Reg
330
11/7

KY-543

AEC RESEARCH AND DEVELOPMENT REPORT

MASTER

ENVIRONMENTAL MONITORING SUMMARY
FOR THE
PADUCAH PLANT FOR 1965 & 1966

R. C. BAKER
K. A. DAVIS

UNION CARBIDE CORPORATION
NUCLEAR DIVISION

Operating the

- OAK RIDGE GASEOUS DIFFUSION PLANT
- OAK RIDGE Y-12 PLANT
- OAK RIDGE NATIONAL LABORATORY
- PADUCAH GASEOUS DIFFUSION PLANT

For the Atomic Energy Commission
Under U.S. Government Contract W7405 eng 26

DISCLAIMER

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

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

Date of Issue: September 1, 1967

Report Number: KY-543

Subject Category: UC-41 - Health and
Safety
(TID-4500, 50 Ed.)

ENVIRONMENTAL MONITORING SUMMARY
FOR THE
PADUCAH PLANT FOR 1965 & 1966

R. C. Baker
K. A. Davis

UNION CARBIDE CORPORATION
NUCLEAR DIVISION
Paducah Gaseous Diffusion Plant
Paducah, Kentucky

LEGAL NOTICE

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission, makes any warranty or representation, expressed or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or

B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission, or employee of such contractor, to the extent that such employee or contractor of the Commission, or employee of such contractor prepares, disseminates, or provides access to, any information pursuant to his employment or contract with the Commission, or his employment with such contractor.

Reg

Report Number: KY-543

Subject Category: UC-41 - Health and
Safety

Title: ENVIRONMENTAL MONITORING
SUMMARY FOR THE PADUCAH
PLANT FOR 1965-1966

Authors: R. C. Baker
K. A. Davis

A B S T R A C T

Outdoor monitoring of air, water and vegetation in the vicinity of the Paducah Plant is summarized for the years of 1965-1966.

Previous Reports

Environmental monitoring summaries for previous years were issued as Reports Numbered KY-484 (1964), KY-458 (1962-1963), KY-419 (1961), KY-371 (1960), KY-332 (1959), and KY-273 (1958).

ENVIRONMENTAL MONITORING SUMMARY

FOR THE

PADUCAH PLANT FOR 1965 & 1966

The Paducah Gaseous Diffusion Plant is a government-owned plant operated by Union Carbide Corporation, Nuclear Division, for the Atomic Energy Commission. The gaseous diffusion cascade adds little to plant effluents. Auxiliary units such as the uranium recovery and scrap processing units, and the uranium metal foundry, which is operated on a campaign basis, process large quantities of oxides and fluorides of uranium. Nitric acid is used in several processes. Significant quantities of hexavalent chromium are used each day as a corrosion inhibitor in the recirculating water of the plant cooling system; therefore, uranium, fluorides, nitrates, and hexavalent chromium are of primary interest in the environmental monitoring program of the Paducah Gaseous Diffusion Plant. Other factors routinely checked are pH, alpha and beta activity, and background gamma radiation.

Air and water are sampled continuously in the vicinity of the plant, grab samples of Ohio River water are collected monthly, and vegetation samples are taken on alternate months. These samples are analyzed for the chemical which might reasonably be expected to affect the use of the air, water, or vegetation, and which may originate in effluents from the Paducah Plant. Gamma radiation readings are taken periodically at 3-feet above ground level at each of the 9 air sampling stations.

ENVIRONMENTAL MONITORING METHODS

Air Sampling: Four air sampling stations are just inside the perimeter fence, and 5 are approximately 1 mile from the plant. Air is continuously sampled at the 9 locations by pumping 0.3 cubic feet per minute through a membrane filter

to collect particulate matter and at the 4 perimeter fence locations through a weak (0.5%) sodium hydroxide solution in a conical, glass-bead-filled scrubber to collect soluble gaseous fluorides. The locations are indicated on the map (Appendix A).

The membrane filter is replaced each week and alpha and beta activity is determined by standard counting procedures. The scrubber with its solution was changed each week, (each month since February, 1967) and the fluoride is distilled out of the bubbler and determined by back titration with thorium nitrate and sodium fluoride with sodium alizarin used as an indicator.

