DOSE EQUIVALENT ESTIMATE OF WORKS IN A BRAZILIAN MONAZITE SAND PLANT

Ney, C.L.V., Tauhata, L. And Oliveira Filho, D.S.
Instituto de Radioproteção e Dosimetria (IRD)
Comissão Nacional de Energia Nuclear (CNEN)
Av. Salvador Allende, s/nº - Barra da Tijuca - C.P. 37750
CEP.: 22642 - Rio de Janeiro - Brasil

ABSTRACT

Dose equivalent estimate of workers in a brazilian monazite sand plant, due to concentration of thorium in the air is presented, uzing in air monitoring program and utilizing calculation model described in publication nº 30 of the International Commission on Radiological Protection (ICRP).

The sample area, the number of measurements and the results evaluation were made using the experimental design techniques. The results of the dose equivalent estimation due to internal and external radiation exposure indicate the existence of operation areas, for example mill and magnetic field separation, where the dose values surpassed the recommended limits, demanding improvement in radiological protection and the modification of the engineering process, in order to obey the international standards.

INTRODUCTION

The Nuclear Energy National Commission (CNEN) has been developing for many years programs of accompanying of radiological conditions at instalations that use ores with reasonable thorium and uranium tails, as those that processes monazite sand mill to produce rare earth and trissodic phosphate. The brazilian industry analysed, processes monazite with the following sequences of operation: magnetic field separation, milling, alkaline treatment, trissodic phosphate filtration and thorium and uranium cake filtration.

The radiological conditions evaluations were performed by an area monitoring program in the various processes steps location. The results obtained from monitoring were considered as input data in the dose equivalent calculation model, recommended by ICRP publication nº 30[1].

METHODOLOGY

The use monitoring program performs the sampling of measurement in the positions of major ocupation of workers, inside of a process area. The permanence time used was the time of labour agreement, i.e., 40 hours/week.

The evaluation of the dose was given by the sum of the doses due external and internal exposure. The dose due to external exposure was estimeted by direct measurement in the radiation field, using a Geiger Muller detector, and considering the quality factor for gamma radiation equal to 1. The dose due to internal radiation was estimated by indirect method, measuring the portion that was inhaled through the determination of the concentration of radionuclides in the air, sampling the air and total alpha couting, and multiplying by permanence time, and using models for internal dose calculation.

The main difficult in the monitoring program is to find the distribution representative value or values of the results. It was resolved by using the technique of statistics planning. The planning took into consideration that the mains source of flutuation would be the measurement of the sample point and time/day of its execution.

Therefore, the value of an individual measurement was expressed by:

$$Y_{ijk} = \bar{y} + P_i + D_j + PD_{ij} + \varepsilon_{(ij)k}$$

where:

Y_{ijk} - individual measuremente value

$\bar{y}$ - distribution meam value

P_i - measurement influency in a "i" point

D_j - measurement influency in a "j" day

PD_{ij} - combined influency in a "i" point and in a "j" day

$\varepsilon_{(ij)k}$ - variation due random error and other influencies.

Using this equation we obtain the number of measurement, the measurement points and sampling days. Hence, we draw lots the days and points sequence to be monitored, to obtain an statistics planning of the type "totality random". The obtained results were submeted to variance analysis.

Using the results distribution of the gamma exposure rate and radionuclide concentration in air, we estimate the dose equivalent using the dosimetric model for the determination of internal and external dose.

RESULTS AND DISCUSSIONS

The estimates of the dose equivalent due to external exposure are presented in table 1. The results do not present higher risks to the workers.

Table 1 - Annual dose equivalent due to external exposure to gamma radiation in several areas of the instalation.

Processing area	Dose (mSv)
Monazite mill	15,4
Magnetic separation	35,0
Light fraction deposition	21,0
Autoclave (alkaline treatment)	8,0
Filter-press	10,5

The dose equivalent results due to internal exposure to radiation are presented in table 2. All the results are higher than the limits set by safety series nº 82. That indicates the need for improvement in the radiation protection and the modification in the industrial process.

Table 2 - Annual dose equivalent due to internal exposure.

Processing area	Mean Concentration (Bq/m^3)	Dose (mSv)
Monazite mill	0,25	150,6
Magnetic separation	0,56	300,0
Light fraction deposition	0,43	259,0
Autoclave(alkaline treatment)	0,20	120,5
Filter-press	0,13	78,3

The total dose equivalent are presented in table 3.

Table 3 - Total annual dose equivalent.

Processing area	Dose (mSv)
Monazite mill	166,0
Magnetic separation	335,0
Light fraction deposition	280,0
Autoclave (alkaline treatment)	128,5
Filter-press	88,3

The results in table 3 show that all the values are higher than the primary limits (50 mSv/year). To avoid those doses it was adopted the following remedial actions: reduction of working journey; the use of masks for radiactive particulate; and modifications in the processing, like deactivation of the magnetic separation.

CONCLUSIONS

1) The monazite processing to obtain rare earth trissodic phosphate, in areas that have associated thorium, can yield doses equivalents up to 335,00 mSv a year, mainly during milling and magnetic separation.

2) According to the results from mean concentration given in table 2 and concidering the limits for thorium associate ore dust, 0,082 Bq/m^3, by safety series 82, we conclude:

a) For free air sampling one should use techniques to retain paticles of breathing size such as Cyclones.

b) The total alpha techinique is not adequated to aplay those limits for concentration. It is necessary a additional techinique that allow discriminat the contribution from thorium, radium and uranium.

c) Since the dose equivalent values are grather than 3/10 of the primary limit, it is recomended a individual monitoring program using personal air sampler and/or bionalysis.

3) The Company should execute cost-benefity analysis to obtain a conclusive solution for the radiological problems.

BIBLIOGRAPHY

1 - International Commission on Radiological Protection, Limits for Intakes of Radionuclides by workers, ICPR nº 30, (1978)

2 - Ney, C.L.V., Determination of the Dose and Risks in the Thorium Cicle, Master Thesis, IME (1988)

3 - International Atomic Energy Agency, Apllication of the Dose Limitation System to the Mining and Milling of Radioactive Ores, Safety Series nº 82 (1987).