RECENT TRENDS IN MONITORING RADON AND DAUGHTER PRODUCTS IN INDIAN URANIUM MINES

A.H. Khan and M. Raghavayya

Health Physics Division
Bhabha Atomic Research Centre

Health Physics Unit, Jaduguda
Jaduguda Mines, Singhbhum - 832102
INDIA

1. INTRODUCTION

Monitoring programme in the Jaduguda uranium mine in India is tuned to the estimation of radon concentrations in work places. It is well known that in some countries, notably in the United States of America and in Canada, the practice is to estimate the radon daughters in Working Level (WL) unit and to express the cumulative individual exposure to these contaminants in Working Level Months (WLM). This has been a convenient and useful tool in the hands of the epidemiologists for correlating the incidence of lung cancer with exposure of the lungs to alpha radiation (1 - 4). But when it comes to translating the exposure in WLM to lung dose in rads no definite relation has so far been formulated (5-7).

In our mines in India, although we continue to use radon monitoring as the principal method of hazard evaluation, we have also in addition carried out simultaneous estimation of the WL values on many occasions. More recently some attempt has been made at determining the percentage of radon daughter activity in the unattached state obtaining in mine air.

2. RADON IN MINE AIR

Using the direct scintillation method which is now well known and widely adopted, radon concentration in the work places in our mines is measured on a routine basis. The data thus collected over the last 10 years has been summarised in Table 1. For this purpose the radon levels obtaining during the same operation have been averaged. The main mining operations considered are 'drilling', 'mucking (slushing)' and all others collectively as 'general'.

3. RADON DAUGHTERS IN MINE AIR

The radon daughters concentrations have been measured on many occasions along with radon estimations. The mean WL values during the different operations are presented in Table 2

4. UNATTACHED RADON DAUGHTERS

The method adopted for estimating the percentage of unattached radon daughters was the wire screen technique (8) with the computational modification

suggested by MERCER (9). The sampling rate was 9.5 lpm through a 59 mesh/cm prefilter and glass fibre filter combination. The collection efficiency of the prefilter for unattached radon daughters was calculated to be 64.7%. Earlier sporadic attempts had yielded very widely varying values for the unattached fractions f_a, (for RaA), f_b (for RaB) and f_c (for RaC) with median values at about 6%, 3% and 1% respectively. Recent measurements however, gave considerably higher figures. All the measurements reported here were carried out just inside the adit mouth where one of the main exhaust fans is located. Hourly readings during one work shift over a period of two weeks were taken under operational (mine working) and passive (on holidays when the mining operations were suspended) conditions. For convenience we have reported only the mean values of the total unattached fraction f_t in Fig. 1.

5. DISCUSSION

We have adopted an MPC$_a$ value of 250 pCi/l for a 48 hour work week in our mine on the basis of the recommendations of IAEA (10). Table 1 shows that the average radon levels in our mines have been mostly below this level. From Table 2 we can see that the WL values also have been quite lowwhich is due to the good ventilation conditions and the consequent disruption of equilibrium between radon and its daughters. The degree of disequilibrium can be gauged from the fact that the WL to radon concentration ratio has all along been much below the theoretical value of 0.01, varying between 0.00072 in 1973 to 0.002 in 1976. Based on the WL values the mean cumulative exposure of drillers to radon daughters during the last 10 years has been 2.39 ± 1.11 WLM/year and the corresponding figures for the muckers (slushing crew) and remaining category of workers have been 3.21 ± 1.35 WLM/year and 1.61 ± 0.17 WLM/year respectively. These figures compare well with the current United States standard of 4 WLM/year.

From Fig. 1 it may be seen that the f_t values in the exhaust air under passive conditions are higher and less varying than under operational conditions. As soon as the mining operations commence the values tend to decrease, reaching a somewhat steady state in about 5 hours. The f_t values reported here are necessarily higher than those reported by other investigators elsewhere because these measurements have been carried out at a place well removed from actual work locations.

6. ACKNOWLEDGEMENT

We gratefully acknowledge the constant encouragement received from Mr. S.D. Soman, Head, Health Physics Division, Bhabha Atomic Research Centre and our thanks are due to Mr. M.A. Batra, Managing Director, Uranium Corporation of India Ltd., Jaduguda for all the facilities provided for these measurements.

Year	OPERATION		
	Drilling	Mucking	General
1967	120 ± 34	230 ± 83	188 ± 55
1968	248 ± 68	175 ± 48	38 ± 29
1969	265 ± 75	358 ± 102	115 ± 39
1970	132 ± 37	103 ± 22	78 ± 27
1971	110 ± 27	110 ± 32	58 ± 8
1972	38 ± 8	72 ± 21	60 ± 20
1973	79 ± 13	74 ± 11	78 ± 21
1974	36 ± 12	168 ± 53	151 ± 52
1975	80 ± 48	70 ± 20	109 ± 40
1976	123 ± 27	46 ± 9	68 ± 9

