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AEC RESEARCH AND DEVELOPMENT REPORT

MASTER

ENVIRONMENTAL MONITORING SUMMARY

FOR THE

PADUCAH PLANT FOR 1962 AND 1963

R. C. BAKER

UNION CARBIDE CORPORATION
NUCLEAR DIVISION

Operating the

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

For the Atomic Energy Commission
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ENVIRONMENTAL MONITORING SUMMARY

FOR THE

PADUCAH PLANT FOR 1962 AND 1963

R. C. Baker

UNION CARBIDE CORPORATION

NUCLEAR DIVISION

Paducah Gaseous Diffusion Plant

Paducah, Kentucky

Report Number: KY-458

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Title: ENVIRONMENTAL MONITORING
FOR THE PADUCAH PLANT FOR
1962 AND 1963

Author: R. C. Baker

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 1962 and 1963.

Previous Reports

Environmental monitoring summaries for previous years were issued as Report Numbers KY-419 (1961), KY-371 (1960), KY-332 (1959), and KY-273 (1958).

ENVIRONMENTAL MONITORING SUMMARY
FOR THE
PADUCAH PLANT FOR 1962 AND 1963

INTRODUCTION

The Paducah Plant is a government-owned gaseous diffusion plant operated by Union Carbide Corporation, Nuclear Division, for the Atomic Energy Commission. In addition to the uranium hexafluoride in the isotope separation cascade, large quantities of uranium fluorides and oxides are processed in the feed manufacturing plant and in the uranium metal foundry. 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, and hexavalent chromium are of primary interest in the environmental monitoring program of the Paducah Plant. Other factors routinely checked are pH, beta activity, and background gamma radiation.

Air and water are sampled continuously in the vicinity of the plant, and grab samples of Ohio River water and vegetation samples are collected monthly. These samples are analyzed for the chemicals 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 13 air sampling stations.

ENVIRONMENTAL MONITORING METHODS

Air Sampling: Air is continuously sampled at 13 locations by pumping 0.3 cubic feet per minute through a membrane filter to collect particulate matter

and through a weak (0.5%) sodium hydroxide solution in a conical, glass bead-filled, scrubber to collect soluble gaseous fluorides. Four of the sampling stations are just inside the perimeter fence, 5 are approximately 1 mile and 4 at approximately 5 miles from the plant. 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 is also changed each week, 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: Sixteen vegetation sampling locations were established on 8 compass points in such a manner that 8 of the locations were approximately one-half mile from the midpoint of the Paducah Plant and 8 were approximately 1 mile from the same location. These locations are shown on Appendix B. In February of 1963 the locations were changed to the vicinity of the air sampling stations. (See Appendix A.) A sample consisting of approximately 20 grams of a broad-leafed grass is obtained at each sampling point each month. 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

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

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 4 locations in the Ohio River downstream from the plant, at one upstream location in the Ohio River, at one upstream location in Big Bayou Creek, and from a monitoring well 60 feet deep drilled within the plant. Individual or composited samples are analyzed for the same contents as were the creek samples.

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) was slightly higher than at other stations. Except for this station there appeared to be no significant difference in the average activity at the fence, 1 mile, or 5 miles from the plant, which were respectively 0.13, 0.1, and 0.14 dpm/meter³. In general, individual results were not significantly different from zero. The average result at each station is shown in table 1.

The average beta activity at the sampling stations established during this report period (in July, 1963) was lower than that at the stations which were operated during the entire period. The air-borne activity at all the stations decreased after cessation of atmospheric weapons testing.

The average concentration of gaseous fluorides decreases with distance from

the plant and was highest at the north perimeter fence. This sampling station is closer to the fluoride processing facilities than the other stations. The average gaseous fluoride concentrations, calculated as hydrogen fluoride, were 2.3 parts hydrogen fluoride per billion parts of air (2.3 ppb) at the perimeter fence, 0.5 ppb at the 1 mile stations and 0.1 ppb at the 5 mile stations. These concentrations are far below the 3 ppm threshold limit value (TLV) for hydrogen fluoride or the 100 ppb TLV for fluorine. The highest analysis on a week-long sample was 34 ppb. The highest analysis at a 1 mile station was 22 ppb.

