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MLM-2758

Radon Monitoring Program: February-April 1980

William G. Yates, G. Richard Hagee,

and Phillip H. Jenkins

August 21, 1980

MOUND FACILITY
Miamisburg, Ohio 45342

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MONSANTO RESEARCH CORPORATION
a subsidiary of Monsanto Company

for the
U. S. DEPARTMENT OF ENERGY

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Foreword

Mound Facility, under the sponsorship of the DOE Division of Environmental Control Technology, is responsible for assessing the environmental impact of radon at the inactive Atomic Energy Commission/Manhattan Engineering District (AEC/MED) uranium processing and mill tailings sites. Twelve of the approximately 50 AEC/MED sites that were involved in the fabrication or processing of uranium for nuclear weapons applications are currently included in Mound's radon monitoring plan. Following at least a year of data collection from radon monitors deployed at each site, Mound will recommend and execute corrective steps to reduce the radon levels.

This is the initial report in a series.

Contents

Abstract

The radon monitoring plan for Canonsburg, Pa., was implemented on 29 January 1980. Thirty-eight offsite locations were being monitored by the end of the quarter. Additional locations were planned to fulfill DOE Division of Environmental Control Technology requests. Overall distribution of the radon measurements has not yet been determined.

Introduction

Radon measurements were initiated by Mound Facility in the Canonsburg, Pa., area on January 29, 1980. Passive Environmental Radon Monitors (PERM's) of the type developed at the Department of Energy's (DOE's) Environmental Measurements Laboratory [1] and manufactured by EDA Instruments, Inc., Toronto, Canada, have been used in this work. The instruments were calibrated in the radon chamber at the Environmental Measurements Laboratory prior to placement in the field.

Thirty-one monitoring sites made up the original network. This was expanded to 38 locations on March 18 with the addition of seven sites close to the perimeter of the Canon Industrial Park. The present offsite monitoring network in Canonsburg represents an expansion in numbers of sampling locations over that which was operated by the Environmental Measurements Laboratory, DOE. Samplers in each location are run continuously, a typical sample being an integrated measurement over a one-week period to provide maximum information on variations in radon concentration as a function of geographical location, climatic changes, and season of year.

A meteorological data acquisition system is also operational. This work is being subcontracted with Weston Company in West Chester, Pa. They are supplying Mound Facility the following meteorological data:

(1) Wind speed
(2) Wind direction (hourly standard deviation of wind direction)
(3) Relative humidity
(4) Precipitation
(5) Temperature
(6) Solar radiation

Discussion of data

Table 1 is a summary of average radon concentrations obtained for the period ranked in order of diminishing concentration. The number of measurements at each location ranges from two to eleven. Averages for locations 16 through 38, inclusive, pool into the background group, to be described more fully below. The remaining 15 locations fall above this background group and range in concentration from 0.24 to 0.83 pCi/liter. Of these 15 locations, concentrations at three exceed 0.48 pCi/liter, six range from 0.31 to 0.33 pCi/liter, and six range from 0.24 to 0.30 pCi/liter.

In Figure 1 are shown data for the 15 locations where concentrations exceed the background group plotted on a map of the environs of the Canon Industrial Park. Ten of these 15 locations are situated

Table 1 - SUMMARY OF CANONSBURG MONITORING DATA FOR THE PERIOD FROM JANUARY 29, 1980 TO APRIL 29, 1980

	Locations	Number of Samples	Av Radon Conc. pCi/liter	Av Radon Conc. Standard Error	General Direction from Site
Above Range of Background	1	9	0.83	0.14	E
	2	6	0.58	0.11	E
	3	7	0.48	0.12	E
	4	11	0.33	0.05	S
	5	11	0.33	0.05	E
	6	6	0.33	0.04	NE
	7	11	0.33	0.05	W
	8	10	0.32	0.03	E
	9	2*	0.31	0.18	E
	10	10	0.30	0.05	E
	11	9	0.28	0.05	S
	12	9	0.26	0.03	S
	13	9	0.26	0.05	E
	14	6	0.26	0.04	W
	15	10	0.24	0.03	E
Background Range	16	10	0.22	0.04	E
	17	6	0.22	0.03	W
	18	8	0.22	0.03	S
	19	5	0.22	0.05	S
	20	7	0.19	0.03	W
	21	8	0.19	0.03	S
	22	9	0.19	0.03	S
	23	11	0.18	0.01	S
	24	7	0.17	0.02	N
Background Control Group	25	10	0.23	0.03	E
	26	9	0.23	0.04	W
	27	11	0.20	0.03	S
	28	11	0.20	0.02	N
	29	10	0.20	0.02	E
	30	7	0.19	0.02	N
	31	10	0.19	0.02	W
	32	9	0.16	0.02	N
	33	8	0.16	0.02	W
	34	10	0.15	0.02	S
	35	9	0.15	0.02	W
	36	9	0.15	0.01	S
	37	9	0.13	0.02	N
	38	9	0.12	0.02	N

*Instrument vandalized, thus out of service for several weeks.