TABLE 1 Mean radon levels (pCi/l) in Jaduguda uranium mine

Year	OPERATION		
	Drilling	Mucking	General
1967	0.17 ± 0.05	0.33 ± 0.12	0.27 ± 0.08
1968	0.36 ± 0.10	0.25 ± 0.07	0.06 ± 0.04
1969	0.38 ± 0.11	0.52 ± 0.15	0.17 ± 0.06
1970	0.19 ± 0.05	0.25 ± 0.03	0.11 ± 0.04
1971	0.16 ± 0.04	0.17 ± 0.05	0.08 ± 0.01
1972	0.06 ± 0.01	0.05 ± 0.01	0.09 ± 0.03
1973	0.06 ± 0.01	0.11 ± 0.03	0.06 ± 0.02
1974	0.14 ± 0.03	0.41 ± 0.13	0.37 ± 0.13
1975	0.21 ± 0.06	0.18 ± 0.15	0.32 ± 0.31
1976	0.59 ± 0.48	0.22 ± 0.10	0.06 ± 0.01

TABLE 2 Mean radon daughters working level (WL) in Jaduguda uranium mine

REFERENCES

(1) WAGONER, J.K., et al., Mortality patterns among US uranium miners and millers - 1950 through 1962, Proc. IAEA Symposium on Radiological Health and Safety in Nuclear Materials Mining and Milling. 1, p - 37 (1963)

(2) SACCOMANNO, G., et al., Lung Cancer of uranium miners on the Colorado plateau. Health Physics. 10. p - 1195. (1964)

(3) DONALDSON, A.W., Epidemiology of lung cancer among uranium miners. Health Physics, 16. p - 563, (1969)

(4) LUNDIN, F.E. Jr., et al., Radon daughter exposure and respiratory cancer-qualitative and temporal aspects. "NIOSH-NIEHS Joint Monograph" USPHS (1971)

(5) BALE, W.F., and SHAPIRO, J.V., Radiation dosage to lungs from radon and daughter products. Proc. UN International Conference on Peaceful Uses of Atomic Energy. 13. p - 253 (1955)

(6) ALTSHULER, B., et al., Estimation of the lung tissue dose from inhalation of radon and daughters. Health Physics, 10. p - 1137, (1964)

(7) JACOBI, W., The dose to the human respiratory tract by inhalation of short lived Rn-222 and Th-220 decay products. Health Physics, 10. p - 1163, (1964)

(8) RAGHAVAYYA, M, and JONES, J.H., A wire screen filter paper combination for the measurement of fractions of unattached radon daughters in uranium mines. Health Physics, 26. p- 417. (1974)

(9) MERCER, T.T., Unattached radon decay products in mine air, Health Physics. 28, p - 158., (1975)

(10) IAEA, "Basic safety standards for Radiation Protection" No. 9, (1967)

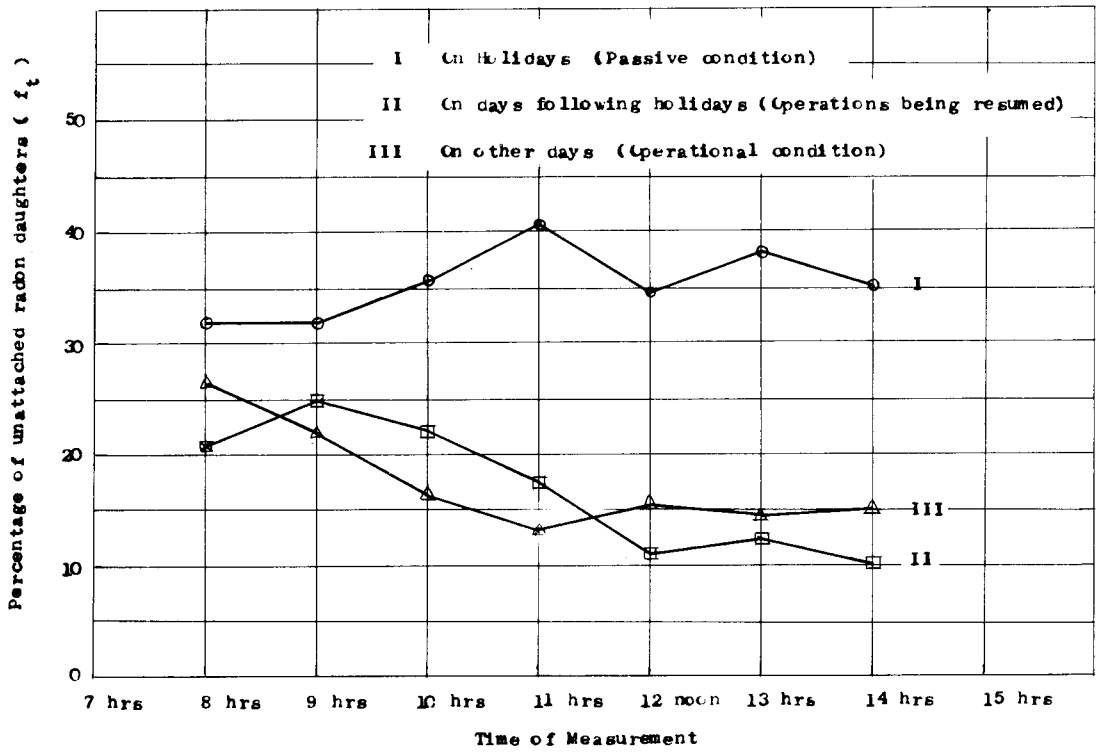

FIG. 1 Temporal variation of unattached radon daughter fractions