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 maps, Appendices A and B. The concentrations of grass on governmental property generally exceeded the guide concentration, but those for the more distant collection points were below the guide.

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 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 the Little Bayou decreased from 5.8 ppm in 1961 to 4.1 ppm in each of 1962 and 1963. However, the total quantity of Cr^{+6} discharged was significantly less following a change in corrosion control which permitted a reduction in total blowdown volume. The fluoride concentration with less dilution water available increased from 14 ppm in 1961 to 35 ppm in 1962 and 28 ppm in 1963.

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 in excess of the limits established for water used to supply municipalities, these guides are well below those concentrations considered harmful to cattle. The average fluoride concentration in the Big Bayou increased from 2.2 ppm in 1961 to 3.2 ppm in 1962 and 4.8 ppm in 1963. Results of weekly analyses are observed, and acid leaks are isolated by sewer sampling and are repaired whenever an increase in fluoride concentration is noted. The average chromate concentration decreased from 0.76 ppm as Cr^{+6} in 1961 to 0.34 ppm in 1962 and 0.31 ppm in 1963. 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 table 3 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 table 3.

Ground water is also sampled to determine that uranium and fluoride wastes buried on site are not contaminating sub-surface water. Samples from a well 60 feet deep drilled about 600 feet north of the principle burial area have had no significant contamination; results are summarized in table 3.

Gamma Radiation: Gamma radiation levels were 0.02 ± 0.01 mR/hour at all stations except at PE, where nearby storage of uranium caused some readings to be 0.03 ± 0.01 mR/hour.

CONCLUSIONS

Effluents from the Paducah Plant operations were channelled and controlled as necessary for the environmental concentrations of chemicals and radioactivity in air, water, and vegetation to be at acceptably low levels during 1962 and 1963.

TABLE 1

OUTDOOR AIR SAMPLING RESULTS* FOR 1962 - 1963

Sampling Point Location***	Fluorides (ppb as HF)		Uranium as Alpha Activity ($\mu\text{c/cc} \times 10^{-13}$)		Beta Activity ($\mu\text{c/cc} \times 10^{-12}$)	
	Range	Mean	Range	Mean	Range	Mean
PN	1.0 - 34	5.9	0 - 11	0.80	0.4 - 170	8.6
PE	0.2 - 9.9	1.9	0 - 2.4	0.66	0.4 - 120	6.9
PS	<0.1 - 6.0	0.8	0 - 1.9	0.51	0.4 - 15	4.8
PW	<0.1 - 7.1	0.7	0 - 2.0	0.46	0.4 - 20	5.3
Sub-Group P	<0.1 - 34	2.3	0 - 11	0.61 (3% of RCG)	0.4 - 170 (0.6% of RCG)	6.4
1N	0.1 - 4.5	0.5	0 - 6.0	0.46	0.9 - 24	5.3
1E	0.1 - 11	0.4	0 - 9.0	0.46	0.2 - 14	4.8
1S	<0.1 - 1.6	0.3	0 - 2.6	0.46	0.9 - 16	5.0
1W	0.1 - 22	0.8	0 - 1.5	0.37	<0.07 - 12	4.8
1SE**	0.1 - 0.3	0.14	0 - 2.0	0.37	0.9 - 5	2.3
Sub-Group 1	<0.1 - 22	0.5	0 - 9.0	0.44 (2% of RCG)	<0.07 - 24 (0.5% of RCG)	4.9
5NW**	<0.1 - 0.2	0.1	<0.2 - 2.7	0.91	0.4 - 5	2.3
5NE**	<0.1 - 0.4	0.1	<0.2 - 2.7	0.77	0.4 - 7	2.3
5SE**	<0.1 - 0.2	0.1	<0.2 - 1.6	0.53	0.4 - 7	2.3
5SW**	<0.1 - 0.3	0.1	<0.2 - 1.4	0.42	0.4 - 7	2.3
Sub-Group 5	<0.1 - 0.4	0.1	<0.2 - 2.7	0.66 (3% of RCG)	0.4 - 7 (0.2% of RCG)	2.3

*All results are based on continuous sampling collected at weekly intervals.