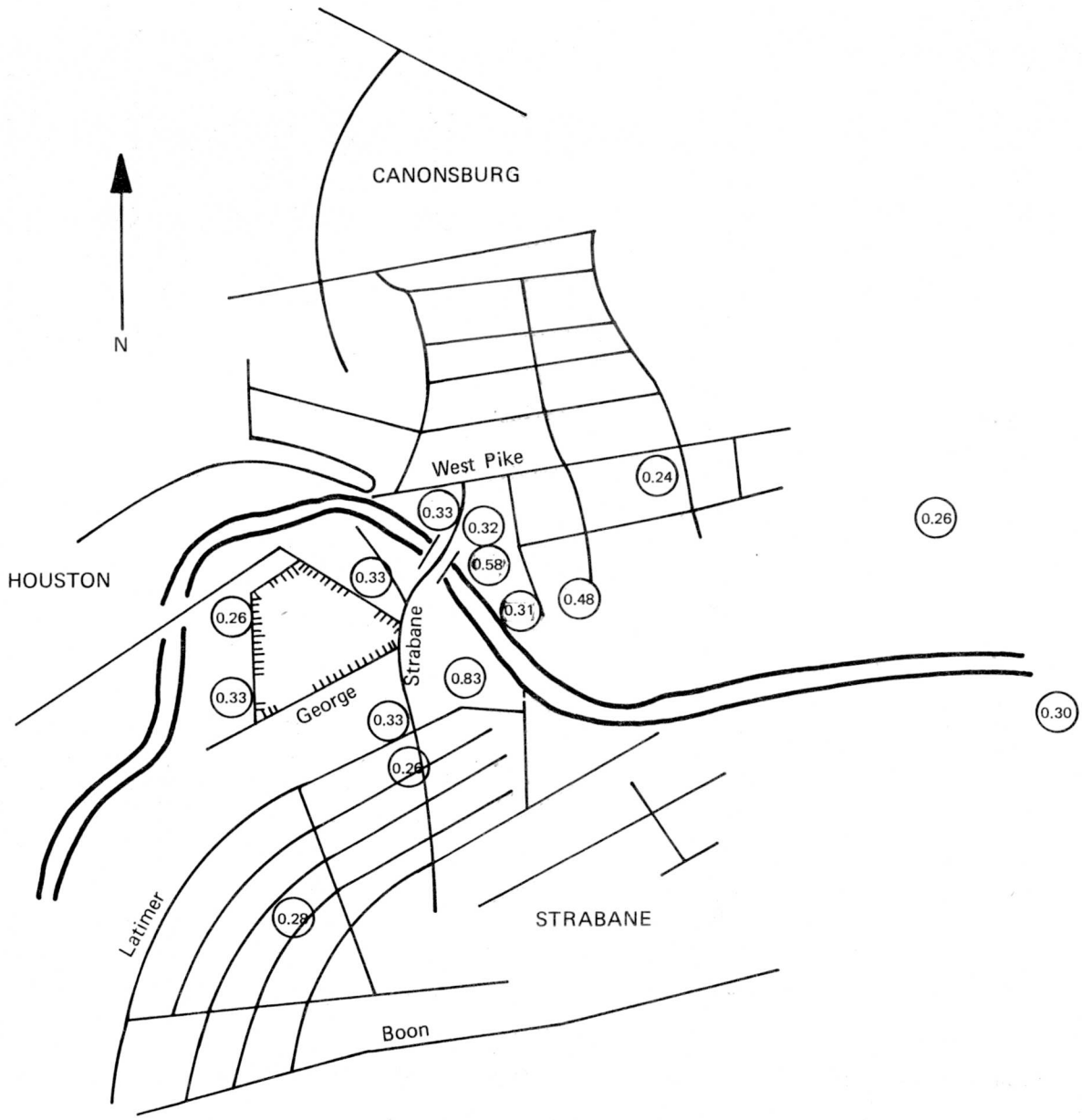

FIGURE 1 - Location of sites with average radon concentrations exceeding background range of 0.12 to 0.23 pCi/liter. Values in pCi/liter.

along the general direction of prevailing westerly winds, through the valley along West Pike Street and Chartiers Creek. Two of the locations are the closest to the Canon Industrial Park (Locations 7 and 14), being located on its western perimeter. One location (Location 6) adjoins the site in a northeasterly direction. Three locations are almost directly south of the Industrial Park in the Borough of Strabane (Locations 4, 11 and 12).

The three locations with the highest average concentrations are essentially the closest locations to the site in an easterly direction, being located 150 to 250 m from the perimeter of the Industrial Park. Concentrations at other locations downwind of the Industrial Park exceed background to a distance of about 1 km, in agreement with the previous results obtained by the Environmental Measurements Laboratory [2]. A concentration gradient along the direction of prevailing westerly winds downwind of the Industrial Park is thus evident.