Vegetation Sampling: Samples consisting of about 20 grams of a broad-leaved grass are collected each month (every 2 months since June, 1966) at the air sampling locations and at supplementary locations at approximately 1 & 5 miles from the perimeter fence. The vegetation samples are allowed to dry at room temperature for 5 to 7 days and are pulverized in a Wiley cutting mill prior to being analyzed for fluoride content by the Willard and Winter method.

Water Sampling: Water flowing in the 2 creeks carrying liquid effluents from the Paducah Plant is sampled continuously by samplers developed⁽¹⁾ at this plant. The samplers are emptied each week and the contents are analyzed fluorimetrically for uranium, for fluorides by the Willard and Winter method, colorimetrically for hexavalent chromium, and pH is measured on a Beckman Model H-2 pH meter. Alpha and beta activity is counted after evaporation. Grab samples are collected at monthly intervals at 5 locations in the Ohio River,

(1) Mitchell, K. K. and R. C. Baker, "Continuous Leak Water Sampler," November 30, 1962. (KY-423).

at one upstream location in Big Bayou Creek, and from 2 monitoring wells, one 60 feet deep drilled within the plant and another 85 feet deep about 1 mile north of the plant. Individual or composited samples are analyzed for the same contents as were the creek samples. Nitrate analysis was added in 1966.

Gamma Radiation: Gamma radiation readings are taken at approximately monthly intervals in the vicinity of the air sampling stations. The readings are taken with a NICC Model 2610A beta-gamma survey meter held at approximately 3 feet above ground level.

DISCUSSION OF DATA

Air Samples: The alpha activity measured on particulate samples collected at the north perimeter fence (Station PN) averaged 0.12 dpm/M^3 during 1965 and 0.06 dpm/M^3 during 1966. The activity measured at the other stations was generally not significantly different from zero. The average results for the 2 years are shown on tables I & IA for each station.

The average beta activity decreased during this period and averaged about one-fifth the activity of the previous year.

Gaseous fluoride concentrations (calculated as HF) averaged 0.3 ppb during 1965 and 1966 at the perimeter fence, and 0.2 ppb during 1965 and the 1st 6 months of 1966 at the 1-mile stations. Because of sufficient data indicating insignificant gaseous fluoride concentrations and because of the feed plant being shut down, the 1 mile scrubbers were discontinued on June 30, 1966.

Grass Samples: Air-borne fluorides, both gaseous and particulate, are known to be a source of contamination of vegetation; the forage fluoridation, if great enough, can be deleterious to grazing animals. Therefore, vegetation in the vicinity of the Paducah Plant has been sampled since 1955. Fluoride

emissions are controlled to as low a value as practical; a concentration of 25 micrograms of fluoride per gram of dry grass (25 ppm) was adopted as an acceptable guide. The results of fluoride-in-grass determinations are shown in table 2 and the sampling points are shown on the map, Appendix A. The concentrations of fluoride-in-grass on government property generally exceeded the guide concentration until July, 1964, but those for the more distant collection points were below the guide. Grass sampling was continued at a reduced frequency at sampling stations within 5 miles of the plant.

Water Samples: Drainage from the Paducah Plant traverses the 4 to 5 miles to the Ohio River by way of 2 creeks, the Big Bayou on the west and the Little Bayou on the east. Liquid effluents carrying significant quantities of recirculated cooling water or chemicals from operational areas are diverted to the Little Bayou, which is entirely on government-owned land and which also mixes with the alkaline wastes from the ash disposal area of the Shawnee Steam Plant. These alkaline wastes completely neutralize all the acidity in the Little Bayou. The average concentration of hexavalent chromium in Little Bayou has been almost constant during the past 2 years; however, plant changes continue to reduce the total amount discharged, but since plant discharge water constitutes almost all the flow, a reduction of only 20% in concentration was experienced.

The Big Bayou leaves government-owned land about 1/2 mile downstream from the western ends of the plant storm sewers and traverses private land until it enters TVA property near the Ohio River. The water of the creek has no known use, but it is accessible to cattle. On this basis, guides were established for fluoride and chromate concentrations in the Big Bayou at 5 ppm and 2 ppm, respectively. While excess of the limits established for water used to supply municipalities, these guides are well below those concentrations considered harmful to cattle. The average concentration of fluorides in Big

Bayou decreased from 2.0 ppm in 1964 to 0.8 ppm in 1965 and 0.7 ppm in 1966. The chromate concentration remained about the same in 1965 (0.4 ppm) but decreased to an average of 0.2 ppm for 1966. The radioactivity concentration guides used for uranium and for beta activity are those recommended by the National Committee on Radiation Protection and Measurement and published in NBS Handbook 69. The average analyses shown on tables 3 & 3A for the Big Bayou are well within these guides.

