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RAS
WM-40 9/29

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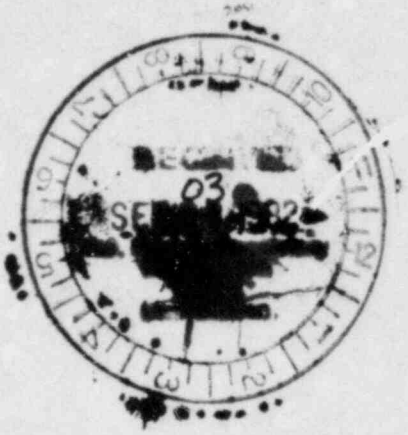

August 25, 1982

Mr. Claude A. Flory
Uranium Recovery Licensing Branch
Division of Waste Management
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Flory:

Enclosed is the requested report, "Results of the First Set of Completed RPISU Measurements in Edgemont, South Dakota", including tabulated results prepared by the EPA and Annual Property Averages calculated from the tabulations by PNL. If you have questions, please feel free to contact me.

Sincerely,

P. O. Jackson
Senior Research Scientist
Radiological Sciences Department

POJ:dlc

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RESULTS OF THE FIRST SET OF COMPLETED RPISU MEASURMENTS IN EDGEMONT, SOUTH DAKOTA

Introduction

The protocol for radiological screening surveys at vicinity properties in Edgemont, South Dakota includes tests for the exposure levels of radon progeny in the indoor air. Since the standards for such properties, proposed by the U. S. Environmental Protection Agency (USEPA) stipulate that the annual average exposure rate must not exceed 0.015 working levels including background, the protocol includes screening tests which have a reasonable certainty of locating those properties which exceed the limit. When a five minute grab sample, collected in accordance with strict sampling condition criteria, is less than 0.01 W.L., the protocol accepts the expectation that the annual average will not exceed 0.015. Likewise, when the average of two grab samples exceeds 0.033 W.L. the protocol accepts the expectation that the annual average will probably exceed 0.015 W.L. Between those levels, the protocol recognizes that the variability of sampling causes too great an uncertainty for a grab sample to establish whether or not the annual average exposure rate exceeds 0.015 Working Levels. In those cases, a long-term sampling program using radon progeny integrating sampling units (RPISU's) is specified. This report contains the results of the first set of completed long-term measurements taken in Edgemont.

Experimental

The RPISU's are shop-made and are obtained from the Las Vegas laboratory of the U.S. EPA. These units consist of an air pump and clock contained

in a capped plastic pipe about 30 cm in diameter by 60 cm tall. The RPISU collects radon daughters on a filter located next to a thermoluminescent dosimeter (TLD) chip. A second TLD chip that is shielded from alpha and beta particles is also used to give a correction for background gamma radiation. These components are contained in a small externally mounted head which is detachable from the unit. The heads are also received from the EPA laboratory and are returned there promptly after the air sampling has been completed. There, they are disassembled, and the thermoluminescent emissions are read and converted to radon progeny exposure rates using calibrations which the EPA has established for each batch of TLD chips.

The total quantity of air sampled is determined using a rotometer, supplied by the EPA to measure the flow rate at the beginning and completion of sampling. The running time clock readings are also recorded.

Six measurements of at least 100 hours duration are made. Each measurement is made approximately every other month for a year. If a problem occurs in sampling during a scheduled month, a sample is collected in the succeeding month. If that cannot be done, then it is necessary to repeat the sampling during a succeeding year sometime in the three month interval which is centered on the scheduled month. (For example, a sample is taken in February, 1981 which cannot be used for some reason. For some other reason it is not possible to take a repeat sample in March, 1981. Then a repeat sample must be taken during January, February, or March of 1982).

Since the minimum sampling time is 100 hours, it is sometimes necessary to use more than one sampling head when there is frequent plugging

of the filter after shorter intervals than 100 hours. (Filter plugging frequently occurs as a result of the accumulation of particulates from cigarette smoke). If more than one RPISU sampling head is used to obtain the minimum total of 100 hours of sampling, the valid measurement is calculated from the time-weighted average of all the individual RPISU sampling head measurements as follows:

$$\overline{W.L.} = \sum \frac{t_i \, W_i}{T}$$

Where:

W.L. = time weighted Working Level

t_i = sampling time for the i th sample

W_i = Working Level for i th sample

$T = \quad t_i$ = total time for all sampling heads, and must be at least 100 hours.

When filter head plugging reduces the flow rate below a preset point, a safety switch turns the pump off to protect it from damage. The flow can be checked by installing a rotometer at the inlet and momentarily restarting the pump. A built-in time delay prevents shutdown for a long enough interval to take the reading.

