BSF)	ORNL/CF-79/136
3/1	The 1978 Reactor Operations Review Committee Review of the Oak Ridge Research Reactor	ORNL/CF-79/137
3/28	The 1978 Review of the Tower Shielding Facility (TSF) by the Reactor Operations Review Committee	ORNL/CF-79/138
5/25	RORC Quarterly Meeting	Memo/Conlin-Hopkins 6/21/79
9/7	RORC Quarterly Meeting	Memo/Conlin-Hopkins 9/27/79
10/1	Annual Meeting with C. C. Hopkins	--
11/28	Prepare for Annual (1979) Reviews of ORR & HPRR	--
12/13	Annual Meeting with HPRR Operators	To be submitted
12/13	Annual Meeting with ORR Operators	To be submitted
12/17	Continue Annual Reviews of HPRR & ORR	
	Radioactive Operations Committee	
1/17	Intermediate Level Waste Safety Analysis Rpt.	Approved by ROC 1/17/79
2/9	Radioactive Operations Committee Review - Radioactive Materials Analytical Lab (RMAL) Building 2026, 2/9/79	ORNL/CF-79/54
2/27	Review of R. W. Schaich's Proposal to Dispose of Sr-90 Titanate Heat Source	Internal Memo

Date	Subject	Action
3/29	Radioactive Operations Committee Review - Metal Recovery Facility, Building 3505	ORNL/CF-79/188
3/29	Radioactive Operations Committee Review of Fission Products Development Laboratory	ORNL/CF-79/189
4/11	Radioactive Operations Committee Review of Building 3033, Radioisotope Production Lab. F	ORNL/CF-79/245
4/11	Radioactive Operations Committee Review of Building 3033 Annex, IRML	ORNL/CF-79/288
6/6	Radioactive Operations Committee Review - Alpha Handling Facility, Building 3038 (AHF)	ORNL/CF-80/26
6/19	Radioactive Operations Committee (ROC) Review of the Solid Waste Storage Area	ORNL/CF-79/276
7/2	Operation in Building 3508	Internal Memo
7/30	Intermediate Level Waste Operations Safety Requirements	Internal Memo
8/23	Annual Meeting with C. C. Hopkins	--
9/11	Radioactive Operations Committee Review - Physical Examination Hot Cells, Building 3025	ORNL/CF-79/302
10/17	Radioactive Operations Committee Review - High Radiation Level Alpha Facility (HRLAF), Building 3019B	ORNL/CF-80/36
11/2	Radioactive Operations Committee (ROC) Review of Building 7025, Tritium Target Facility	ORNL/CF-79/327
11/8	Radioactive Operations Committee Review - High Level Chemical Development Laboratory	ORNL/CF-79/315
12/5	Radioactive Operations Committee Review of the Recently Modified Intermediate-Level Liquid Waste Evaporator System, 2531, 2531 Annex & 2537	ORNL/CF-79/338
11/	Review of Proposal to Bury HFIR Control Plates	Internal Memo 1/29/80

Date	Subject	Action
	Transportation Committee	
2/79	Safety Analysis Report for Packaging: The Unirradiated Fuel Shipping Container	Memo/King - Mouring 2/28/79
5/8	French Iridium-192 Shipping Container	Memo/King - Hopkins 5/8/79
7/17	Amendment to Certificate of Compliance 5507 HFIR Cask TC 7903	Memo/King - Dist. 7/17/79
11/5	Annual Meeting with C. C. Hopkins	--
12/79	Review of Technical Operations Proposed Iridium-192 Shipment	Memo/King - Hopkins 12/13/79

Transportation Committee engineered approximately six new tie-down schemes in 1979.

Date	Subject	Action
	Reactor Experiments Review Committee	
3/19-21	Installation & Operation of Engineering Technology Gamma Heating-Measuring Assembly in ORR Poolside	Memo/4/4/79
8/16	Annual meeting with C. C. Hopkins	--
9/20	Operations Production of Fission ^{99}Mo in ORR	Memo/10/5/79
10/11	Installation of Pressure Vessel Simulator at ORR	Memo/10/29/79
11/30	TRIGA-LEU Fuel Element Experiment in ORR	Memo/1/8/80
	1978 RERC Reviews of Continuing HFIR Experiments	ORNL/CF-79/61

The RERC began periodic reviews of ORR Beam Tube and Pneumatic Tube Experiments (Ref. internal memos G. H. Jenks to C. C. Hopkins 8/28/79 and C. C. Hopkins to RERC 1/4/80). Results of all periodic reviews in ORR will be summarized in a CF memo when completed.

