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ENVIRONMENTAL LEVELS OF RADIOACTIVITY
FOR THE OAK RIDGE AREA

(Report for Period July - December, 1969)

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Compiled by the

Health Physics and Safety Section

Health Physics Division

OAK RIDGE NATIONAL LABORATORY

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This document has been approved for release
to the public by:

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Introduction

Radioactive waste materials arising from the operation of atomic energy installations at Oak Ridge are collected, treated, and disposed of according to their physical states.

Solid wastes are buried in a Conasauga shale formation. This shale has a marked ability to fix radioactive materials by an ion exchange mechanism.

Liquid wastes which contain long-lived fission products are confined in storage tanks or are concentrated by evaporation and disposed of in deep wells by the hydrofracture technique. Low level liquid wastes are discharged, after preliminary treatment to surface streams.

Air that may become contaminated by radioactive materials is exhausted to the atmosphere from several tall stacks after treatment by means of scrubbers and filters.

This report presents data on the environmental levels of radioactivity for the Oak Ridge area and compares the data with established maximum permissible concentrations.

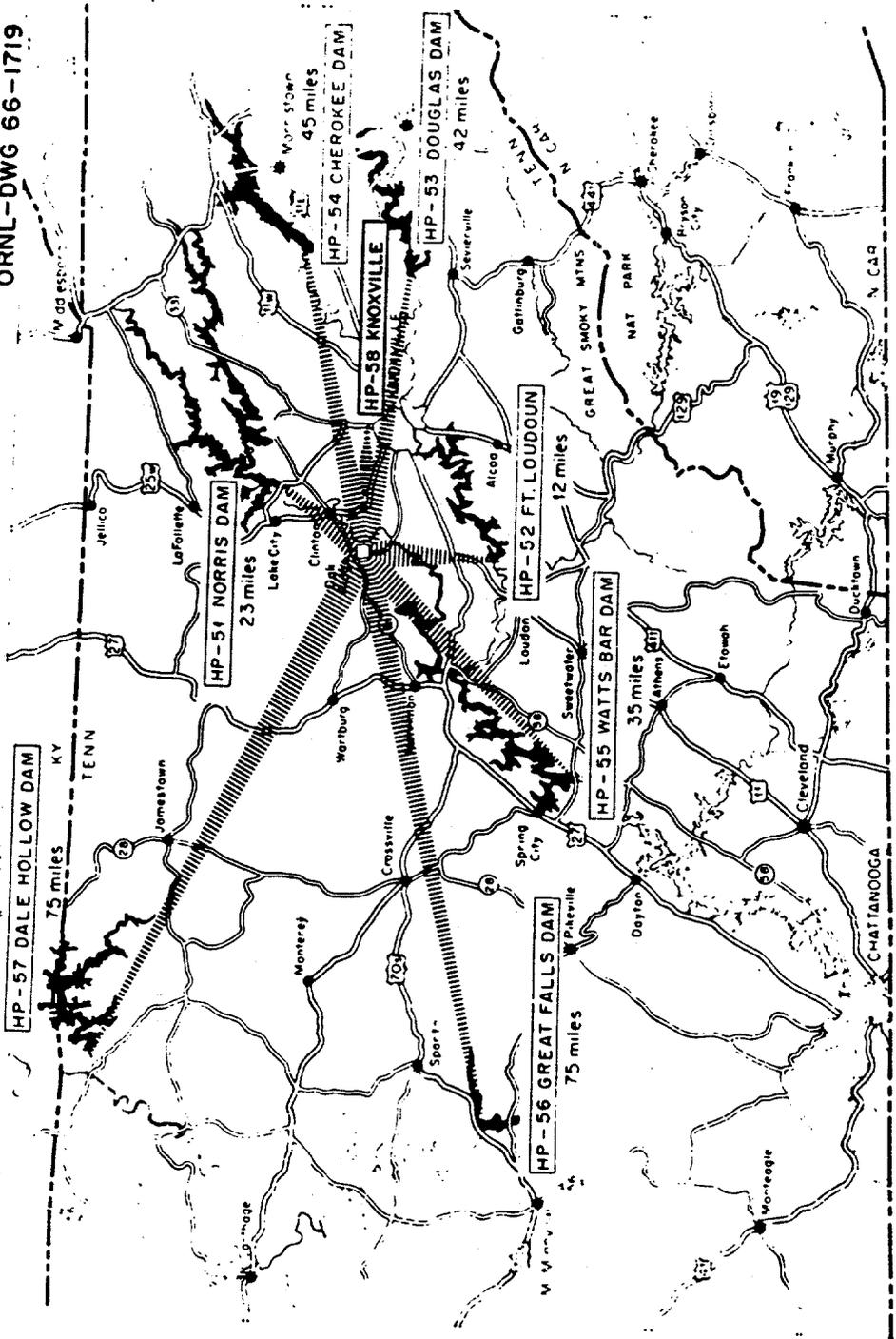
Air Monitoring

Atmospheric contamination by radioactive materials occurring in the general environment of East Tennessee is monitored by two systems of monitoring stations. One system consists of nine stations which encircle the plant area (Fig. 1) and provides data for evaluating the impact of all Oak Ridge Operations on the immediate environment. A second system consists of eight stations encircling the Oak Ridge area at distances of from 12 to 75 miles (Fig. 2). This system provides data to aid in evaluating local conditions and to assist in determining the spread or dispersal of contamination should a major incident occur. Sampling for radioactive particulates is carried out by passing air continuously through a filter paper. Airborne radioactive iodine is monitored in the immediate environment of the plant area by passing air through a cartridge containing activated charcoal. Data collected are accumulated, tabulated, and averaged in units of $\mu\text{Ci}/\text{cc}$ of air sampled.

