CONTAMINATION OF RESIDENTIAL AREAS BY A FORMER RADIUM PROCESSING PLANT

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INTRODUCTION

Residential areas affected by increased radon concentrations and gamma radiation levels have previously been reported for lands contaminated with uranium mill tailings,[1,2] and land enriched in radium 226 from wastes from phosphate processing.[3]

In Sydney, Australia a plant operated from 1912 to 1915 to produce radium bromide from uranium ore concentrates which originated in South Australia and were transported to the plant, a distance of 2,000 kilometres, by sea.

A total of approximately 500 tonnes of low grade ore concentrate (1.4% uranium) were treated to produce an estimated 1.8 grams of radium bromide.[4]

The site has since been developed as prime waterfront residential areas, and a radiation survey of the site was carried out after a request from a resident who had learned of the plant's existence from records with the local historical society.

DESCRIPTION OF AREA

The processing plant was built on land reclaimed from Sydney harbour and extended up a sheer cliff face to road level. A series of terraces were constructed to enable level surfaces to be created for the construction of the plant. The total area of contamination was 2000 m^2 which includes 1300 m^2 over six residential blocks and 700 m^2 of harbour foreshore. The estimated volume of contaminated soil is 1000 m^3 with an average depth of 0.5 metres. A plan of the contaminated areas is shown in Fig. 1.

MEASUREMENT TECHNIQUES

(i) Dose rates were measured at waist level using Berthold LB-1200 and Eberline PRM-7 monitors calibrated against a radium 226 standard.

(ii) Radon was measured by the two filter method [5] and by a Johnson 955B radioactive gas monitor.

(iii) Working levels were determined by the Rolle method.[6]

(iv) Radium 226 in soil samples was determined either by direct gamma counting or by radiochemical analyses.

CONTAMINATED AREAS

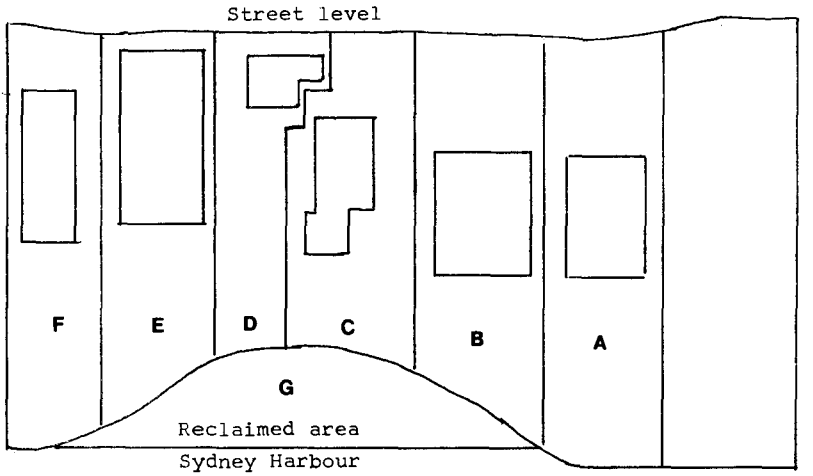

Fig. 1

Area A

A small area of contamination near the cliff face had a dose rate 1 μSv/hr and a radium content of approximately 6 kBq/g. The area on which the house was constructed was not contaminated.

Area B

From old photographs of the plant, this is identified as the site of the plant manager's residence, since demolished. Areas around the new house were free of contamination. Radon was not detectable inside the house.

A hot spot with a dose rate of 30 μSv/hr was found in the grounds and consisted of broken bricks, crucibles etc. Gross alpha and beta activity of samples of this rubble were an average of 60 kBq/g and 190 kBq/g respectively. Scrapings from an iron bar had a gross alpha activity of 920 kBq/g and gross beta activity of 3.2 MBq/g.

Apart from this "hot spot", general contamination of about 4 kBq/g of radium was found in an area near the swimming pool constructed adjacent to the house. The dose rate was 0.5 μSv/hr.