Date	Subject	Action
	High Pressure Equipment Review Committee	
3/29	High Pressure, High Temperature Phase Equilibrium & Crystallization Studies of Model Magma Systems	Memo/5/16/79
4/14	High Pressure, High Temperature System Room BG-72, 4501	--
4/17 6/7	Coal Liquefaction Material Test Facility in Room T-26, 4500S	--
8/2	High Pressure Equipment for Geochemical Research	--
	Electrical Safety Committee	
3/8	Double insulated tools Buildings located under power lines Coding of defective electrical cords	--
3/26	Discuss double insulated electrical hand tools with purchasing staff	--
7/17	Comparison of double insulated and three-wire hand tools with Black & Decker Safety Assurance Manager	--
10/22	Annual Meeting with C. C. Hopkins	--
Miscellaneous meetings of committee and subcommittees on "as called" basis.		
	Accelerators and Radiation Sources Review Committee	
4/4	Review of Solid State Division's Van de Graaff Accelerators in Building 3003	ORNL/CF-79/218
7/31	Accelerators and Radiation Sources Review Committee Review - Physics Division's Tandem Van de Graaff Accelerator in Building 5500	ORNL/CF-79/322
10/8	Annual Meeting with C. C. Hopkins	--
11/1	Accelerators and Radiation Sources Review Committee Review of TURF Cell B Operations	ORNL/CF-79/326

Date	Subject	Action
	Criticality Committee	
	1978 Nuclear Safety Annual Review	ORNL/CF-79/200
7/24	Gunite Tank Sludge Removal Program	Memo
7/26	Annual meeting with C. C. Hopkins	Memo

As in 1978 the majority of operations of the Committee were handled by the Committee Chairman through the Office of Operational Safety. These included processing 18 new Nuclear Safety Review Requests and numerous extensions of NSRs where operations or procedures previously granted approval, but were continuing, had not been changed.

The 1979 annual audit by the Criticality Committee was conducted in November and December and reported in ORNL/CF-80/27.

Other Audits

1979 was the year for triennial audit of the Reactor Operations Review Committee and the Reactor Experiments Review Committee. These were reported in ORNL/CF-79/269. The triennial review of the Criticality Committee was reported in ORNL/CF-79/259.

8.0 PUBLICATIONS

J. A. Auxier and D. M. Davis, Industrial Safety and Applied Health Physics Annual Report for 1978, ORNL-5543.

J. A. Auxier, C. D. Berger, C. M. Eisenhauer, T. F. Gesell, A. R. Jones, and M. E. Msterson, "Task Group Report on Health Physics and Dosimetry," President's Commission on the Accident at Three Mile Island, Government Printing Office, October 1979.

C. D. Berger and R. E. Goans, "A Rapid Method of ^{131}I Detection in Milk," pp. 783-784, in Health Physics, (37), December 1979.

G. H. Burger, M. E. Ramsey, G. C. Cain, D. M. Davis, C. L. Fox, R. V. McCord, F. R. Bruce, 1978 Appraisal of the Oak Ridge National Laboratory's Emergency Preparedness Program, ORNL/CF-79/278, September 20, 1979.

H. M. Butler, W. F. Ohnesorge, and J. A. Auxier, "Measured Distribution of Neutrons Inside Containment of a Pressurized Water Reactor," in Radiation Streaming in Power Reactors, US-DOE Report ORNL/RSIC (1979) 110.

J. S. Eldridge, T. W. Oakes, and K. E. Shank, "Fallout Monitoring", in Analytical Chemistry Division Annual Progress Report, ORNL-5518, May 1979.

J. S. Eldridge, T. W. Oakes and K. E. Shank, "Specific Radionuclide Analyses Applied to Air Monitoring Samples," Trans. of the Amer. Nucl. Soc., Atlanta, Georgia, June 1979.