Milk Monitoring

Raw milk is monitored for ^{131}I and ^{90}Sr by the collection and analysis of samples from twelve sampling stations located within a radius of 50 miles of ORNL. Samples are collected weekly at each of eight stations located on the fringe of the Oak Ridge area. Four stations, located more remotely with respect to Oak Ridge Operations, are sampled at a rate of one station each week. The purpose of the

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STATION SITES FOR REMOTE AIR MONITORING SYSTEM
Figure 2

milk sampling program is two-fold: first, samples collected in the immediate vicinity of the Oak Ridge area provide data by which one may evaluate possible exposure to the neighboring population resulting from waste releases from Oak Ridge Operations; second, samples collected at the more remote stations provide background data which are essential in establishing the proper index for the evaluation of data obtained from local samples.

Water Monitoring

Large volume, low level liquid wastes originating at Oak Ridge National Laboratory are discharged, after some preliminary treatment, to the Tennessee River system by way of White Oak Creek and the Clinch River. Liquid wastes originating at the Oak Ridge Gaseous Diffusion Plant and the Y-12 Plant are discharged to Poplar Creek and thence to the Clinch River. Releases are controlled so that resulting average concentrations in the Clinch River comply with the maximum permissible levels for population groups in uncontrolled areas as specified by AEC Manual, Chapter 0524. The concentration of radioactivity leaving White Oak Creek is measured and concentration values for the Clinch River are calculated on the basis of the dilution provided by the river.

Radioactive liquid wastes are sampled at a number of locations as shown in Figs. 3 and 4. Samples are taken at a number of locations in the Clinch River, beginning at a point above the entry of wastes into the river and ending at Center's Ferry near Kingston, Tennessee. Stream gauging operations are carried on continuously to obtain dilution factors for calculating the probable concentrations of wastes in the river.

