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Health and Safety

AEC RESEARCH AND DEVELOPMENT REPORT

MASTER

**AUTOMATED AIR SAMPLING BY THE USE OF
APERTURE CARDS (U)**

Merwyn Sanders

RELEASED FOR ANNOUNCEMENT
IN NUCLEAR SCIENCE ABSTRACTS

**UNION CARBIDE CORPORATION
NUCLEAR DIVISION
OAK RIDGE Y-12 PLANT**

operated for the **ATOMIC ENERGY COMMISSION** *under* **U. S. GOVERNMENT Contract W-7405 eng 26**

**UNION
CARBIDE**

OAK RIDGE Y-12 PLANT
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UNION CARBIDE CORPORATION
Nuclear Division

Y-12 PLANT

Contract W-7405-eng-26
With the US Atomic Energy Commission

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Oak Ridge, Tennessee

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ABSTRACT

A device has been constructed which permits successful air monitoring on IBM aperture cards equipped with Whatman 41 filter paper. This technique has been proven at the Y-12 Plant to be a highly successful air-monitoring program compared to the more conventional programs.

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INTRODUCTION

A study of environmental air monitoring for radioactive particulates and associated laboratory handling techniques revealed that costs could be drastically reduced if sample handling and data records could be combined into one unit. The results of this study brought about developments which reduced general air monitoring costs to one-sixth that of conventional programs. A conventional air-monitoring program normally includes the following major steps: (1) inserting a one-inch-diameter Whatman 41 filter paper into a machined aluminum holder; (2) sampling by drawing air through the paper at a measured rate; (3) removing the filter paper from the holder and placing it on the planchet for counting after recording the sampling time, sampling rate, and sampler location on the edge of the planchet; (4) handloading the planchet containing the filter standards and blanks into a Berkeley automatic scintillation counter in identical printout sequence with data cards which are fed to an IBM 026 keypunch; and (5) machine processing the results punched on the IBM cards for each sample.

Detailed consideration of this procedure indicated that improvements were needed to minimize the number of hand operations, and to reduce the time involved in counting preparation and programming of the automatic counter for each run. The general solution appeared to be a system which would combine permanently the sample and data results into a single unit while permitting machine identification of samples at all times.

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SUMMARY

The technique and principle of using aperture cards equipped with filter paper in air monitoring for radioactive particulates has proven to be highly successful at the Y-12 Plant. This technique of air monitoring offers several advantages compared to conventional air sampling programs:

1. By combining records and analysis into one unit, the possibility of laboratory errors in recording and reporting analyses of samples is greatly reduced.
2. A means of automating the analysis for many air-monitoring programs is provided. (Filter paper is used as the collection medium.)
3. Commercially available materials and card-handling equipment are utilized.
4. Practicable, standardized procedures for collecting samples can be established.
5. Large numbers of samples can be processed automatically by data processing machines.
6. Convenient storage of sampling results for historical references, statistical comparisons, and legal records is achieved.
7. Costs of air sampling and analysis are reduced several fold compared to conventional air-monitoring programs.
8. By programming input data cards that can be returned to a central laboratory for analysis, air monitoring can be performed in areas that have no laboratory facilities.

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AUTOMATED AIR SAMPLING USING APERTURE CARDS

DEVELOPMENT AND TESTING

Aperture Card Air-Sampling Device

The most promising idea investigated involved the use of standard IBM aperture cards that are normally used to hold microfilm. These cards offered a potential means of automated card handling and data processing using commercially available equipment. The principal problem was to find a satisfactory way to insert the filter medium into the aperture. Air samples must be collected without distorting the filter paper because an uneven paper surface would negate the sampling result.

On the basis of tests with approximately 50 IBM aperture cards which were hand prepared to contain Whatman 41 filter paper inserts, it was determined that developments were necessary to: (1) protect the card from physical damage during sampling periods, and (2) permit the impingement of particulates on a filter paper without paper rupture.

The card-holding sampling device which was finally designed, constructed, and tested successfully is shown in Figure 1. This device is made of polypropylene injected-molded plastic and consists of the following features: (1) a top and bottom cover, (2) a hinge connecting the two sections, (3) a latch for securing the two components, (4) a sampling port on the bottom which is automatically positioned over the filter medium when the card is inserted into the holder, (5) a vacuum connection on the top side over the sampling port, and (6) a rubber O ring on the inside portion of the sampling port and a raised plastic ring of the same diameter on the top inside of the vacuum connection that permit an air-tight seal on the filter medium when the two sections of the card holder are closed. With approximately five pounds of pressure on the filter paper, the O ring flattens and moves in an outward direction creating a drum-head effect on the sampling medium. The drum-head pressure prevents excessive paper distortion which, in turn, permits machine processing.

