

URANIUM MINING AND MILLING BY COGEMA ENVIRONMENTAL IMPACT COMPARED TO 1 mSv LIMIT

S. BERNHARD ¹, J.L. DAROUSSIN ², J.P. PFIFFELMANN ²

¹ ALGADE - Cogema, Bessines, France

² COGEMA Vélizy - Uranium Division, Vélizy, France

CEA then COGEMA have been operating mines and mills in France since 1948. Total production nears 70000 t of U in the concentrate which were contained in some 85 millions tons of ores (pulp and heap leaching). Many sites are now undergoing remediation [1] and impact on the environment has always been a great concern.

RADIOLOGICAL MONITORING

Throughout the life of the operations, monitoring goes on using a complete network on site and in the neighbourhood. This includes geotechnical monitoring (to ascertain the stability and good confinement of the waste), radiological and chemical monitoring. The radiological monitoring implies :

- water sampling up and down stream (Ra, U analyses),
- integrated site dosimeter measuring Potential Alpha Energy from radon and alpha activity of airborne dust particles,
- thermoluminescent dosimeter for external irradiation measurements,
- periodic analyses in the food chain.

For the evaluation of the impact we need :

- the annual radiological measurements of the main pathways during and after remediation,
- similar values for the natural background (a method is described in [2]),
- the complete description of the critical group,
- in order to calculate the Added Total Annual Exposure (ATAE) which is the sum of the different exposures due to the mining with deduction of the initial natural exposure.
- The regulatory value is the sum of these values rated to their equivalent to the maximum recommended value. In France, the maximum recommended value is 5 mSv according to ICRP 26 recommendations. The Added Total Annual Exposure Rate (ATAER - complete formula herunder) must be less than 1.

$$TAER = \frac{\text{gamma}}{1 \text{ mSv}} + \frac{PAE \text{ Rn } 222}{1.68 \text{ mJ}} + \frac{PAE \text{ } 220}{0.56 \text{ mJ}} + \frac{IE \text{ dust}}{100 \text{ Bq alpha}} + \frac{IE \text{ Ra } 226}{4500 \text{ Bq}} + \frac{IE \text{ U } 238}{1 \text{ g}}$$

$$ATAER = TAER (\text{station}) - TAER (\text{background}) < 1$$

Based on field measures, the exposure and the regulatory value of ATAER of the critical group are evaluated with the following parameters :

- annual residence time : 7000 hours
- standard breathing rate : 0.8 m³.h⁻¹
- daily amount of ingested water : 2.2 liters of the downstream water. This figure includes water ingested through food consumption.