There was no significant difference in the concentration of fluorides, chromates, uranium, pH, or radioactivity in the Ohio River below the mouth of the drainage creeks and that in the river upstream from the Paducah Plant. The average values at the individual sampling points and the guides to which they are compared are shown in tables 3 & 3A.

Ground water is also sampled to determine that uranium and fluoride wastes buried on site are not contaminating sub-surface water. Samples from 2 wells, one 60 feet deep drilled about 600 feet north of the principle burial area and one 80 feet deep approximately 1 mile north of the plantsite, have had no significant contamination; results are summarized in tables 3 & 3A.

Gamma Radiation: Gamma radiation levels were 0.02 ± 0.01 mR/hour at all stations.

CONCLUSIONS

Effluents from the Paducah Gaseous Diffusion Plant operations were channeled and controlled as necessary for the environmental concentrations of chemicals and radioactivity in air, water, and vegetation to be at acceptably low levels during 1965 and 1966.

TABLE I
OUTDOOR AIR SAMPLING RESULTS FOR 1965

Sampling Point Location	Fluorides (ppb as HF)		Uranium as Alpha Activity (pc/M ³)		Beta Activity (pc/M ³)	
	Range	Mean	Range	Mean	Range	Mean
PN	0.2 - 2.3	0.6	0 - 0.13	0.03	0 - 1.6	0.4
PE	0.1 - 0.7	0.3	0 - 0.38	0.02	0 - 1.2	0.3
PS	0.1 - 1.0	0.3	0 - 0.11	0.02	0 - 0.8	0.2
PW	0.1 - 0.7	0.2	0 - 0.13	0.02	0 - 1.0	0.3
Sub-Group P	0.1 - 2.3	0.3	0 - 0.38 (1% of RCG)	0.02	0 - 1.6 (0.03% of RCG)	0.3
IN	0 - 0.5	0.2	0 - 0.09	0.02	0 - 1.1	0.3
IE	0 - 0.5	0.2	0 - 0.11	0.02	0 - 0.9	0.3
ISE	0 - 1.0	0.2	0 - 0.09	0.02	0 - 0.9	0.3
IS	0 - 0.3	0.2	0 - 0.12	0.02	0 - 1.0	0.3
IW	0 - 0.3	0.2	0 - 0.10	0.02	0 - 1.0	0.3
Sub-Group I	0 - 1.0	0.2	0 - 0.12 (1% of RCG)	0.02	0 - 1.1 (0.03% of RCG)	0.3

The zero level indicated above is less than the 0.02 alpha and 0.1 beta, lower detectable limits.

TABLE 1-A
OUTDOOR AIR SAMPLING RESULTS FOR 1966

Sampling Point Location	Fluorides (ppb as HF)		Uranium as Alpha Activity (pc/M ³)		Beta Activity (pc/M ³)	
	Range	Mean	Range	Mean	Range	Mean
PN	0.03 - 1.02	0.43	0 - 0.10	< 0.02	0 - 0.98	0.33
PE	0.1 - 0.9	0.34	0 - 0.17	< 0.02	0 - 1.20	0.19
PS	0.00 - 0.51	0.26	0 - 0.14	< 0.02	0 - 0.95	0.15
PW	0.09 - 1.08	0.28	0 - 0.06	< 0.02	0 - 0.95	0.16
Sub-Group P	0.00 - 1.08	0.33	0 - 0.17 (< 1% of RCG)	< 0.02	0 - 1.20 (0.02% of RCG)	0.20
IN	0.08 - 0.74*	0.25	0 - 0.06	< 0.02	0 - 0.79	0.17
IE	0.1 - 0.5*	0.27	0 - 0.12	< 0.02	0 - 0.89	0.18
ISE	0.06 - 0.5*	0.23	0 - 0.20	< 0.02	0 - 1.38	0.19
IS	0.09 - 0.4*	0.23	0 - 0.10	< 0.02	0 - 0.86	0.17
IW	0.08 - 0.3*	0.21	0 - 0.13	< 0.02	0 - 1.85	0.22
Sub-Group I	0.06 - 0.74*	0.23	0 - 0.20 (< 1% of RCG)	< 0.02	0 - 1.86 (0.02% of RCG)	0.19

The zero level indicated above is less than the 0.02 alpha and 0.1 beta, lower detectable limits.