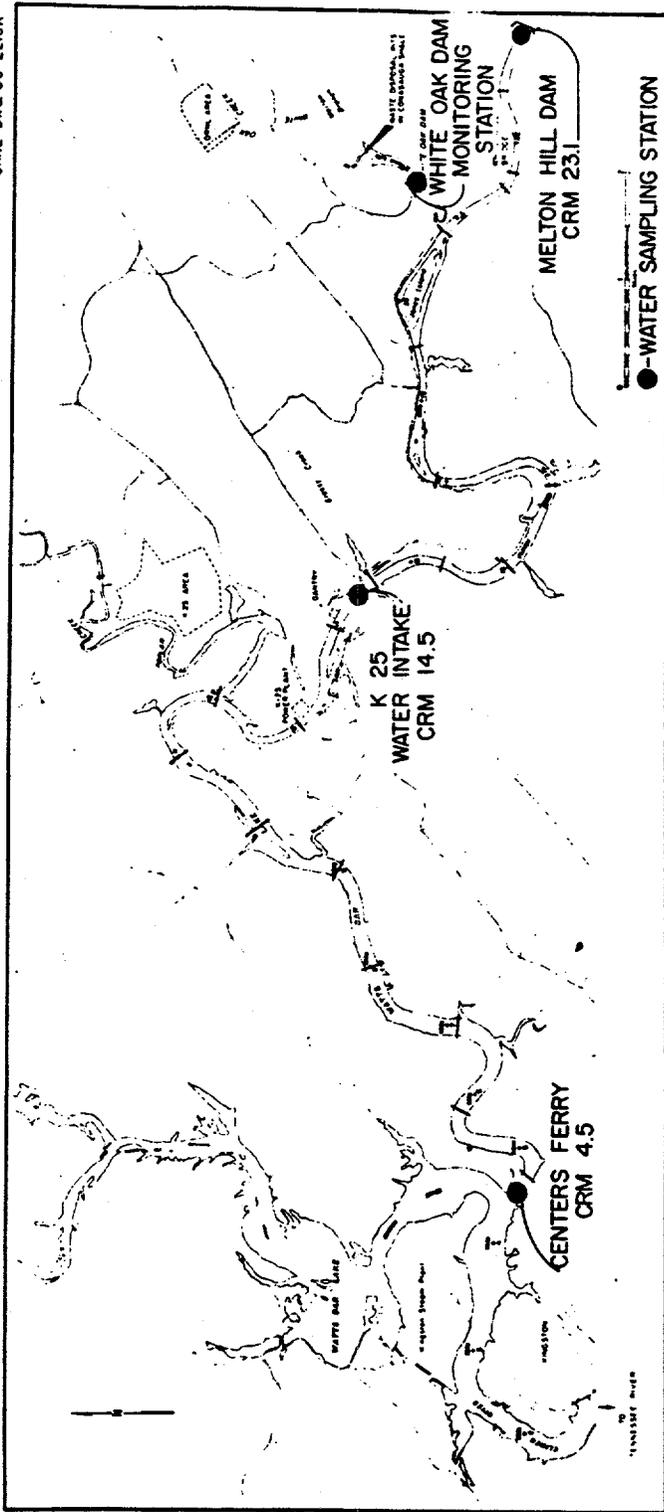
Samples are analyzed for the long-lived beta emitters, for uranium, and for the transuranic alpha emitters.

The concentrations of those isotopes present in significant amounts are determined by analysis. The concentration of each isotope is compared with its respective MPC value as specified by AEC Manual, Chapter 0524,¹ and the resulting fractions summed to arrive at the % (MPC)_w in the Clinch River.

The concentration of uranium is compared with the specific (MPC)_w value for uranium.

¹AEC Manual, Chapter 0524, Appendix, Annex 1, Table II.