Area C

A soil sample taken from under the kitchen of the house had a radium concentration of 244 kBq/g and it is likely that the house has been erected over the site of the plant's chemical laboratory. Soil under other areas of the house had an average radium content of 18.5 kBq/g

A number of spot measurements of radon and working levels were made which showed wide fluctuations. Radon varied from 260 - 3000 kBq/m^3 with an average of 1200 kBq/m^3 and working levels ranged from 0.02 - 0.32 with an average of 0.12.

Fluctuations in radon levels were also evident with the use of a continuous radioactive gas monitor. The average radon concentration was 190 kBq/m^3 with a maximum concentration of 2600 kBq/m^3. Radon built up to a maximum between 9.00 am and 6.00 pm each day.

The average indoor gamma dose rate was 0.3 μSv/hr and the average outdoor dose rate was 0.5 μSv/hr.

The radium concentration of surface samples ranged from 1.1 to 24 kBq/g with an average of 37 kBq/g. Core sampling showed maximum activity at 0.7 metres.

Area D

The grounds were extensively contaminated. However, the house was built on the upper (road level) and was not affected by increased radon or gamma levels (working level 0.003, dose rate 0.1 μSv/hr).

The average dose rate in the grounds was 0.5 μSv/hr with localised "hot spots".

Samples of soil from one "hot spot" with a dose rate of 10 μSv/hr had an average gross alpha activity of 27 kBq/g and gross beta activity of 92 kBq/g. Another "hot spot" had a radium concentration of 592 MBq/g.

The radium concentration of surface samples excluding the "hot spots" ranged from 1.1 - 37 kBq/g with an average of 13 kBq/g.

Activity increased with depth to a maximum at 0.7 metres.

Area E

One "hot spot" found in the grounds with a dose rate of 10 μSv/hr had an activity of 1.5 MBq/g of radium.

The rest of the block was relatively free of contamination due to extensive movement of soil for the construction of the house. The house was not affected by increased radon or gamma radiation.

Area F

One "hot spot" was found which had a radium concentration of 52 MBq/g and was a cardboard type material. Apart from this, radium concentrations of surface samples ranged from 1.1 - 74 kBq/g with an average of 15.5 kBq/g.

Area G

This was land reclaimed from the harbour. Contamination was unevenly distributed. One "hot spot" had a radium concentration of 137 kBq/g. The average radium concentration over the rest of this area was 8 kBq/g. The average gamma dose rate was 0.5 μSv/hr.

REMEDIAL ACTION

The Radiological Advisory Council, of New South Wales has adopted the recommendation of the U.S. Surgeon General's guidelines for construction of houses over land contaminated with uranium mill tailings[7]. It has recommended removal of contaminated soil.

DISCUSSION

This contamination problem is unlike other cases of contaminated residential areas in that -

(i) the plant was not associated with any nearby deposit of uranium ore

and

(ii) Radium was being extracted and not dumped. That is, radium would ingrow from Uranium 238 and Thorium 230 and radioactivity would increase with time.

In addition the plant was operating long before any legislation regarding radioactive materials was introduced in New South Wales and subsequently there were no records of the plant with the Radiation Health Services. Subsequently the contamination would have remained undiscovered if the local resident had not learned of the plant's existence.

REFERENCES

1) United States Congress. Joint Committee on Atomic Energy. Use of Uranium Mill Tailings for Construction Purposes. Washington, 1971.

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4) South Australian Review of Mining Operations; 1908-1912, No. 17.

5) Thomas J.W., & Le Clare P.C., Health Physics 18; 113-122 (1970).

6) Rolle R., Health Physics 32; 233-238 (1972).

7) U.S. Atomic Energy Commission (1972) Grand Junction Remedial Action Criteria - Federal Register, Vol. 37 (235) - Wednesday December 6th - pp. 25918-25919.