Several of these units were installed in a variety of processing areas for test and evaluation. The units were operated over a three-month period. Sample change-out frequency was from 8 - 72 hours at sampling rates from 17 - 28 liters per minute. Sampling periods longer than 72 hours at 28 liters per minute were not pursued because of the growing pressure drop across the filter (depending on the extent of atmospheric dust loading) resulting in an overall 20 - 30 percent reduction in the flow rate. However, even with 72-hour sampling periods, no rupture of the filter paper occurred and only minimal paper distortion was experienced for over 300 samples.

Figure 1. APERTURE CARD AIR-SAMPLING DEVICE.

Counting Equipment

Automation of the counting and card handling was simple because of a previous successful development involving the counting of an IBM smear card with an automatic counter.⁽¹⁾ Briefly, this counting equipment consists of an IBM 026 card punch (Figures 2 and 3) which transports the cards automatically during the counting process, and a scintillation detector suitable for measuring alpha activity. The activity detected by the scintillator is registered by a Berkeley scaler. A digital scanner and decoder mechanism relays the results from the scaler to the key punch for automatic punching of count results into the aperture cards.

Statistical Support

Approximately one hundred of these cards were used to collect air samples. At first each card was kept separated for the purpose of determining if the material collected on aperture cards would transfer from one card to another and/or lose activity during automatic card handling and counting. To determine this, each card received three counts. The initial count was performed on individual cards in a nonautomatic counter; for the second and third counts, the same cards were combined into a deck and counted in the IBM automatic counter. The results reported in Tables 1 and 2 reveal that loss of activity is not significant and does not negate the utilization of IBM card handling equipment where uranium alpha is the contaminant. The reproducibility of results on subsequent counting of samples was within normal counting statistics.

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Figure 2. APERTURE CARD TRANSPORT INSTRUMENT AND SCINTILLATION DETECTOR. (IBM-026 Card Punch)

Table I
RESULTS OF TEST TO DETERMINE COLLECTION RELIABILITY

Range of Samples (c/6 min)	Number of Samples	Count	Counting Results (c/6 min)	
			Mean of Samples	Difference ($\pm$ LE)
0 - 200	71	1st	88.0	3.6 ± 5.8
		2nd	87.8	
		3rd	91.6	
200 - 600	20	1st	329	26 ± 26
		2nd	288	
		3rd	303	
600 - 800	9	1st	1020	9 ± 96
		2nd	940	
		3rd	1011	

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Figure 3. SCINTILLATION DETECTOR AND ASSOCIATED ELECTRONIC COUNTING EQUIPMENT.

THE APERTURE SYSTEM

Aperture Card Equipped with Filter Paper

Aperture cards with Whatman 41 filter-paper inserts are obtained from a commercial vendor. These cards (Figure 4) are prepunched with certain information one week prior to use in the field: (1) sampler location, (2) date card is to be used for sample collection, (3) the total sampling time for this particular sample, and (4) the code of the operator responsible for changing the card.

Automated Counting

After completing the sampling period in the processing areas, the cards are collected and held for sixteen hours before counting. This period allows the naturally occurring short-half-life daughter products to decay. After the decay period, the sample cards are placed in the automatic counter. Known standards are included to assure proper counting efficiency. If the automatic counter should, at any time during the counting cycle, fail to register the proper counts for any given standard or to reveal

Table 2
REPRODUCIBILITY OF COUNTING RESULTS

Test Number	Results (c/3 min)		High - Low Result
	1st Count	2nd Count	
1	122	122	0
2	43	59	+ 16
3	178	209	+ 31
4	73	99	+ 26
5	18	24	+ 6
6	25	28	+ 3
7	133	151	+ 18
8	46	33	- 13
9	201	202	+ 1
10	42	38	- 4
11	19	28	+ 9
12	53	57	+ 4
13	25	19	- 6
14	23	22	- 1
15	17	27	+ 10
16	15	12	- 3
17	205	223	+ 18
18	33	30	- 3
19	66	65	- 1
20	25	24	- 1
21	304	330	+ 26
22	4	7	+ 3
23	33	34	+ 1
24	19	18	- 1

increased background counts above normal counting statistics, the instrument will shut off and sound an audible alarm. The instrument is also programmed to screen samples with low activity, registering only one-minute counts for samples below the screening level. Samples with higher activity receive six-minute counts. On completing the counting cycle, the aperture sample cards are tabulated on an IBM 1401 data processing machine which requires approximately fifteen minutes to prepare a typical air-data report (shown in Figure 5). These reports, which serve as a current and useful index and guide to environmental conditions, are distributed daily to Plant supervision.