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WATER SAMPLING LOCATIONS
Figure 3

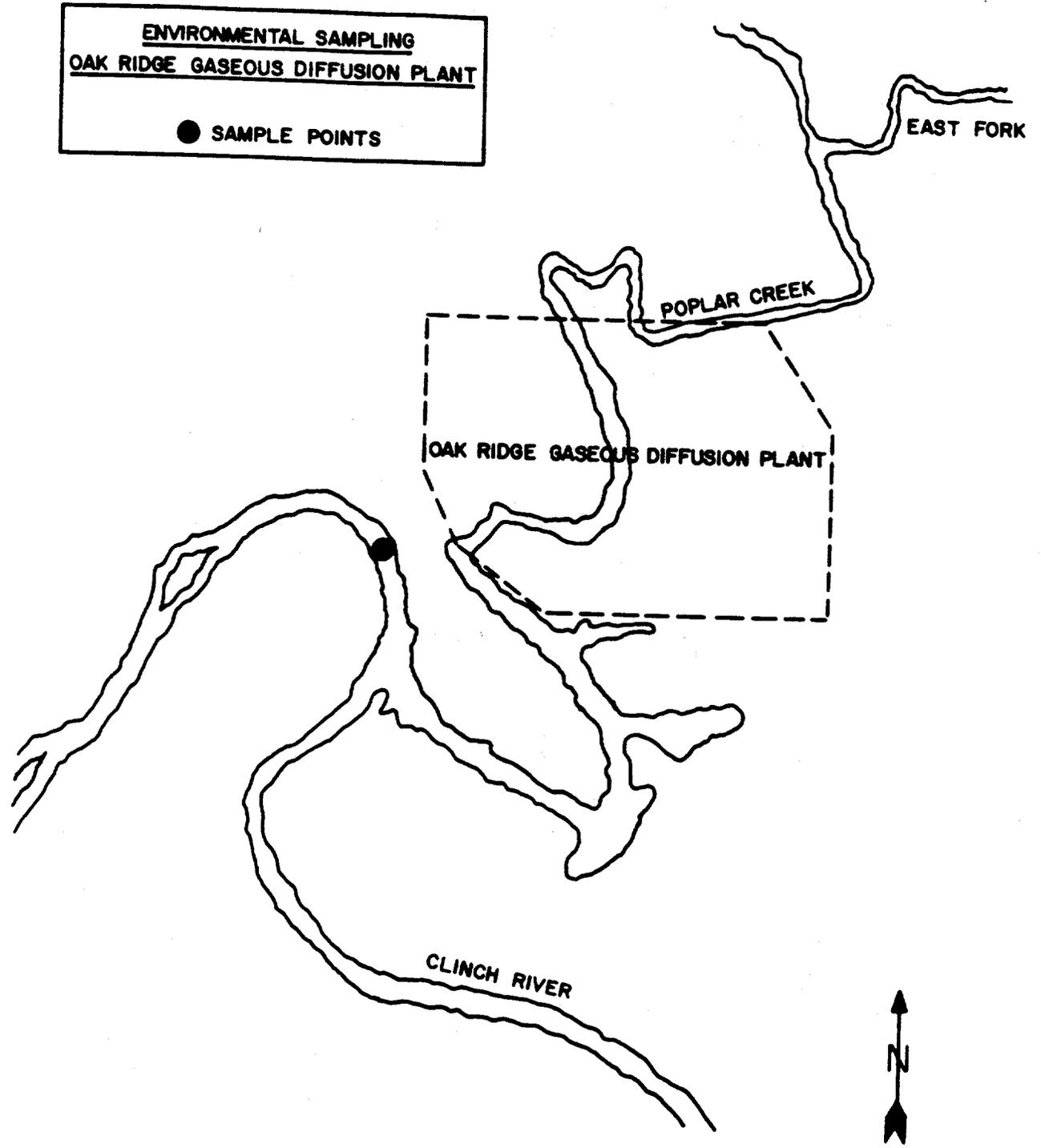


Figure 4

Gamma Measurements

External gamma radiation levels are measured monthly at a number of locations in the Oak Ridge area. Measurements are taken with a Geiger-Müller tube at a distance of three feet above the ground, and the results are tabulated in terms of mR/hr.

