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CONTINUOUS, ENVIRONMENTAL RADON MONITORING PROGRAM AT THE YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT

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ABSTRACT

A preliminary study on radon concentrations in the outdoor atmosphere at the Yucca Mountain Project (YMP) site is discussed in this paper. Diurnal pattern was observed in the continuous monitoring results. It was confirmed that the meteorological conditions had a significant effect on the ambient radon concentrations. Exposure to short lived radon progeny was assessed using NCRP-78 methodology.

INTRODUCTION

A continuous, environmental radon monitoring program has been established in support of the Department of Energy's (DOE) Yucca Mountain Site Characterization Project (YMP). The monitoring program is to characterize the natural radon emissions at the YMP site, to understand the existing radon concentrations in the environmental background, and to assess and control the potential work exposure [4].

Based upon a study of the monitoring results, this paper presents a preliminary understanding of the magnitudes, characteristics, and exposure levels of radon at the YMP site.

MATERIALS AND METHOD

The Pylon PMT-TEL/AB-5 system was selected to measure the ambient radon concentrations because of its sensitivity and versatility. Two monitoring stations, NF6 and NF87, have been installed in the near field (near field is the area within 16 kilometer (km) radius of the north portal of the Exploratory Studies Facility (ESF)). The radon concentrations are measured on a 10-minute basis. Quality control measures are in place to ensure that the data collected in the field are accurate and reliable.

Radon concentration data included in this analysis were collected during April 1994. They were completely reviewed and validated in accordance with the appropriate procedures. Meanwhile, hourly meteorological parameters were measured in parallel at NF6 station, and the data are used to support the analysis.

Exposure rate to radon progeny while working in the near field of the YMP site is evaluated in accordance with the NCRP-78 methodology. Assuming a 2,040 hour work year, or 170 work hours per month, the following equation is used to calculate the radon progeny exposure dose rates.

$$Dose\ rate(\mu Sv\ hr^{-1}) = \frac{CF * Rn * Q * WF * C}{WY}$$

where:
CF = Conversion Factor (Gy yr^{-1} [Bq $m^{-3}]^{-1}$)
Rn = Radon Concentration (Bq m^{-3})
Q = Quality Factor, 20 (Sv Rad^{-1})
WF = Weighting Factor, 0.12
C = Unit Conversion, 10^6 (μSv Sv^{-1})
WY = Work Year, 2040 (hrs yr^{-1})

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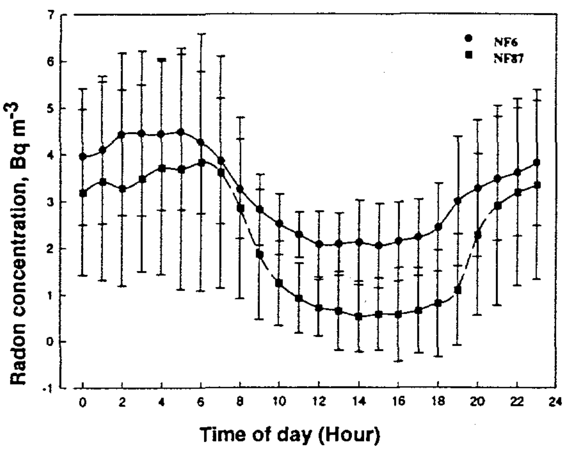

Fig. 1 Hourly Average Radon Concentrations at NF6 and NF87 during April 1994

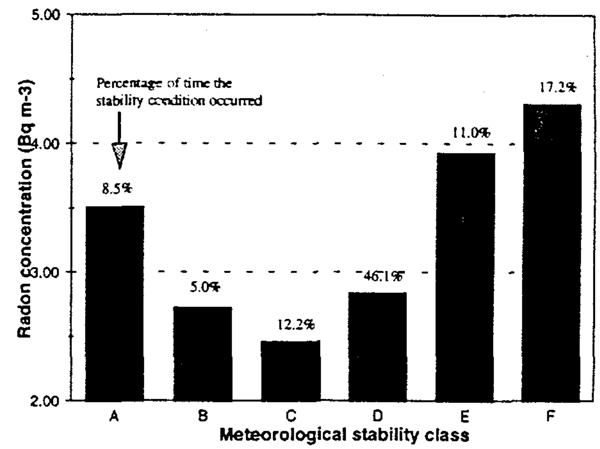

Fig. 2 Average Radon Concentrations vs. Meteorological Stability Classes at NF 6 during April 1994

RESULTS

A. Radon Concentrations and Their Diurnal Pattern

To minimize the uncertainties due to the counting statistics, 10-minute readings are integrated into hourly averages. Fig. 1 illustrates the average hourly radon concentrations during April 1994. This visual analysis reveals a diurnal pattern. At both locations, radon concentrations are higher during night time than day time. They reach the crests around 0400 hours and drop to the troughs around 1500 hours with continuous change in between. The illustration also suggests that the radon concentrations at NF6 are higher than those at NF87.

During April 1994, the average radon concentrations were 3.22 ± 1.67 (Bq m^{-3}) and 2.18 ± 2.22 (Bq m^{-3}) for NF6 and NF87, respectively. Quantitative statistical analysis indicates that the difference is significant at the 95% confidence level (p value = 0.0001).

B. Influence of Meteorological Condition

The ambient radon concentration is determined by the quantity of radon released to the air and dilutional factors. The dilution of radon gas in the atmosphere is governed by meteorological conditions[1]. These meteorological conditions can be accounted for by the Pasquill-Gifford stability classes, which distinguishes six stability classes from A (highly unstable) to F (highly stable) [2].

Fig. 2 presents the average radon concentration measured for each stability class during April 1994. It also indicates the percentage of time a particular stability condition occurred. The radon concentration trend depicted in Fig. 2 suggests a strong relationship between radon concentrations and meteorological conditions. Class A, B and C are called unstable conditions. These conditions are conducible for gas dispersion, thus, radon gas is dispelled before it accumulates into a high concentration. A neutral condition, or class D, is another favorable condition for mixing air. Under this condition, radon can be quickly diluted after it enters into the atmosphere. Class E and F are stable conditions. They are the least conducive conditions for gas dispersion, therefore, radon is likely to be trapped and results in a relatively higher concentration in this category.

Statistical test confirms that the meteorological stability conditions have a significant effect on the ambient radon concentrations.

C. Dose Assessment

Taking the diurnal pattern into consideration, exposure dose rate is evaluated based on the normal work hours, which is from 0700 to 1700 hours. Calculations and assumptions are made in accordance with NCRP-78[3]. The exposure dose rates to short-lived radon progeny while working in the near field of the YMP site (excluding underground) are estimated to be 0.13 (μSv hr^{-1}), or 259.2 (μSv yr^{-1}) for male, and 0.12 (μSv hr^{-1}), or 250.6 (μSv yr^{-1}) for female.

CONCLUSIONS

The ambient radon concentrations measured at the YMP site show a clear diurnal pattern, and the meteorological conditions are found to be responsible for this daily variation. A simplified dose assessment indicates that the exposure to environmental radon progeny while working in the near field of the YMP site is very low.

The applicability of the conclusions is limited by the number of monitoring stations, the amount of data, and the assumptions involved in the analysis. Additional monitoring stations and data are required to ensure the understanding of the radon emissions at the YMP site.

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