Occupational radiation risks in conveyance of bulk Phosphate and Potash

Y. Grof, O. Even, T. Schlesinger and M. Margaliot
Radiation Safety Division, Soreq NRC, Yavne 81800, Israel.

abstract

The issue of occupational ionizing radiation risks encountered in the conveyance and storage of Phosphates and Potash as loose cargo got very minor attention from the national health and occupational safety authorities in the world. In Israel, the Phosphates include an average 100-150 ppm of Uranium in equilibrium with its daughters, while in Phosphates produced in most other countries the fraction reaches regularly only few ppm up to 50 ppm.

Because of the high content of the Uranium in the Phosphate in Israel we must take into consideration the radiological implications involved in the handling of this mineral. The radiological implications of handling Potash are less significant but can not be neglected as we demonstrate bellow.

In this presentation we will estimate the occupational radiological risks involved in the storing and transportation of Phosphate and Potash.

Note, that the main risk in working with Phosphate and Potash is the risk from the dust itself.

To the basic risk of external radiation from the Uranium and its daughters and from K-40 (natural potassium contents 0.0118% of ^{40}K which emits beta and high energy gamma radiation), we must add risks related to the ingestion and inhalation of the dust particles, basically, and by the inhalation of the Radon and its daughters. Therefore ,workers engaged in handling both Phosphates and Potash are potentially exposed both to external and internal radiation.

The results of actual measurements of external radiation dose rates and of radioactive contamination in the air, made by us recently in a Phosphate and Potash storage, are also will be presented. These measurements enabled the analysis related to the loose

cargo transportation, and discuss the potential radiation risks to the workers and to the people who live near by.

A preliminary work dealing with the same subject was published by us in 1987, but due to changes that will be discussed later, in the evaluation of ionizing radiation risks by the ICRP and in the international radiation protection standards, and because of the improvements in the measuring methods, we found it necessary to repeat the survey and the measurements and their analysis.

The presence of Uranium in the Phosphate has a double significance:

1.External radiation caused by the gamma rays from the Uranium chain.

2. Internal contamination from:

a. The Uranium itself and its long living daughters in the dust.

b. The short lived daughters of the Radon 222, causing radiation dose to the respiratory tract.

The Uranium and its long lived daughters appear as a component of Phosphate dust, airborne around Phosphate storage . This dust enter the respiratory tract, with the inhaled air.

All of the Uranium in Phosphate, appear as non soluble compounds, and is captured at the deeper parts of the respiratory tract, specially in the pulmonary region and the tracheobronchial lymph Nodes . The dose to a human inhaling this natural Uranium dust , is therefore caused mainly by the Uranium trapped in the lungs.

Radon is produced in the decay process of ^{226}Ra . It is a noble gas, and therefore it is not chemically connected to its surrounding media in the Phosphate and part of it can be emitted to the air. Radon decays radioactively in the air. The health risks of Radon and its daughters are well documented. National legislation in many countries require to limit Radon concentrations in homes and working premises. Remedy action levels of 200-600 Bq/m^3 in homes and 500-1500 Bq/m^3 on working premises has been set in these countries. In Israel the limit set by the ministry of the environment is 200 Bq/m^3 for homes. The national advisory committee on radiation protection recommended in 1994 to set a remedy level of 500 Bq/m^3 for Radon concentration in air in working premises in Israel. Note that such a level will lead to an effective dose of about 2.5 mSv during 2000 hours of stay on the premises (this estimation is based on an effective dose of 5 mSv/WLM).

Updated radiological data for internal contamination by members of the ^{238}U series are presented in table 1, e(g) is the effective dose per unit activity intake (Sv/Bq) for AMAD (Aerodynamic Median Activity Diameter) of 5 μm as presented in IAEA Safety Series No 115, 1995.

Also presented in the table are ALI values that we calculated from these e(g) values for an annual effective dose of 50 mSv (5 rem). For comparison we presented the ALI values for the same radionuclides as recommended in the earlier version of the International Basic Safety Standards for Radiation Protection, IAEA safety series -9, 1982.

Isotope	Inhalation			Ingestion		
	e(g) 5 μm	ALI		e(g) 5 μm	ALI	
		ss 115	old*		ss 115	old*
	Sv/Bq	(Bq)	(Bq)	Sv/Bq	(Bq)	(Bq)
^{238}U	5.70E-06	8.7E3	2E3	4.40E-08	1.1E6	5E5
^{234}Th	5.80E-09	8.6E6	6E6	3.40E-09	1.5E7	1E7
^{234}Pa	5.50E-10	9.1E7	2E8	5.10E-10	9.8E7	9E7
^{234}U	6.80E-06	7.3E3	1E3	4.90E-08	1.0E6	4E5
^{230}Th	2.80E-05	1.8E3	2E2	2.10E-07	2.4E5	1E5
^{226}Ra	2.20E-06	2.3E4	2E4	2.80E-07	1.8E5	7E4
^{222}Rn						
^{218}Po						
^{214}Pb	4.80E-09	1.0E7	3E7	1.40E-10	3.6E8	3E8
^{218}At						
^{214}Bi	2.10E-08	2.4E6	3E7	1.10E-10	4.5E8	6E8
^{210}Pb	1.10E-06	4.5E4	9E3	6.80E-07	7.4E4	2E4
^{210}Bi	6.00E-08	8.3E5	1E6	1.30E-09	3.8E7	3E7
^{210}Po	2.20E-06	2.3E4	2E4	2.40E-07	2.1E5	1E5
^{206}Tl						
^{206}Pb						

Table 1. ALI values for the ^{238}U series (most restricting values) e(g) values (Sv/Bq) are taken from IAEA Safety Series no 115.

Old* - values from IAEA Safety Series No. 9.

Based on these data, the effective updated ALI for inhalation of ^{238}U in equilibrium with its daughters is 1.1×10^3 Bq. The effective DAC for the same group is therefore 0.46 Bq/m^3 .

It can be seen from the table that for most of the radionuclides in the series the dose per unit intake is now considered to be lower than thought before (the ALI is higher). Also it can be seen that the ingestion risks are, in general, much lower than the inhalation risks.

We conducted preliminary measurements in a Phosphate and Potash storage , related to gamma dose rate levels and concentration of Radon and of Uranium dust in the air in several areas.

Results from the measurements made by us will be introduced in the meeting.

In conclusion we can see that particularly in Israel radiological risks in the handling of Phosphates and Potash is not negligible .