Discussion of Data

Data on the environmental levels of radioactivity for the second half of 1969 in the Oak Ridge and surrounding areas are presented in Table I through Table VIII.

The average air contamination level for gross beta activity, as shown by the continuous air monitoring filter data, for both the immediate and remote environs of the plants was 0.16% of the maximum permissible concentration applicable to uncontrolled areas (Table I).

The average air contamination levels for gross alpha activity, as shown by the continuous air monitoring filter data, for the immediate and remote environs of the plants were 0.10% and 0.05%, respectively, of the $(MPC)_a$ for natural uranium for application to uncontrolled areas (Table II).

The average concentration of ^{131}I in air in the immediate environs of the plants was 0.01×10^{-12} $\mu\text{Ci/cc}$ (Table III). This is approximately 0.01% of the maximum permissible concentration for application to uncontrolled areas.

The average concentrations of ^{131}I in raw milk in the immediate and remote environs of the Oak Ridge area were both less than 10 pCi/l (Table IV). These levels fall within the limits of FRC Range I if one assumes the average intake per individual to be 1 liter of milk per day.

The average concentration of ^{90}Sr in raw milk in both the immediate and remote environs of the controlled area was 15 pCi/l (Table V). The averages fall within the limits of FRC Range I for transient rates of daily intake of ^{90}Sr for application to the average of suitable samples of an exposed population.

The percent maximum permissible concentrations of radioactivity in the Clinch River at Mile 20.8, the point of entry of most of the wastes, and at Mile 4.5, near Kingston, Tennessee, were 0.39% and 0.25%, respectively, of the $(MPC)_w$ for application to uncontrolled areas. The higher than normal concentration of ^{60}Co measured at Mile 23.1 (Table VI) above the ORNL waste outfall was the result of a source of contamination other than Oak Ridge Operations.

The average concentration of transuranic alpha emitters in the Clinch River at Mile 20.8 was 1.4×10^{-10} $\mu\text{Ci/ml}$ which is 0.14% of the $(\text{MPC})_w$ value for water containing a mixture of unknown radionuclides.²

The average concentration of natural uranium materials in the Clinch River reflecting the effects of all Oak Ridge plants, was < 0.1% of the $(\text{MPC})_w$ for uranium (Table VII).

The average external gamma radiation measured in the town of Oak Ridge and at the perimeter of the Oak Ridge area was 0.012 mR/hr (Table VIII), which is approximately the same as the level measured in the early period prior to Oak Ridge Operations.

Conclusion

Surveillance of the radioactivity in the Oak Ridge environs indicated that the radioactivity levels were not significantly different from other areas of East Tennessee. Only very low level radioactivity is being released to the environment from plant operations and the resulting concentrations in both the atmosphere and surface streams of the Oak Ridge environment are well below established maximum permissible concentrations and intake guides for the neighboring population.

² $(\text{MPC})_w$ is taken to be 1×10^{-7} $\mu\text{Ci/ml}$ as specified by AEC Manual, Chapter 0524, Appendix, Annex 1, Table II.