**Sampling was started at these points in July, 1963.

***See Map, Appendix A.

TABLE 2

FLUORIDE-IN-GRASS DETERMINATIONS FOR 1962 AND 1963					
1962 ($\mu\text{g F/gram dry grass}$)			1963 ($\mu\text{g F/gram dry grass}$)		
Sample Point	Range	Average	Sample Point	Range	Average
1	22 - 302	63	PN	220 - 1080	563
2	11 - 47	24	PE	34 - 836	308
3	11 - 172	59	PS	16 - 97	47
4	9 - 38	22	PW	20 - 116	61
5	12 - 96	45			
6	21 - 150	70	1 N	8 - 37	22
7	17 - 158	110	1 NE	5 - 46	19
8	10 - 98	36	1 E	5 - 31	13
9	9 - 49	20	1 ESE	8 - 47	24
10	4 - 116	24	1 SE	8 - 27	15
11	9 - 398	50	1 S	5 - 34	13
12	7 - 50	21	1 W	8 - 21	15
13	10 - 88	25	1 NW	2 - 44	10
14	6 - 38	18			
15	8 - 118	38	5 NE	6 - 25	13
16	9 - 78	27	5 SE	6 - 22	13
			5 SW	6 - 25	15
			5 NW	3 - 36	10

The locations (See Appendices A & B) at which grass samples are collected each month were changed in February, 1963, to correspond more closely to the air sampling points.

TABLE 3

EFFLUENT WATER ANALYSES FOR 1962 AND 1963

Sample* Point	No. of Samples		Fluorides (mg F/liter)		pH Range		Chromate (mg Cr/liter)		Uranium (microgram U/l)		Beta Activity ($\mu\text{c/ml} \times 10^{-5}$)	
	1962	1963	1962	1963	1962	1963	1962	1963	1962	1963	1962	1963
OHIO RIVER												
9	12	12	0.27	0.28	7.2 - 7.9	7.4 - 8.3	0.02	<0.02	2.3	0.8	0.01	0.032
50	12	12	0.30	0.30	6.9 - 7.5	6.7 - 7.8	0.02	<0.02	2.5	2.3	0.01	0.04
51	12	12			7.3 - 8.4	7.5 - 8.6	0.02	<0.02				
52	12	12			7.3 - 7.9	7.4 - 8.6	0.02	<0.02				
53	12	12			7.4 - 8.3	7.4 - 8.6	0.03	<0.02				
Guide Concentrations			1.2		6.3 - 9.0		0.05		60,000		2	
BIG BAYOU												
1	12	12	0.3	0.3	6.2 - 7.6	6.3 - 7.1	<0.02	<0.02	2	3	0.1	0.06
3	53	52	3.2	4.8	6.4 - 11.9	3.4 - 10.5	0.34	0.31	36	105	0.02	0.07
Guide Concentrations			5		----	----	2.0		60,000		2	
LITTLE BAYOU												
17	53	52	35	28	3.2 - 6.0	3.2 - 5.5	4.1	4.1	690	540	0.5	1.0
GROUND WATER												
11	12	12	0.3	0.2	6.5 - 6.9	6.3 - 7.6	---	---	2	1	0.01	0.04

*See map, Appendix A for locations.

Appendix A

□ - Air and Grass ○ - Grass only ● - Water

*Sampling Points — Paducah Plant
Environmental Monitoring Program*