Results and Discussions

The computerized summary of individual RPISU measurements is contained in the appendix to this report. There were 99 locations at which the requirements for a valid annual property average were fulfilled. Many of the other measurements were performed for the EPA by the State of South Dakota and did not follow the current sampling protocol. In some

because of severe problems with filter plugging. The "Averge Working Level" appears on the right-hand side of the EPA report (Appendix) at the last sample for each different location. This is a simple arithmetic average of all the individual working level measurements at that location. It is not a time-weighted average. Note that "NV" results are not included in the Average Working Level.

The EPA has a number of criteria for acceptability of results. If a particular sample fails to meet any criterion, the result, which is printed on a computer form, is accompanied by an NV-X symbol where X is a number from 1 to 6 which indicates the criterion which was not met. Other identifying codes where X takes on the values of 7 through 9 and 0 are also used. The following codes are used:

NV-1 No measurable "off" flow rate at the end of sampling period due to pump failure, "plugged" filter, etc.

NV-2 Insufficient exposure to radon progeny; i.e., less than one working level liter was measured for the sampling period

NV-3 Invalid average working level due to insufficient time lapse between sample collection

NV-4 Error made during TLD readout

NV-5 Damaged filter or sampling head

NV-6 Miscellaneous

NV-7 RPISU samplers run simultaneously in different areas of the same location

NV-8 RPISU only run during "working hours"

NV-9 Special study

NV-0 RPISU clock failure

Invalid sample results appear on the printout in order to maintain a record of the sample, but invalid results are not included in calculating the average working level.

The results, as computed by EPA do not always follow PNL's protocols. Since six results that represent the bi-monthly sampling frequency should be linearly averaged to obtain the annual average, it is not correct to average "extra" measurements linearly. For the purpose of this report, six bi-monthly intervals are chosen for the property and the "extra" samples are allocated to the appropriate intervals. If the "extra" samples are greater than 100 hours, a simple linear average of the results for that interval is taken. If the "extra" sample is less than 100 hours it is treated as if it were one of a set of multiple heads and a time weighted average is taken as shown above. When all measurements have been allocated to intervals, the linear average of the six interval results is taken for the annual average. This has been typed on the table as "PNL Property Average = XXX". Intermediate averages for intervals are typed on the form in the "combined working level" column near one of the values used in the average.

The EPA gives a separate listing for each room sampled and does not average between rooms within a given structure. Since it was often necessary to change locations during sampling, these data have been combined by PNL to obtain the average irrespective of location. To clarify the table, different properties are separated by double bars and rooms within a given structure are separated by a partial single bar.

In the case of non-valid results, this laboratory feels that the omission of results from individual sampling heads because the total reading is below a detection limit threshold (NV-2) may tend to give a

positive bias to the results for that interval. When several heads have been used for an interval, it is possible to evaluate the results for NV-2 cases and, unless there is evidence that a significant bias exists between them and the other heads, to use those results. In a number of cases, the interval average has been recalculated using NV-2 sample results. Those cases have been indicated. In addition, the NV-6 results in the appendix were caused by a failure to properly anneal the detector heads at the time of reading them. This can cause a significantly different than normal reading to occur. However, calibration standard TLD chips which had been exposed to a known level were run with each batch of samples. When the NV-6 readings occurred, the results were normalized for the output of those standards. Thus, the expected error from this process is not expected to be large. NV-6 results were used for an interval unless the reading of those samples could change the status of the average relative to the EPA standard of 0.015 W.L.

The results in this tabulation which do not have a "PNL Property Average" result failed to meet the criterion of six bi-monthly intervals of at least 100 hours total duration. The 99 valid annual property average results are classified by exposure level in Table 1. A log-normal plot of these data is shown in Figure 1. The data fit the log-normal distribution very well. Only the five highest measurements and two lowest appeared to be somewhat elevated relative to the general population. As shown in Table 2, the median exposure level among this group of properties was 0.012 W.L. From Table 1, it can be seen that concentrations exceeded 0.015 W.L. at about 33% of the properties in this group. From Figure 1 it can be seen that most, if not all, of those properties belong to the general population that was tested.

