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INTERPRETING FAECAL ANALYSIS RESULTS FOR MONITORING EXPOSURE TO URANIUM

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I INTRODUCTION

Radiotoxicological monitoring of workers exposed to non-transferable forms of uranium requires six-monthly examinations. These examinations are prescribed according to the kind of product manipulated and to the industrial risk attached to the workplace. The range of examinations that are useful for this kind of monitoring includes whole body counting examinations, urine analyses and in-line faecal sampling:

- ⇨ whole body examinations, which are fundamental to monitoring, provide a lung retention value. However, the detection limit of lung examinations is not low enough for chronic operational monitoring;
- ⇨ urine examinations are extremely sensitive to alpha activity (1mBq per isotope) but the fraction detected in the urine after incorporation by inhalation is very small;
- ⇨ in-line 24-hour faecal sampling allows avoiding any workplace exclusion;

Before 1989, faecal examinations were not prescribed systematically but only in case of incident. In 1989, after being informed of particular modifications in two workrooms, the occupational medical doctors decided to settle systematic faecal monitoring in addition to the existing radiotoxicological examinations (lung retention examinations and urine analyses). The authors intend to present their experience acquired over a six year period in the field of interpreting systematic faecal examinations after chronic inhalation of the different uranium compounds. They also present results of a study carried out to determine normal uranium concentrations in the faeces of a non-exposed population, the uranium content in drinking waters and the consequences on faecal excretion. Establishing the isotopic content of uranium in the faeces makes it possible to determine practical investigation levels for occupational monitoring.

Even if faecal sampling may be critically perceived by the personnel, the authors' experience highlights the value of this kind of analysis which allows to track down the industrial reality of the exposure. Internal dosimetry calculations cannot, however, be carried out, because the physical parameters of the inhaled aerosols are not always known.

II MATERIALS AND METHODS

The sampling of the faeces takes place over a period of 24 hours. It is prescribed without any prior exclusion. The notifications are sent out at the same time as the notifications for the lung retention examinations and the 24-hours urine analyses.

Measurement of uranium in the faeces : analytical method

The samples are reduced to ashes using a heating programme. They are then mineralised by an acid solution. The uranium is extracted and specifically eluted. Once the uranium present has been electrically deposited, alpha spectrometry is carried out.

Measurement of uranium in drinking water : analytical method

The samples come from the drinking fountains of the company restaurant and from bottles of water sold in the self-service cafeteria. The uranium present is extracted and specifically eluted. After electrodeposition, the eluate is analysed by alpha spectrometry. A weight measurement is also carried out on the eluate.

III RESULTS

Table 1: Uranium content in drinking water bottles sold by the company restaurant

Water samples	Uranium weight	Uranium activity	^{234}U	^{235}U	^{238}U	^{234}U / ^{238}U ratio	activity / weight ratio
	$\mu g.l^{-1}$	$mBq.l^{-1}$	$mBq.l^{-1}$	$mBq.l^{-1}$	$mBq.l^{-1}$		$mBq.\mu g^{-1}$
1	2.8	72	35	2	35	1	26
2	2.9	64	36	< 1	28	1.3	22
3	3.7	246	211	5	30	7	67
4	81	3800	2600	46	1154	2.3	47
5	0.3	15	11	< 1	4	2.8	50
6	0.5	12	8	< 1	4	2	24
7	0.1	2	1	< 1	1	1.0	20
8	< 0.1	< 1	< 1	< 1	< 1	om	om
9	4.9	115	54	15	46	1.2	24
10	1.4	49	30	< 1	19	1.6	35

om = out of matter

The results presented in table 1 show the importance of knowing the water intake (and, more generally, the food intake) of the workers being monitored. The variation of the isotopic composition is apparently due to the depth of the water capture source.

Table 2 : Yearly time series of faecal uranium content

Year	1989	1990	1991	1992	1993	1994	1995	general
Faecal content mBq/24h	350	325	942	325	300	218	200	390