TABLE I
CONTINUOUS AIR MONITORING DATA

Long-Lived Gross Beta Activity of
Particulates in Air

July - December, 1969

Station Number	Location	Number of Samples Taken	Units of 10^{-13} $\mu\text{Ci/cc}$			% (MPC) _a ^c
			Maximum ^a	Minimum ^b	Average	
<u>Perimeter Stations</u>						
HP-31	Kerr Hollow Gate	25	4.3	0.32	1.6	0.16
HP-32	Midway Gate	26	5.3	0.25	1.9	0.19
HP-33	Gallaher Gate	26	3.5	< 0.01	1.2	0.12
HP-34	White Oak Dam	26	4.3	0.38	1.4	0.14
HP-35	Blair Gate	26	4.4	0.42	1.6	0.16
HP-36	Turnpike Gate	119 ^d	4.3	0.19	1.8	0.18
HP-37	Hickory Creek Bend	26	3.9	0.07	1.6	0.16
HP-38	East of EGCR	26	4.3	0.35	1.6	0.16
HP-39	Townsite	26	5.7	0.40	1.9	0.19
Average			4.4	0.27	1.6	0.16
<u>Remote Stations</u>						
HP-51	Norris Dam	26	4.2	0.47	1.6	0.16
HP-52	Loudoun Dam	25	5.0	0.35	1.7	0.17
HP-53	Douglas Dam	26	4.9	0.08	1.6	0.16
HP-54	Cherokee Dam	25	4.2	0.35	1.5	0.15
HP-55	Watts Bar Dam	25	3.2	0.13	1.1	0.11
HP-56	Great Falls Dam	26	5.5	0.21	1.7	0.17
HP-57	Dale Hollow Dam	26	4.6	0.38	1.6	0.16
HP-58	Knoxville	23	4.9	0.30	1.9	0.19
Average			4.6	0.28	1.6	0.16

^aMaximum weekly average concentration.

^bMinimum weekly average concentration.

^c(MPC)_a is taken to be 10^{-10} $\mu\text{Ci/cc}$ as specified in AEC Manual, Chapter 0524, Appendix, Annex 1, Table II.

^dSamples collected five days per week beginning 9/20/68.

TABLE II
CONTINUOUS AIR MONITORING DATA

Long-Lived Gross Alpha Activity of
Particulates in Air

July - December, 1969

Station Number	Location	Number of Samples Taken	Units of 10^{-13} $\mu\text{Ci/cc}$			% (MPC) _a ^c
			Maximum ^a	Minimum ^b	Average	
<u>Perimeter Stations</u>						
HP-31	Kerr Hollow Gate	25	0.06	< 0.01	0.02	0.10
HP-32	Midway Gate	26	0.08	< 0.01	0.02	0.10
HP-33	Gallaher Gate	26	0.05	< 0.01	0.02	0.10
HP-34	White Oak Dam	26	0.03	< 0.01	0.01	0.05
HP-35	Blair Gate	26	0.08	< 0.01	0.02	0.10
HP-36	Turnpike Gate	119 ^d	0.25	< 0.01	0.05	0.25
HP-37	Hickory Creek Bend	26	0.05	< 0.01	0.02	0.10
HP-38	East of EGCR	26	0.03	< 0.01	0.01	0.05
HP-39	Townsite	26	0.08	< 0.01	0.02	0.10
Average			0.08	< 0.01	0.02	0.10
<u>Remote Stations</u>						
HP-51	Norris Dam	26	0.03	< 0.01	0.01	0.05
HP-52	Loudoun Dam	25	0.05	< 0.01	0.02	0.10
HP-53	Douglas Dam	26	0.04	< 0.01	0.01	0.05
HP-54	Cherokee Dam	25	0.04	< 0.01	0.01	0.05
HP-55	Watts Bar Dam	25	0.03	< 0.01	0.01	0.05
HP-56	Great Falls Dam	26	0.04	< 0.01	0.01	0.05
HP-57	Dale Hollow Dam	26	0.04	< 0.01	0.01	0.05
HP-58	Knoxville	24	0.06	< 0.01	0.02	0.10
Average			0.04	< 0.01	0.01	0.05

^a Maximum weekly average concentration.

^b Minimum weekly average concentration.

^c (MPC)_a used is 20×10^{-13} $\mu\text{Ci/cc}$, the MPC for natural uranium as specified in AEC Manual, Chapter 0524 Appendix, Annex 1, Table II.

TABLE III
 CONCENTRATION OF ^{131}I IN AIR
 AS MEASURED BY THE PERIMETER AIR MONITORING STATIONS

July - December, 1969

Number of Samples	Units of 10^{-12} $\mu\text{Ci}/\text{cc}$			% (MPC) _a ^b
	Maximum	Minimum ^a	Average	
233	0.15	< 0.01	0.01	0.01

^a Minimum detectable amount of ^{131}I is 20 d/m. At the average sampling rate used, this corresponds to approximately 0.010×10^{-12} $\mu\text{Ci}/\text{cc}$. In averaging, one-half of this value, 10 d/m, is used for all samples showing a total amount of ^{131}I less than 20 d/m.