Average concentrations from the remaining 23 locations pool into the background group, as mentioned. They range in distance from the western perimeter of the Industrial Park (Location 17) to approximately 3.5 km (Locations 25 and 29). Twenty of the 23 locations in this group are generally north, south, or west of the Industrial Park and are thus upwind or in the crosswind direction. This is borne out in Table 1 wherein the general direction of each location from the Industrial Park is shown. Of the three locations in this background group which are in an easterly direction from the Industrial Park, only one is within 1 km (Location 16). The other two sites (Locations 25 and 29) are the most distant from the Industrial Park in any direction.

Statistical considerations

All information pertaining to the radon measurements at Canonsburg is placed in a computer data base. This is essential for efficient storage and handling of the large quantity of data generated by the monitoring program. The computer makes it easier to identify and correct errors in the data, and makes it possible to perform statistical analyses on the data rapidly and accurately.

Tests were performed on the data from each location to determine how the radon measurements were distributed. Based on the limited quantity of data available it was not possible to reach a firm conclusion regarding the overall distribution of the measurements. It was found in general that the data supported the assumption of a normal distribution, although at several locations the measurements tended to be log-normally distributed. Therefore, normal statistics was used throughout the analyses of the data. This same approach was used by the Environmental Measurements Laboratory in their analyses of radon measurements from the Canonsburg area [2].

An attempt was made to determine, on a purely statistical basis, a group of locations whose means of the radon concentration measurements were close to estimates of radiation background for the Canonsburg area. It was found that the quantity of data was insufficient for the

statistical tests to determine such a "background" group of locations. Therefore, other, less objective methods were used to determine this group.

First, we selected a group of locations which, based on their positions in relation to the site, would not be expected to be affected by radon released from the site. These were locations remote from the site or well away from the site perimeter in a direction other than that of the prevailing wind. Locations in Strabane were not included in this group because of possible effects from offsite contamination. Fourteen locations were included in this group: Locations 25-38. The means of the radon concentration measurements for these locations ranged from 0.12 to 0.23 nCi/liter. The average of all radon measurements made at these locations was 0.18 pCi/liter.

Nine locations whose means of the radon concentration measurements were between 0.12 and 0.23 pCi/liter appeared to be at background radon concentration regardless of their proximity to the site. These nine were designated Locations 16-24. However, the nine were not used as part of the control group for background radon concentrations.

The frequency distribution of the means of the radon concentration measurements for all locations was examined. A break in the distribution indicated that the (approximately) 15 highest means were outside of the background distribution. Thus, the background group should consist of the (approximately) 14 lowest means. The nine remaining locations appear to be in the range of radiation background, but were not a part of the control group.

Based on all the information presented above, it was concluded that the best estimate of average background in the Canonsburg area for this monitoring period is 0.18 pCi/liter, and that the means of the radon concentration measurements at locations which can be considered to be background range from 0.12 to 0.23 pCi/liter. As more data become available, it should be possible to determine a background range on a more objective, statistical basis.

In the Passive Environmental Radon Monitor employed, radon concentrations are assessed by exposure of thermoluminescent dosimeter (TLD) chips of lithium fluoride. Prior to field measurements, chips in instruments are exposed to known concentrations of radon in the calibration chamber at the Environmental Measurements Laboratory. Following exposure, the chips are read out on TLD reader instrumentation at Mound Facility. Chip response can thus be related to exposure in units of (pCi·hr)/liter. Experience with calibration studies indicates that the accuracy (1 σ) of an individual measurement is 18% of the measured value. The minimum detectable concentration is 0.05 pCi/liter. When the calibration chamber at Mound Facility is completed and more extensive studies are conducted, some adjustment of these values may be forthcoming.

Summary

Radon concentration measurements at 38 locations in the monitoring network at Canonsburg, Pa., are reported for the period January 29, 1980, to April 29, 1980. Average concentration measurements at each location pool into: (1) a background group consisting of the 14 loca-

tions showing the lowest concentrations, ranging from 0.12 to 0.23 pCi/liter; and (2) 15 locations wherein the average concentrations exceed background and range from 0.24 to 0.83 pCi/liter. Average background in the Canonsburg area for the period is 0.18 pCi/liter. Locations exceeding background are predominantly east of the site, exhibiting a decreasing concentration gradient in that direction from the Canon Industrial Park.

The floating PERM system (two PERM's at one location for a statistically valid time) was not implemented in the first quarter because the monitoring locations at Canonsburg were being expanded, and because some instruments had been sent to Middlesex, N. J., for preliminary data gathering. However, it is planned to implement this system in the Canonsburg area in July 1980. Monitoring will next begin at Lewiston, N.Y., and Middlesex, N. J.

References

1. A. C. George, A Passive Environmental Radon Monitor, HASL-325, AEC Health and Safety Laboratory, New York, N.Y. (July 1977).

2. Status Report of Radon Monitoring at Canonsburg: November 1979, compiled by Environmental Measurements Laboratory, DOE, New York, N. Y.

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