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ENVIRONMENTAL MONITORING SUMMARY

FOR THE

PADUCAH PLANT FOR 1967 AND 1968

**K. A. DAVIS
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**UNION CARBIDE CORPORATION
NUCLEAR DIVISION
PADUCAH GASEOUS DIFFUSION PLANT**

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Title: ENVIRONMENTAL MONITORING
SUMMARY FOR THE PADUCAH
PLANT FOR 1967-1968

Authors: K. A. Davis
E. G. Brown

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 1967-1968.

Previous Reports

Environmental monitoring summaries for previous years were issued as Reports Numbered KY-543 (1965-1966), 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 1967 & 1968

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, the uranium metal foundry, and the feed plant which was reactivated in August, 1968, and converts uranium trioxide to uranium hexafluoride, 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 is changed each month (since February, 1967, weekly prior to that) 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 broad-leaved grass are collected every 2 months 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 from 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

(1)

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

for uranium, for fluorides by the Willard and Winter method, colorimetrically for nitrate nitrogen and 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, 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.

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 east perimeter fence (Station PE) averaged 0.02 pCi/M^3 during 1967 and 1968 and those collected at the north perimeter fence (Station PN) averaged 0.04 pCi/M^3 during 1968. 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 and IA for each station.

The average beta activity continued to decrease during 1967 but showed an increase during 1968 from $< 0.02\%$ to 0.035% of the Radiation Concentration Guide (RCG).

Gaseous fluoride concentrations (calculated as HF) averaged 0.2 ppb during 1967 and 0.5 ppb in 1968 at the perimeter fence. This increase reflects the

resumption of uranium hexafluoride production in the feed plant and the reduction of depleted UF_6 to UF_4 in the uranium metal foundry. Concentrations at the plant perimeter fence do not indicate the need to resume gaseous fluoride sampling at the 1 mile locations; these were discontinued June 30, 1966.

Grass Sampling: 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 (25ppm) was adopted as an acceptable guide. The results of fluoride-in-grass determinations are shown on table 2 and 2A. Sampling points are shown on the map, Appendix A. The concentrations of fluoride-in-grass on government property generally exceeded the guide concentration after the resumption of UF_6 production, 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 re-circulated 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. Plant changes continue to reduce the total amount of hexavalent chromium discharged to Little Bayou. Though plant discharge water constitutes almost all of the flow, a Cr^{+6} concentration reduction of 30% in 1967 and 50% during 1968 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 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 concentration of fluorides in Big Bayou remained 0.7 ppm in 1967 and increased to 1.3 ppm in 1968. The chromate concentration decreased about 50% in 1967 (0.2 ppm-0.1 ppm) but increased to an average of 0.2 ppm for 1968. 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 on 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 on 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 1967 and 1968.

TABLE I

OUTDOOR AIR SAMPLING RESULTS FOR 1967

Sampling Point Location	Fluorides (ppb as HF)		Uranium as Alpha Activity (pCi/M ³)		Beta Activity (pCi/M ³)	
	Range	Mean	Range	Mean	Range	Mean
PN	0.10 - 0.42	0.24	0 - 0.09	< 0.02	0 - 1.30	0.13
PE	0.05 - 0.40	0.21	0 - 0.20	0.02	0 - 2.03	0.23
PS	0.04 - 0.34	0.16	0 - 0.09	< 0.02	0 - 0.48	0.12
PW	0.09 - 0.47	0.21	0 - 0.09	< 0.02	0 - 1.70	0.14
Sub-Group P	0.04 - 0.47	0.20	0 - 0.20 (< 1% of RCG)	< 0.02	0 - 2.03 (< 0.02% of RCG)	0.16
IN	*		0 - 0.09	< 0.02	0 - 1.10	0.15
IE	*		0 - 0.09	< 0.02	0 - 0.90	0.14
ISE	*		0 - 0.09	< 0.02	0 - 2.60	0.18
IS	*		0 - 0.10	< 0.02	0 - 0.44	0.09
IW	*		0 - 0.11	< 0.02	0 - 4.30	0.20
Sub-Group I	*		0 - 0.11 (< 1% of RCG)	< 0.02	0 - 4.30 (< 0.02% of RCG)	0.15

The zero levels indicated above are less than the 0.02 pCi/M³ Alpha and 0.1 pCi/M³ beta, lower detectable limits.

* Discontinued June 30, 1966.