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J. S. Eldridge and T. W. Oakes, "Environmental Surveillance," Analytical Chemistry Division Annual Progress Report for Period Ending December 31, 1978, ORNL-5518, p. 88, June 1979.

J. S. Eldrige, T. W. Oakes, W. C. Massey and K. E. Shank, "Low-Level Gamma-Ray Spectrometry Development for Environmental Monitoring," Analytical Chemistry Division Annual Progress Report for Period Ending December 31, 1978, ORNL-5518, p. 90, June 1979.

J. S. Eldridge and T. W. Oakes, "Radiochemical Emergency Preparedness Program," Analytical Chemistry Division Annual Progress Report for Period Ending December 31, 1978, ORNL-5518, p. 91, June 1979.

C. B. Fulmer, H. M. Butler, W. F. Ohnesorge, and S. W. Mosko, "Fast Neutron Dose Equivalent Rates in Heavy Ion Target Areas," in IEEE Translations on Nuclear Sciences, (NS-26), No. 2, April 1979.

F. F. Haywood, W. A. Goldsmith, P. M. Lantz, W. F. Fox, W. H. Shinpaugh, and H. M. Hubbard, Jr., Assessment of the Radiological Impact of the Inactive Uranium-Mill Tailings at Shiprock, New Mexico, ORNL-5447, December, 1979.

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, December, 1979.

T. D. Jones, D. G. Jacobs, J. A. Auxier, G. D. Kerr, "Risk of Cancer Based on Promotion from Cytotoxicity," National Bureau of Standards Publ. NBS SP 554, 1979.

R. A. Muntear, G. D. O'Kelley and J. S. Eldridge, "Geochemistry of Achondritic Meteorites: Gamma-Ray Studies," in Analytical Chemistry Division Annual Progress Report for Period Ending December 31, 1978, ORNL-5518, p. 92, June 1979.

T. W. Oakes and K. E. Shank, "A Review of Environmental Surveillance Data Around Low-Level Waste Disposal Areas at Oak Ridge National Laboratory," in Proceedings of the Twelfth Midyear Topical Symposium of the Health Physics Society, pp. 421-441, Williamsburg, Virginia, February 12-15, 1979.

T. W. Oakes and K. E. Shank, "ECO Watch: Environmental Protection at ORNL," ORNL Review 12(1) (1979).

T. W. Oakes and K. E. Shank, "Review of the Resources Conservation and Recovery Act," in Proceedings of the 1979 UCC-ND Waste Management Seminar, Oak Ridge, Tennessee, K-25 (March 6-7, 1979).

T. W. Oakes, J. S. Eldridge and K. E. Shank, "Investigation of ^{137}Cs, ^{60}Co, and ^{90}Sr Concentrations in Water and Sediment as a Function of Flow in White Oak Creek," Health Physics 37: 826, December 1979.

T. W.Oakes, J. S. Eldridge, K. E. Shank, W. R. Strodl, W. D. Travers, S. G. Oberg, G. L. Love, J. V. Panesko and J. B. Selby, "Mechanisms for Environmental Radiation Information Exchange," Health Physics 37: 838, December 1979.

T. W. Oakes and K. E. Shank, Radioactive Waste Disposal Areas and Associated Environmental Surveillance Data at Oak Ridge National Laboratory, ORNL/TM-5805, December 1979.

K. E. Shank and T. W. Oakes, "Environmental Surveillance and Evaluation Section," Industrial Safety and Applied Health Physics Annual Report for 1978, ORNL-5543, September 1979.

K. E. Shank, C. E. Easterly and T. W. Oakes, Congenital Malformation and Fetal Mortality Trends in Counties Surrounding Oak Ridge, ORNL/TM-5805, December 1979.

PRESENTATIONS

J. A. Auxier, "Low-Level Effects of Radiation on Humans, "East Tennessee Chapter, Health Physics Society Meeting, Oak Ridge, Tennessee, March 27, 1979.

J. A. Auxier, "Environmental Surveillance and Radiation Protection at ORNL," presentation to delegation from Chinese Nuclear Energy Society, People's Republic of China, Oak Ridge, Tennessee, April 2, 1979.