*For 1st 6 months of 1966.

TABLE 2
FLUORIDE-IN-GRASS DETERMINATIONS

Location	1965		1966	
	$\mu\text{g F per Gram of Dry Grass}$ Range	Average	$\mu\text{g F per Gram of Dry Grass}$ Range	Average
PN	8 - 42	24	5 - 35	18
PE	4 - 28	15	10 - 24	18
PS	2 - 30	14	3 - 19	12
PW	3 - 16	9	5 - 14	10
IN	1 - 16	8	3 - 12	7
INE	2 - 10	6	2 - 14	7
IE	3 - 13	7	6 - 17	9
IESE	2 - 18	9	6 - 14	9
ISE	4 - 16	9	0 - 20	9
IS	3 - 12	8	5 - 15	11
IW	1 - 11	6	2 - 18	7
INW	2 - 14	7	0 - 11	7
5NE	4 - 78	15	6 - 17	11
5SE	5 - 34	11	5 - 18	9
5SW	2 - 15	7	4 - 24	11
5NW	4 - 15	10	2 - 14	8

TABLE 3

EFFLUENT WATER ANALYSES FOR 1965

Sample* Point	No. of Samples	Fluorides (mg F/liter)	pH Range	Chromate (mg Cr/liter)	Uranium (μ g U/liter)	Beta Activity (pc/milliliter)
OHIO RIVER						
9	12	0.28	5.6 - 8.1	< 0.02	2	0.12
50	12	0.31	6.4 - 8.1	< 0.02	2	0.11
51	12		7.4 - 8.2	< 0.02		
52	12		7.7 - 8.1	< 0.02		
53	12		7.4 - 8.5	< 0.02		
Guide Concentrations		1.2	6.3 - 9.0	0.05	60,000	20
BIG BAYOU						
1	12	0.29	4.5 - 7.5	< 0.02	3	0.07
3	52	0.80	6.3 - 9.3	0.42	26	0.14
Guide Concentrations		5.0	- -	2.0	60,000	20
LITTLE BAYOU						
17	52	3.5	4.4 - 6.9	3.4	250	0.70
GROUND WATER						
11	12	0.21	6.7 - 7.3	-	1	0.07
12**	7	0.26	6.3 - 6.6	-	2	0.06

*See Map, Appendix A, for locations.

**Last 7 months of 1965.

pc - picocurie = 10^{-12} curies.

TABLE 3-A

EFFLUENT WATER ANALYSES FOR 1966

Sample* Point	No. of Samples	Fluorides (mg F/liter)	pH Range	Chromate (mg Cr/liter)	Nitrate (mg NO ₃ /liter)	Uranium (μg U/liter)	Beta Activity (pc/milliliter)
OHIO RIVER							
9	12	0.29	7.4 - 8.3	< 0.02		2	0.08
50	12	0.44	7.6 - 8.2	< 0.02		1	0.09
51	12		7.6 - 8.6	< 0.02			
52	12		7.6 - 8.3	< 0.02			
53	12		7.6 - 8.2	< 0.02			
Guide Concentrations		1.2	6.3 - 9.0	0.05		60,000	20
BIG BAYOU							
1	12	0.27	5.9 - 7.6	< 0.02		1	0.05
3	52**	0.73	4.5 - 10.4	0.18	3	29	0.08
Guide Concentrations		5.0	- -	2.0	45	60,000	20
LITTLE BAYOU							
17	52**	3.0	4.4 - 7.3	3.5	61	510	1.3
GROUND WATER							
11	12	0.37	6.9 - 7.6	-		1	0.04
12	12	0.29	6.4 - 7.5	-		1	0.05

*See Map, Appendix A, for locations.

**Nitrate analyses resumed March 7, 1967
pc - picocurie = 10⁻¹² curies.

*Sampling Points — Paducah Plant
Environmental Monitoring Program*