TABLE 1A

OUTDOOR AIR SAMPLING RESULTS FOR 1968

Sampling Point Location	Fluorides (ppb as HF)		Uranium as Alpha Activity (pCi/M ³)		Beta Activity (pCi/M ³)	
	Range	Mean	Range	Mean	Range	Mean
PN	0.06 - 7.2	1.2*	0 - 0.33	0.04	0 - 4.1	0.95
PE	0.05 - 2.4	0.52**	0 - 0.13	0.02	0 - 6.3	0.68
PS	0.09 - 0.36	0.18	0 - 0.06	< 0.02	0 - 0.43	0.15
PW	0.08 - 0.30	0.17	0 - 0.05	< 0.02	0 - 0.59	0.20
Sub-Group	0.05 - 7.2	0.51***	0 - 0.33	< 0.02	0 - 6.3	0.50
			(< 1% of RCG)		(0.05% of RCG)	
IN	****		0 - 0.06	< 0.02	0 - 0.68	0.21
IE	****		0 - 0.06	< 0.02	0 - 0.68	0.18
ISE	****		0 - 0.06	< 0.02	0.02 - 0.50	0.18
IS	****		0 - 0.09	< 0.02	0 - 0.72	0.20
IW	****		0 - 0.06	< 0.02	0 - 0.63	0.17
Sub-Group I	****		0 - 0.09	< 0.02	0 - 0.72	0.18
			(< 1% of RCG)		(< 0.02% of RCG)	

The zero levels indicated above are less than the 0.02 pCi/M³ Alpha and 0.1 pCi/M³ beta, lower detectable limits.

*Median was 0.34 ppb.

**Median was 0.26 ppb.

***Median was 0.20 ppb.

****Discontinued June 30, 1966.

TABLE 2-
FLUORIDE-IN-GRASS DETERMINATIONS

Location	1967	
	Range	Average
PN	22 - 40	29
PE	14 - 321	74*
PS	11 - 22	17
PW	4 - 33	14
IN	5 - 13	8
INE	4 - 18	8
IE	4 - 11	6
IESE	9 - 16	12
ISE	4 - 17	8
IS	3 - 9	6
IW	4 - 10	7
INW	3 - 6	5
5NE	5 - 11	8
5SE	3 - 11	7
5SW	0 - 20	6
5NW	3 - 6	5

* Median was 22 μg per gram.

TABLE 2A
FLUORIDE-IN-GRASS DETERMINATIONS

Location	1968	
	Range	Average
PN	12 - 437	120*
PE	14 - 392	98**
PS	13 - 237	61***
PW	8 - 30	13
IN	6 - 22	10
INE	6 - 40	14
IE	7 - 16	10
IESE	7 - 23	14
ISE	6 - 23	12
IS	3 - 10	7
IW	3 - 11	7
INW	4 - 24	9
5NE	7 - 21	10
5SE	6 - 24	13
5SW	3 - 25	8
5NW	4 - 10	5

*Median was 61 μg per gram.

**Median was 41 μg per gram.

***Median was 18 μg per gram.

TABLE 3
EFFLUENT WATER ANALYSES FOR 1967

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 (pCi/milliliter)
OHIO RIVER							
9	12	0.30	7.5 - 8.2	< 0.02		2	0.05
50	12		7.2 - 8.1	< 0.02			
51	12	0.39	7.5 - 8.1	< 0.02		0.75	0.06
52	12		7.7 - 8.2	< 0.02			
53	10		7.6 - 8.2	< 0.02			
Guide Concentrations		1.2	6.3 - 9.0	0.05		60,000	20
BIG BAYOU							
1	12	0.33	5.0 - 7.4	< 0.02		0.75	0.04
3	52	0.74	6.6 - 10.0	0.10	3.6	12	0.09
Guide Concentrations		5.0	- -	2.0	45	60,000	20
LITTLE BAYOU							
17	52	3.5	3.9 - 7.5	2.6	69	210	0.45
GROUND WATER							
11	12	0.30	6.9 - 7.2	-		1.5	0.09
12	12	0.29	6.5 - 7.2	-		0.83	0.07

*See Map, Appendix A, for locations.
pCi - Picocurie = 10⁻¹² curies.

TABLE 3-A
EFFLUENT WATER ANALYSES FOR 1968

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 (pCi/milliliter)
OHIO RIVER							
9	12	0.38	7.8 - 8.2	< 0.02		1	0.08
50	12		7.7 - 8.3	< 0.02			
51	12		7.9 - 8.3	< 0.02			
52	12	0.41	7.7 - 8.4	< 0.02		1	0.06
53	12		7.7 - 8.6	< 0.02			
Guide Concentrations		1.2	6.3 - 9.0	0.05		60,000	20
BIG BAYOU							
1	12	0.57	6.1 - 7.6	< 0.02		1	0.05
3	53	1.3	7.1 - 9.8	0.21	5	10	0.05
Guide Concentrations		5.0	- -	2.0	45	60,000	20
LITTLE BAYOU							
17	53	9.0	3.5 - 7.4	1.7	40	196	0.27
GROUND WATER							
11	12	0.60	6.8 - 7.6	-		1	0.05
12	12	0.53	6.8 - 9.7			1	0.06

*See Map, Appendix A, for locations.
pCi - Picocurie = 10⁻¹² Curies.

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

Sampling Points — Paducah Plant Environmental Monitoring Program