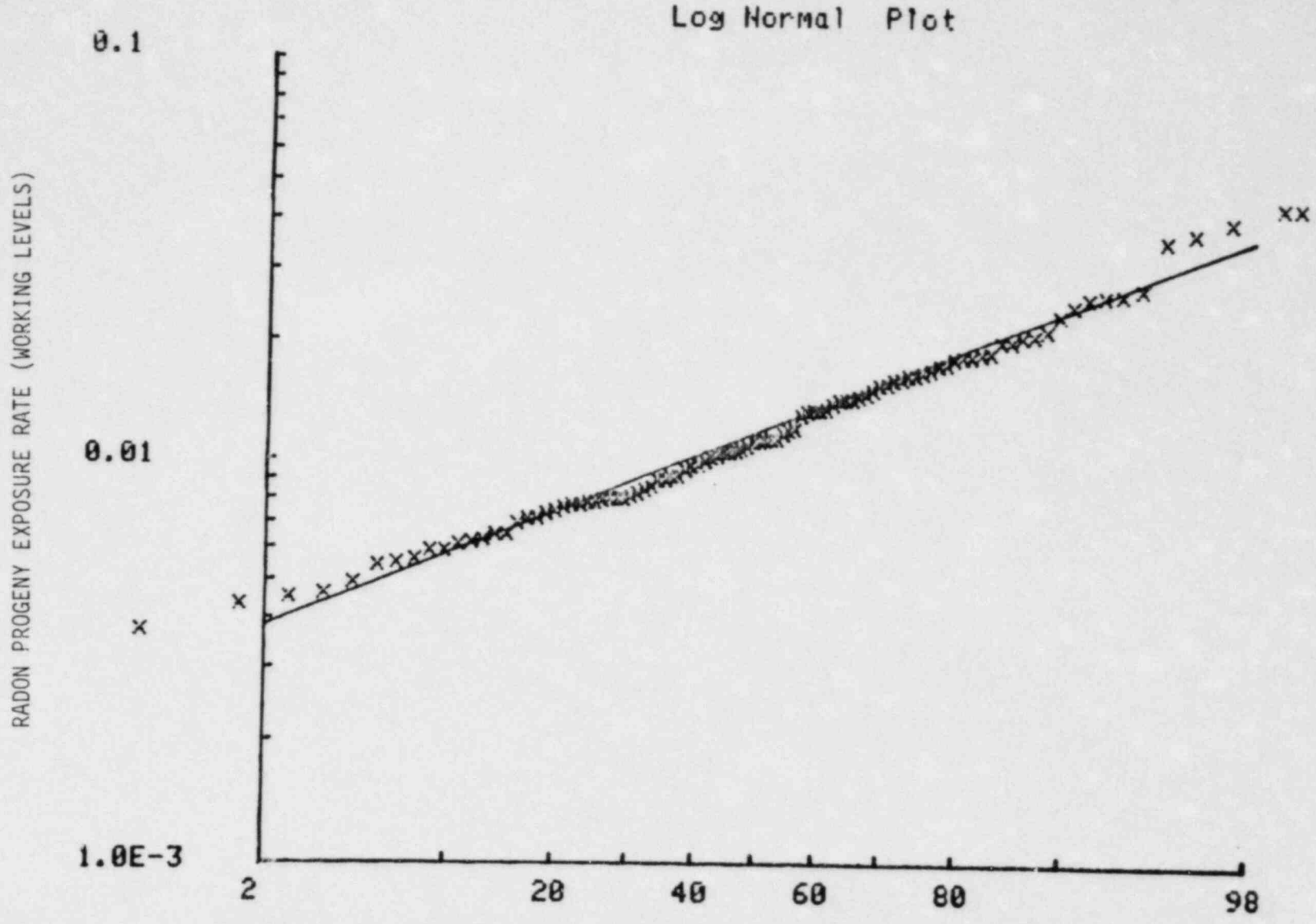

Figure 1. The log-normal distribution fit of annual average RPISU measurements

TABLE 1

STATISTICAL SUMMARY OF PNL
ANNUAL AVERAGE MEASUREMENTS

Annual Average Working Levels	Total Number of Properties	
.0030-.0039	1	
.0040-.0049	4	
X <.005		5
.0050-.0059	5	
.0060-.0069	6	
.0070-.0079	10	
.0080-.0089	9	
.0090-.0099	6	
.005 ≤ X < .010		36
X < .010		41
.0100-.0109	7	
.0110-.0119	8	
.0120-.0129	1	
.0130-.0139	5	
.0140-.0149	6	
.010 ≤ X < .0150		27
X <.015		68
.0150-.0159	4	
.0160-.0169	4	
.0170-.0179	3	
.0180-.0189	4	
.0190-.0199	2	
.0150 ≤ X < .0200		17
X <.0200		85

TABLE 1 (cont.)

Annual Average Working Levels	Total Number of Properties	
.0200-.0209	2	
.0210-.0219	1	
.0220-.0229	0	
.0230-.0239	1	
.0240-.0249	1	
.0250-.0259	1	
.0260-.0269	2	
.0270-.0279	1	
.0280-.0289	0	
.0290-.0299	0	
.0200 ≤ X <.0300		9
X <.0300		94
.0300-.0349	0	
.0350-.0399	3	
.0400-.0449	1	
.0450-.0499	0	
>.050	1	
>.030		5
TOTAL		99

Population Percentiles

Cumulative %	Annual Average Exposure Rate (Working Level)
0.1	0.002140660672446
1.0	0.00325532190454
2.0	0.00378060189721
2.5	0.00398026605902
5.0	0.00473162398247
10.0	0.00577555481711
50.0	0.01166685886965
90.0	0.0235745251629
95.0	0.0287757359566
97.5	0.0342077540413
98.0	0.03601436122228
99.0	0.04182565238O4
99.9	0.06360624808 35

Table 2. Population percentiles of the log-normal distribution fit of annual average RPISU measurements