J. A. Auxier, "Low-Level Effects of Radiation on Humans," Joint Meeting of Eastern Carolinas Section of the American Nuclear Society and North Carolina Chapter of the Health Physics Society, Wrightsville Beach, North Carolina, May 11, 1979.

J. A. Auxier, "Low-Level Effects of Radiation on Humans," Naval Surface Weapons Laboratory, Bethesda, Maryland, September 5, 1979.

J. A. Auxier, "Low-Level Effects of Radiation on Humans," School of Nuclear Engineering, Georgia Institute of Technology, Atlanta, Georgia, September 27, 1979.

C. D. Berger, "A Rapid Method of ^{131}I Dectection in Milk," presented at the Health Physics Society Annual Meeting, Philadelphia, Pennsylvania, July 1979.

C. D. Berger, "^{210}Pb in the Lungs of Smokers," presented at the North Carolina Chapter Health Physics Society Annual Meeting, Boone, North Carolina, October 26, 1979.

C. D. Berger and R. E. Goans, "Comparison of a Hyperpure Germanium Array and a CsI-NaI Phoswich Detector," presented at the HPS Annual Meeting, Philadelphia, Pennsylvania, July 1979.

J. S. Eldridge, T. W. Oakes and K. E. Shank, "Instrumental Methods Used in Environmental Surveillance Programs Around a Low-level Radioactive Burial Site," presented at the 12th Midyear Topical Symposium of the Health Physics Society, Williamsburg, Virginia, February 12-15, 1979.

J. S. Eldridge, T. W. Oakes, and K. E. Shank, "Specific Radionuclide Analyses Applied to Air-Monitoring Samples," presented at the 25th Annual Meeting of the American Nuclear Society, Atlanta, Georgia, June 3-8, 1979.

E. D. Gupton, "Selection, Calibration and Use of Personnel Monitoring Devices," Recent Developments in Radiation Safety, North Carolina State University, Raleigh, North Carolina, November 13-15, 1979.

E. D. Gupton, Panel Member of Workshop on Working with Tritium and Iodine, Recent Developments in Radiation Safety, North Carolina State University, Raleigh, North Carolina, November 13-15, 1979.

E. D. Gupton, "Personnel Monitoring During Hot Cell Recovery," Facility Decontamination Technology Workshop, sponsored by DOE and EPRI, Hershey, Pennsylvania, November 27-29, 1979.

E. D. Gupton, Panel Member of High Beta Field Dosimetry Workshop, Facility Decontamination Technology Workshop, sponsored by DOE and EPRI, Hershey, Pennsylvania, November 27-29, 1979.

T. W. Oakes and K. E. Shank, "A Review of Environmental Surveillance Data Around Low-level Waste Disposal Areas at Oak Ridge National Laboratory," presented at the 12th Midyear Topical Symposium of the Health Physics Society, Williamsburg, Virginia, February 12-15, 1979.

T. W. Oakes, "Radiation Instrumentation for Environmental Surveillance at ORNL," presented at WATTec, Knoxville, Tennessee, February 22, 1979.

T. W. Oakes, "ORNL Site Monitoring Program and ORNL Environmental Impact Statement," presented at the Waste Management Review Meeting, Oak Ridge National Laboratory, Oak Ridge, Tennessee, March 21, 1979.

T. W. Oakes, K. E. Shank, and J. S. Eldridge, "Investigation of ^{137} ^{60}Co, and ^{90}Sr Concentrations in Water and Sediment as a Function of Flow in White Oak Creek," presented at the 24th Annual Meeting of the Health Physics Society, Philadelphia, Pennsylvania, July 8-13, 1979.

T. W. Oakes, J. S. Eldridge, K. E. Shank, W. R. Strodl, W. D. Travers, S. G. Oberg, G. L. Love, J. V. Panesko and J. B. Selby, "Mechanisms for Environmental Radiation Information Exchange," presented at the 24th Annual Meeting of the Health Physics Society, Philadelphia, Pennsylvania, July 8-13, 1979.