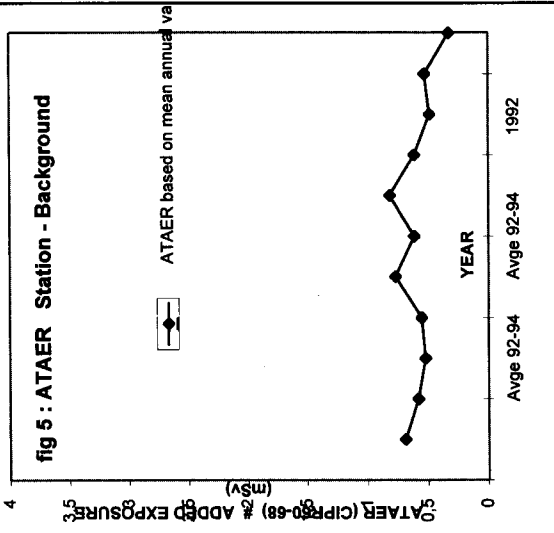
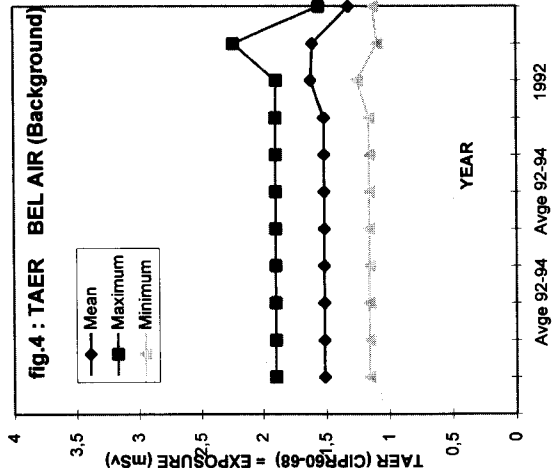
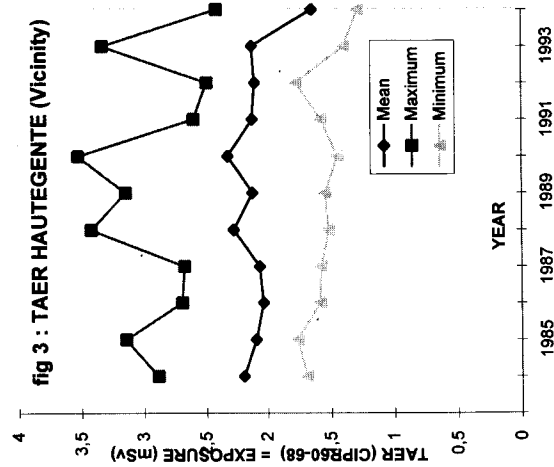
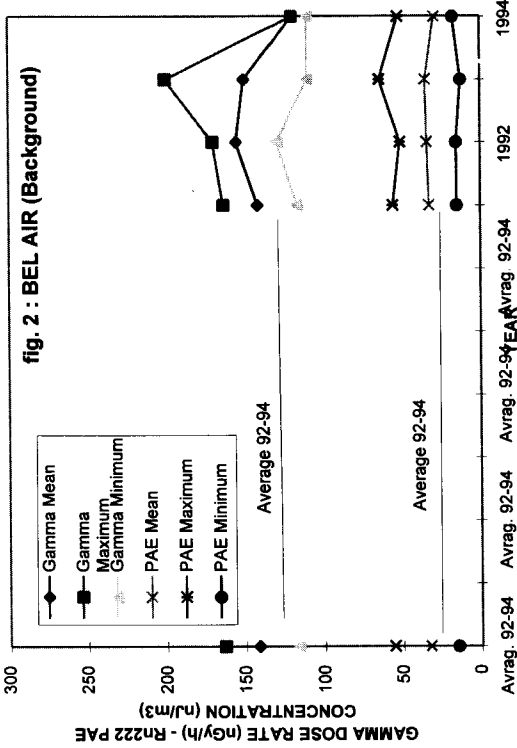
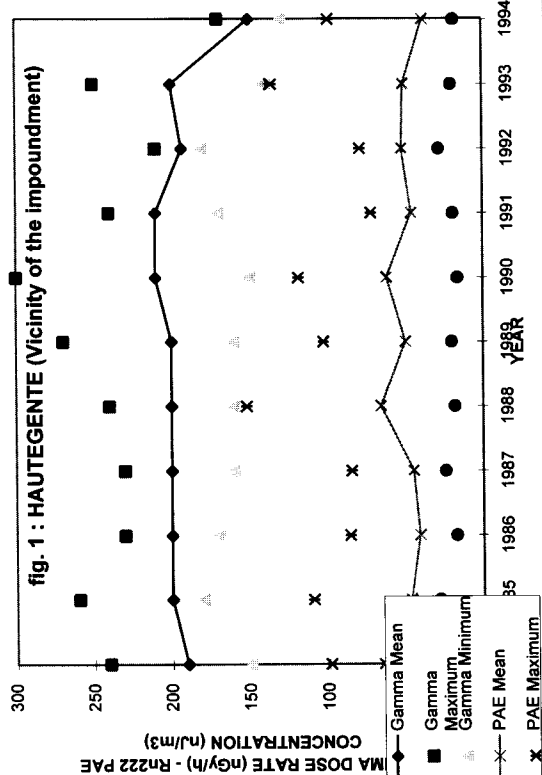
This standard scenario leads to overevaluation as usually people won't stay so long inhouse neither drink water from the river.

