THORIUM BIOASSAY OF MINERAL SANDS WORKERS

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ABSTRACT

The concentration of thorium in the blood serum and urine of Western Australian mineral sands workers was studied to complement estimates of radiation dose derived from air sampling measurements. The measured levels were significantly lower than the values predicted from the application of ICRP biokinetic models to air sampling data. In many cases, the levels were of the same order as background levels measured in occupationally unexposed persons.

AIM OF PROJECT

The study was designed to enable comparisons between measured values of thorium in the blood and urine of mineral sands workers and:

1. measured values for unexposed persons;

2. values reported in the literature for other worker groups exposed to thorium; and

3. predicted values based on air sampling measurements undertaken by the industry.

It was considered that such comparisons would facilitate a comparative assessment of the relative level of exposure.

BACKGROUND

Workers in the mineral sands industry are exposed to varying concentrations of the radioactive mineral, monazite, which contains 6-7% by weight of the radioactive element thorium. The principal radiation exposure pathway is thought to be through inhalation of alpha radiation associated with airborne dust. Estimates of internal radiation dose using the assessment protocols and data contained in ICRP Publications 26 and 30 indicate that up to 15% of the approximately 1500 workers in the mineral sands industry may exceed the formal investigation level of 15 $mSvy^{-1}$.

The existing radiation dose assessment method is based on air sampling, which requires assumptions to be made concerning a number of environmental factors, including the size of the dust particles, the solubility of the dust, the incorporation of dust into the body and the effectiveness of respiratory protective equipment in reducing exposure to dust.

Bioassay monitoring for thorium will assist in improving knowledge of its metabolic behaviour. The blood and urine samples provide an indication of the amount of thorium circulating in the body and being cleared from the body, respectively. Such bioassay studies assist in refining our estimates of radiation dose following inhalation of thorium.

STUDY GROUP AND METHODS

The project commenced in April 1991 and involved thirty four (34) mineral sands workers across five processing plant sites. In addition, a number of samples were collected from unexposed persons to obtain an indication of background levels of thorium.

The cumulative internal exposure history for each worker was obtained from industry records of airborne radioactivity (gross alpha activity) measurements submitted to the Department of Mines. It was assumed that workers were exposed to class Y (i.e. avidly retained) Th ore dust with an AMAD of 10 μm Twenty five millilitres of blood and 1 L of urine were collected using rigorous collection protocols to minimise the possibility of contamination. The samples were analysed using chemical/radiochemical neutron activation analysis procedures.

RESULTS

The results of testing are summarised in the attached figure. The measured average levels for the industry are compared with the expected level, based on industry monitoring of the workplace atmosphere, and also average background levels. The levels of thorium in urine and blood are expressed in parts of thorium per billion parts of either urine of blood.

The following observations are made on the results obtained in this study:

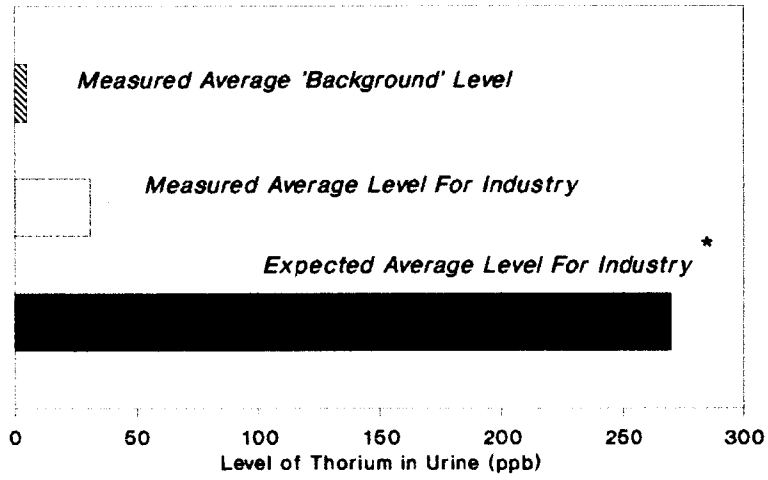
1. The levels of thorium in urine are very low and typically more than <u>ten times lower</u> than those expected based on air sampling measurements.

2. The levels of thorium in blood are typically more than <u>two times lower</u> than those expected based on air sampling measurements.

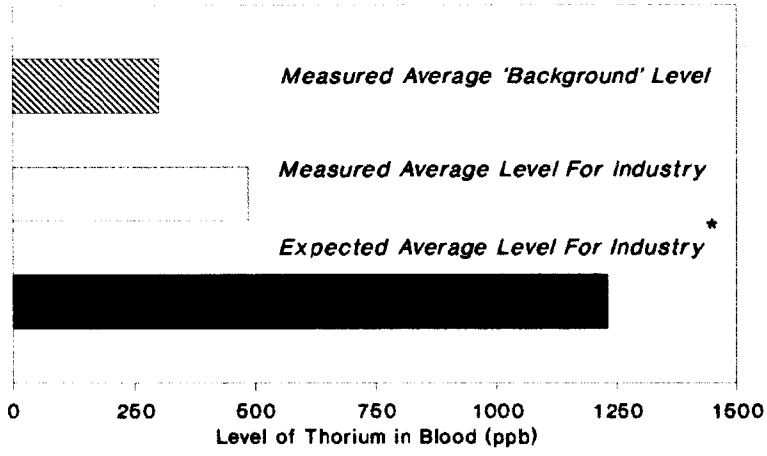
3. The urine results for many workers are not substantially different from those reported for members of the public and are lower than those reported for other groups of workers exposed to thorium.

Results of Bioassay Measurements

(a) Urine Sampling



(b) Blood Sampling



* *Expected Level Based Upon Application Of ICRP Biokinetic Models To Airborne Radioactivity Measurements.*

4. The level of thorium in blood are higher than some reported background levels.

The blood testing is considered to be more reliable than urine testing since varying intake of fluids such as water and alcohol, or loss of water by perspiration, will cause significant differences in the amount of urine excreted.

CONCLUSIONS

This testing program indicates that the absorption of thorium is much less than has been previously assumed. This result suggests:

(1) present industry monitoring procedures may overstate the radiation doses received by workers. The lower results could arise if respirators have been worn for "dusty" jobs and no allowance has been made for their protective effect; or

(2) thorium may be much less soluble than expected and only a small amount passes into the blood or urine. If this is so, then thorium will not be carried to sensitive organs such as bone.

It is likely that, on the basis of this study, average radiation doses in the industry may only be about one-half of those reported.

While this monitoring has indicated that existing protective measures are effective in controlling radiation exposure to low levels, it is still important to maintain radiation exposures As Low As Reasonably Achievable.

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