T. W. Oakes, Subcommittee No. 9 of Committee for Upgrading Environmental Radiation Data, Health Physics Society, "Recommendations of Subcommittee No. 9 Concerning Mechanisms for Environmental Information Exchange," presented at the 24th Annual Meeting of the Health Physics Society, Philadelphia, Pennsylvania, July 8-13, 1979.

S. A. Reynolds and J. S. Eldridge, "Investigation of Cerenkov Counting of Environmental Strontium-90," International Conference on Liquid Scintillation Counting, San Francisco, California, August 21-24, 1979.

K. E. Shank, "Radioactivity and Stable Element Content in Foods," Symposium on Consumer Products, Boone, North Carolina, October 26, 1979.

K. E. Shank, T. W. Oakes, and S. A. Hamley, "Assessment of Radiation Background in Residences in East Tennessee," presented at the 24th Annual Meeting of the Health Physics Society, Philadelphia, Pennsylvania, July 8-13, 1979.

LECTURES

J. A. Auxier

"Nuclear Power and Public Concern," ORAU Traveling Lecture, University of New Orleans, New Orleans, Louisiana, January 12, 1979.

"Low-Level Effects of Radiation on Humans," ORAU Traveling Lecture, Tougaloo College, Tougaloo, Mississippi, January 16, 1979.

"Emergency Procedures," ORAU Training Course, Oak Ridge, Tennessee, January 22, 1979.

"Assessment of Body Burdens," ORAU Training Course, Oak Ridge, Tennessee, March 7, 1979.

"Low-Level Effects of Radiation on Humans," Lecture to the Occupational Health Class at Vanderbilt University, Nashville, Tennessee, April 1979.

C. D. Berger

"Bioassay," Oak Ridge Associated Universities, 10-week training course, April 1979.

"Whole Body Counting," REACTS-ORAU Health Physics in Radiation Accidents Course, September 1979.

"Bioassay," Oak Ridge Associated Universities, 10-week training course, October 1979.

"Laboratory Assessment of Body Burden," REACTS-ORAU Medical Involvement in Radiation Accidents Course, November 1979.

G. H. Burger

"Accidents and Application of MORT Tecniques to Accident Investigations," I&C Division Maintenance Department, March 1979.

H. M. Butler

"Radiation in Perspective," presented to the Knoxville Chapter of Association of Security Officers, Knoxville, Tennessee, May 1979.

M. F. Fair

"Health Physics Course," given to members of the Environmental Management Section, ORNL, February 1979.

"Ten-Hour Health Physics Course," given to members of the Radiation Survey Sections, ORNL, December 1979.

T. W. Oakes

"Routine Environmental Monitoring," Health Physics and Radiation Protection Course, ORAU, April 1979.

"Emergency Environmental Monitoring," Health Physics and Radiation Protection Course, ORAU, April 1979.

"Environmental Monitoring at ORNL," Health Physics and Radiation Protection Course," ORAU, April 1979.

"Environmental Problems of Nuclear Power," University of Tennessee, September 1979.

"Environmental Awareness Seminars," (eighty given) for ORNL Staff, June-September 1979.

K. E. Shank

"Toxicity Evaluations and Threshold Limit Values," Industrial Safety and Applied Health Physics Division Seminar, ORNL, Oak Ridge, Tennessee, March 1979.

"Major Issues in the Energy Debate," Manchester College Discussion Day, Manchester College, North Manchester College, Indiana, March 1979.

"Environmental Laws and Regulations," University of Tennessee, Knoxville, Tennessee, November 1979.

"Environmental and Human Health Impacts of Energy Production," Manchester College Discussion Day, Manchester College, North Manchester, Indiana, March 1979.

TRAINING COURSES

Presented

One-week course in Health Physics for members of the Environmental Management Section, February 1979, M. F. Fair.

"Radiation Control Zones and Zone Procedures," QA&I Safety Meeting, April 1979, C. H. Miller.

Attended

"Nuclear Criticality Safety," LASL, September 1979, G. H. Burger.

"Overhead Cranes and Hoists," Oak Ridge, Tennessee, March 1979, T. J. Burnett, E. M. Robinson.

"Occupational Safety and Health Standards for the Construction Industry," Des Plaines, Illinois, May 1979, T. J. Burnett.