RESULTS - IMPACT ON THE ENVIRONMENT

Figures from the area of ECARPIERE (Vendée) are given, as an example, in the following table. HAUTEGENTE is a location where people live, one kilometer from the impoundment. BEL AIR, further away, is considered as the reference in the area and was set up in 1991 to assess the radiological background of the granitic region.

1994	AIR PATHWAY				WATER PATHWAY		ICRP 26 : 5mSv		ICRP 60-5-8 1mSv	
STATION	EXT.EXP	INTERNAL EXPOSURE					TAER	ATAER	TAER	ATAER
	Gamma ry nGy.h-1	Rn220 nJ.m-3	Rn222 nJ.m-3	Dust Bq.m-3	Ra226 Bq.l-1	Uranium mg.l-1				
HAUTEGENTE	150	17	38	1	0,12	0,1	0,42	0,08	1,64	0,33
BEL AIR (Background)	120	13	29	1	0,05	0,1	0,34		1,32	

fig 3.4.5 : TOTAL and ADDED TOTAL ANNUAL EXPOSURE RATE (TAER and ATAER)



Although the different measures are slightly higher in Hautegehte than in the background, the global impact of the site (ATAER = 0.08 if we consider ICRP 26, 0.33 for ICRP 60-65-68) is limited.

Results and their evolution during the past ten years are plotted on the diagrams for the same two stations :

- figures 1 and 2 show evolution of the measures for the two main pathways : dose rate of external exposure due to gamma irradiation (nGy.h⁻¹) and concentration of Radon 222 Potential Alpha Energy (PAE Rn222 - nJ.m⁻³). The mean annual value is bounded by the maximum and minimum measurements recorded during the same year.
- figures 3 and 4 display the variation of the TAER using the equivalent to 1 mSv recommended by ICRP 60, 65 and 68. In this case TAER is equivalent to the total exposure.

Evolution of the resulting ATAER is shown on figure 5.

Sets of results concerning different areas are presented on the poster. They show variations of the ATAER up to 1mSv and confirm the following discussion.

DISCUSSION - COMPARISON WITH A 1 mSv LIMIT

Individual measurements (maximum and minimum quarterly or monthly values for respectively external exposure and potential alpha energy) show a great dispersion for both Hautegehte and Bel Air. This is due to the natural variability of radioactivity and the uncertainty of the measurements (+/- 20% for Rn222 PAE [3], +/- 10% for external exposure).

Resulting annual TAER (or exposures) range from 1.3 to 3.5 mSv for Hautegehte, 1 to 2.2 mSv for Bel Air that is a maximum difference of 2.2 mSv for Hautegehte, 1.2 for Bel Air if maximum and minimum monthly or quarterly measures were used to calculate the annual TER.

As plotted on figure 3 and 4, the range is reduced to 1.6 to 2.3 (0.7 mSv difference) for Hautegehte and 1.3 to 1.6 (0.3 mSv) if annual means of the different measurements are used for the calculation.

Although use of extreme values for the calculation of TAER is not realistic it confirms that only mean annual values should be taken into account.

In any case all the resulting calculations show that variability of TAE (or TAER) are near to 1 mSv which is the new recommendation of ICRP 60 for a limit to the added total exposure.

CONCLUSION.

- Should the 1 mSv limit be implemented in France, resulting Total Annual Exposure Rate would remain less than 1 in the case of ECARPIERE,
- but we have shown that ICRP 1mSv recommendation is very difficult to adapt when dealing with natural radioactivity and consequently to the mining industry,
- consequently we think that applicability is linked to :
 - * a special attention to choose the measuring equipments used to monitor environment (active dosimeters)
 - * the use of annual means of the measures (as the seasonal variability is too much important),
 - * better and realistic definition of the critical group and scenario used for calculation of the total exposure (7000 hours residence time give only a broad evaluation of the impact)
 - * better definition of how to measure, in the natural background, the different parameters used for calculation of the ATAER.

REFERENCES :

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