POTENTIAL APPLICATIONS

Possible applications of this technique and principle in other fields are virtually unlimited. Areas of immediate interest include: adaptation to the existing National Air Sampling Network, utilization in large-scale biological research programs (such as those currently underway at the Biology Division of the Oak Ridge National Laboratory) and in repetitive medical tests. The scope of this development can also be expanded to include applications to radioactivity counting methods, inspection of biological samples, and optical treatment of film, colorimetric, and particle analysis studies.

(a) Before Sampling

Sampler Location	Date of Sample	Sampling Time (960 min)	Operator Code
13-BB-05	05-06-65	9600	06

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Counts

Counts	Date of Sample	Sampling Time (960 min)	Operator Code
13-BB-05023	05-06-65	9600	06

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(b) After Sampling

Figure 4. PREPUNCHED APERTURE CARDS WITH WHATMAN 41 FILTER PAPER.

Some of the most promising fields where repetitive information is generated and where the aperture card and sample could be combined include: particulate counting, optical density measurement, colorimetric analysis, spectrographic analysis, X-ray analysis, cancer research, miscellaneous blood and urine analysis, radiography, and microscopic tissue recording. (2)

WEEKLY ALPHA GENERAL AIR AND PERMANENT OPERATIONAL REPORT - BY LOCATION

LOC	DATE	D/M/M3	D/M/M3 >35 >70	INSP NO	FLOW RATE	SAMPLE TIME	COUNT ONE	COUNT	TOTAL
A-43	9-03-65	1		6	.0170	960	4		
A-43	9-07-65	0		6	.0170	960	3		
A-43	9-08-65	0		6	.0170	960	1		
A-43	9-09-65	5		6	.0170	960	14		
A-43	9-10-65	10		6	.0170	960	24		
LOCATION AVG G A		3							5
A-44	9-03-65	1		6	.0170	960	4		
A-44	9-07-65	1		6	.0170	960	5		
A-44	9-08-65	1		6	.0170	960	5		
A-44	9-09-65	1		6	.0170	960	6		
A-44	9-10-65	4		6	.0170	960	12		
LOCATION AVG G A		2							5
A-45	9-03-65	0		6	.0170	960	1		
A-45	9-07-65	0		6	.0170	960	2		
A-45	9-08-65	1		6	.0170	960	6		
A-45	9-09-65	0		6	.0170	960	4		
A-45	9-10-65	9		6	.0170	960	22		
LOCATION AVG G A		2							5
AREA AVG G A		3							40
A-02	8-31-65	10		6	.0100	1920	25		
A-02	9-03-65	0		6	.0100	2880	4		
A-02	9-07-65	9		6	.0100	1920	25		
LOCATION AVG G A		6							3
A-04	8-31-65	3		6	.0100	1920	9		
A-04	9-03-65	0		6	.0100	2880	1		
A-04	9-07-65	6		6	.0100	1920	18		
LOCATION AVG G A		3							3
AREA AVG G A		5							6
A-04	8-31-65	5		6	.0150	2880	28		
A-04	9-03-65	5		6	.0150	4320	44		
A-04	9-07-65	8		6	.0150	2880	46		
LOCATION AVG G A		6							3
A-05	8-31-65	0		6	.0150	2880	3		
A-05	9-03-65	1		6	.0150	4320	7		
A-05	9-07-65	1		6	.0150	2880	7		
LOCATION AVG G A		1							3

Figure 5. TYPICAL MACHINE PRINTOUT OF AIR-SAMPLING RESULTS.

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- (1) Sanders, Merwyn; "Automated Smear Program for Radioactive Material", Health Physics, 10, pp 341-344 (1963).
- (2) Gude, W. D. and Jones, D. A.; "Use of IBM Data Processing Cards for Film-Mounted Histology Sections" (to be published in Stain Technology).