"Human Factors in Environment, Safety, and Health," Oak Ridge, Tennessee, T. J. Burnett.

"Management Oversight and Risk Tree" seminar, sponsored by the University of New Mexico, Department of Chemical and Nuclear Engineering, Taox, New Mexico, May 1979, H. M. Butler.

"Continuing Education Courses," sponsored by Health Physics Society, Philadelphia, Pennsylvania, July 1979, H. M. Butler.

"Management Oversight and Risk Tree," seminar sponsored by DOE, Amarillo, Texas, February 1979, D. T. Dice.

"Part I, Human Factors in Environment, Safety, and Health" course sponsored by DOE-EOS, Oak Ridge, December 1979, D. T. Dice.

"Management Oversight Risk Tree," Knoxville, Tennessee, November 1979, M. F. Fair.

"National Safety Congress," Chicago, Illinois, October 1979, D. C. Gary, A. D. Warden.

"Behavior Modification Techniques," Houston, Texas, October 1979, R. E. Millspaugh.

"Basic Safety Management," presented by the International Safety Council, Houston, Texas, March 1979, E. M. Robinson.

"Inspector Training," Houston, Texas, October 1979, E. M. Robinson.

"The Safe Handling of Chemical Carcinogens," Illinois Institute of Technology Research, Chicago, Illinois, August 1979, K. E. Shank.

"Hazardous Chemical Safety School," J. T. Baker Chemical Company, Naperville, Illinois, August 1979, K. E. Shank.

"Environmental Laws and Regulations, Master's Seminar," Government Institutes, Inc., Washington, D. C., October 1979, K. E. Shank.

PROFESSIONAL ACTIVITIES AND ASSOCIATIONS

J. A. Auxier

Head, Task Group on Health Physics and Dosimetry, President's Commission on the Accident at Three Mile Island; Special Consultant to the Radiation Effects Research Foundation, Japan; Consultant, Committee on Federal Research into the Biological Effects of Ionizing Radiation, National Institutes of Health; Member, Subcommittee on Exposure at Tests of Nuclear Weapons, National Research Council; Member, National Council on Radiation Protection and Measurements; Enewetak Advisory Group; Northern Marshall Islands Advisory Group; NCRP Scientific Committee 57; NCRP Scientific Committee 63; American Industrial Hygiene Association; Steering Committee for Project on Upgrading the Quality of Environmental Radiation Data; Chairman, Awards Committee of Health Physics Society; Chairman, Ad Hoc Committee on Scientific and Public Issues of the Health Physics Society.

C. D. Berger

Member of Health Physics and Dosimetry Task Group for the President's Commission on the Accident at Three Mile Island, May 1979-October 1979.

H. M. Butler

President-Elect, East Tennessee Chapter Health Physics; Member Advisory Committee on Nuclear Technology, Chattanooga State Community College.

D. M. Davis

Member, American Physical Society, Health Physics Society, American Industrial Hygiene Association and American Society of Safety Engineers.

D. T. Dice

Member, ANS Standards Committee 15.14 - Physical; Security of Research Reactors.

J. R. Muir

Health Physics Society; Chairman, Rules Committee (1979-80).

T. W. Oakes

Chairman, Public Information Committee, East Tennessee Chapter, American Nuclear Society; Member Health Physic Society, Co-Chairman, Environmental Section, Annual Meeting; Chairman, Subcommittee No. 9 of the Project on Upgrading of the Quality of Environmental Data; Councilman, East Tennessee Chapter, Health Physics Society.

K. E. Shank

American Industrial Hygiene Association - Member, Hygienic Guides Committee and Ionizing Radiation Committee; National Environmental Health Association - Member, Air Quality Committee and Occupational Health and Safety Committee; Technical Editor - Journal of Environmental Health; American Public Health Association - Chairperson-elect, Radiological Health Section; Health Physics Society - Secretary, Subcommittee No. 9 of Ad Hoc Committee on Upgrading the Quality of Environmental Radiation Data; East Tennessee Chapter of the Health Physics Society - Chairman, Public Information Committee; Member, Audio-Visual Aid Committee; Member, Education Committee.

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