^b (MPC)_a is taken to be 1×10^{-10} $\mu\text{Ci}/\text{cc}$ as specified in AEC Manual, Chapter 0524, Appendix, Annex 1, Table II.

TABLE IV
CONCENTRATION OF ^{131}I IN RAW MILK

July - December, 1969

Location	pCi/l		
	Maximum	Minimum ^a	Average
Immediate Environs	48	< 10	< 10
Remote Environs	< 10	< 10	< 10

^aMinimum detectable concentration of ^{131}I is 10 pCi/l.

TABLE V
CONCENTRATION OF ^{90}Sr IN RAW MILK

July - December, 1969

Location	pCi/l		
	Maximum	Minimum ^a	Average
Immediate Environs	32	2.0	15
Remote Environs	22	5.4	15

^a Minimum detectable concentration of ^{90}Sr in milk is 2 pCi/l. In averaging, one-half of this value, 1 pCi/l, was used for all samples showing a concentration less than 2 pCi/l.

TABLE VI
RADIOACTIVITY IN THE CLINCH RIVER

July - December, 1969

Location	Concentration of Radionuclides of Primary Concern Units of 10^{-8} $\mu\text{Ci}/\text{ml}$							% of (MPC) _w
	⁹⁰ Sr	¹⁴⁴ Ce	¹³⁷ Cs	¹⁰³⁻¹⁰⁶ Ru	⁶⁰ Co	⁹⁵ Zr- ⁹⁵ Nb	³ H	
CRM 23.1 ^a	0.13	0.02	0.14	0.04	0.15	0.03	*	0.45
CRM 20.8 ^b	0.08	< 0.01	0.02	0.03	0.01	< 0.01	174	0.39
CRM 4.5 ^a	0.07	< 0.01	0.12	0.15	0.07	0.05	*	0.25

^a Measured values.

^b Values given for this location are calculated values based on the concentrations of waste released from White Oak Dam and the dilution afforded by the Clinch River. They do not include radioactive materials (e.g., fallout) that may enter the river upstream from CRM 20.8.

* No analysis.

TABLE VII

URANIUM CONCENTRATION IN THE CLINCH RIVER

July - December, 1969

Sampling Point	Type of Analyses Made	No. of Samples ^a	Units of 10^{-8} $\mu\text{Ci/ml}$			% (MPC) _w
			Maximum ^b	Minimum ^b	Average ^b	
Downstream from ORGDP	Uranium Concentration	2	< 0.1	< 0.1	< 0.1	< 0.1

^aNormal Sampling Frequency: Continuous, composited over six-month period.

^bNo uranium was detected in Clinch River water samples during this period. Minimum detectable concentration of uranium in river water is 0.1×10^{-8} $\mu\text{Ci/ml}$.

TABLE VIII
EXTERNAL GAMMA RADIATION LEVELS
mR/hr

July - December, 1969

Station Number	Location	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
1	Kerr Hollow Gate	*	0.012	0.012	0.010	0.012	0.013	0.012
2	Y-12, East Portal	*	0.011	0.013	0.011	*	0.018	0.013
3	Newcomb Road, Oak Ridge	*	0.011	0.012	0.011	*	0.012	0.012
4	Gallaher Gate	*	0.011	0.010	0.014	0.019	0.014	0.014
5	White Wing Gate	*	0.011	0.011	0.010	0.011	0.011	0.011
Average			0.011	0.012	0.011	0.014	0.014	0.012

Note: These readings were taken with a calibrated Geiger-Müller tube at a distance of three feet above the ground. The background in the Oak Ridge area in 1943 was determined to be approximately 0.012 mR/hr.

*No measurement made.