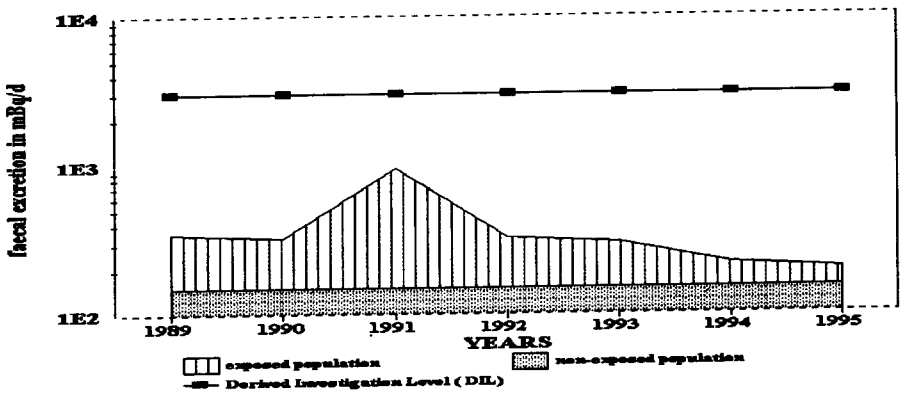

Figure 1 : faecal excretion variation as a function of the year

The table 1 and the figure 1 reveal an increase of total alpha activity in 1991. This evolution was sudden and significant. Since 1992, we observed a distinct decrease of the faecal uranium content. This is due to the information campaigns carried out by occupational medical doctors and the employers who were able to take corrective and preventive radioprotection actions in the workrooms and at individual workplaces.

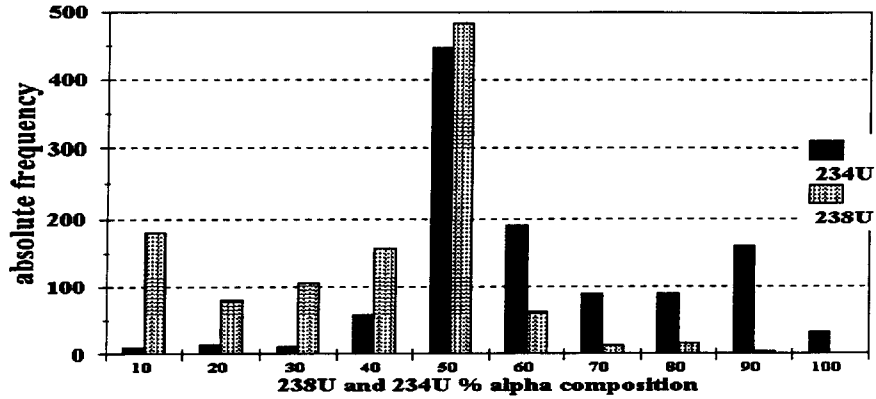

Figure 2 : Histogramms showing the values of faecal isotopic compositions

The figure 2 shows the various isotopic alpha compositions of the faecal samples. The most frequent alpha determinations are around the natural composition of uranium (50% ^{234}U and 50% ^{238}U). All the other isotopic compositions correspond to different workplaces. This informations indicate the origins of the intakes.

IV CONCLUSIONS AND PERSPECTIVES

The analyses prescribed after a contamination incident (urine and faecal measurements and whole body examinations) allow the importance of the incident to be quantified. They also make it possible to estimate the value of the incorporation according to the various International Commission for Radiological Prevention (ICRP) models.
The incorporation mode taken into account in systematic monitoring is chronic uranium inhalation. Given that the results of lung and urine analysis are always negative, the measurements of 24-hour non-exclusive faecal samples make it possible to track the evolution of an exposure to non-transferable compounds of uranium. The study carried out allows to determine normal values in the faeces for a non-exposed population on the one hand and the uranium content in the food supply, in particular in drinking water, on the other. In this way, it allows practical action levels to be established, leading to improved occupational monitoring.

The authors recommend the use of the values given below:

- ⇨ daily food intake value = 150 - 200 mBq
- ⇨ average value calculated for 1300 systematic examinations (over six years) = 390 mBq/24h
- ⇨ value higher than 1 Bq/24h: 24-hour faecal examination check

As well as the information concerning total 24-hour activity, the doctors have information on the isotopic composition of the uranium present in the faeces. This information means that the origin of the exposure can be ascertained so that specific tests may be ordered at the workplaces.
Because the whole body examinations and a 24-hour urine analysis were carried out at the same time as the faecal examinations, this study also makes it possible to satisfactorily quantify the occupational risk attached to a given workplace. However, it does not justify internal dosimetry calculations because the physical parameters of the inhaled aerosols (particularly, the granulometry) are not always known and because the sampling was done without preliminary exclusion.

The authors' experience highlights the usefulness of this type of radiotoxicological monitoring for occupational medical doctors who are able to track the radiological risk of personnel exposed to non-transferable uranium compounds in a manner that reflects industrial reality as closely as possible.