EXPERIENCES OF CONTROLLING INTERNAL CONTAMINATION IN NUCLEAR POWER PLANT WORKERS

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INTRODUCTION

In Finland there are two nuclear power stations, one at Loviisa with two pressurized water reactors and one at Olkiluoto with two boiling water reactors. Both stations have been visited twice a year, once during the annual maintenance shutdown and once during normal operation, to determine internal contamination in nuclear power plant workers with the mobile whole-body counter of the Institute of Radiation Protection (1) and thus to find out which types of jobs cause internal radiation doses.

MATERIAL AND METHODS

The whole-body counting system used for these measurements was installed in a truck and the measuring geometry was that of a modified chair made of lead. Two alternative detectors, a NaI(Tl) detector (diameter 20.3 cm and height 10.2 cm) or a HPGe detector (efficiency 27 per cent), were used. (1). For the whole-body counting the workers were selected by the radiation protection officer at the nuclear power plant according to the instructions given by the Institute of Radiation Protection. These workers represented different types of jobs involving risks of internal radioactive contamination. Each time about fifty workers were measured. Since 1982, those selected for measurement during the annual maintenance shutdown, took a shower and changed into clean clothes before entering the truck.

The radiation doses were calculated assuming that the contamination nuclides were inhaled. The effective dose equivalent commitment of each nuclide was obtained from the annual dose limit by comparing the activity in the body at the time of measurement with the respective ALI value given in the ICRP30 (2).

RESULTS

During the annual maintenance shutdown detectable amounts of ^{51}Cr, ^{54}Mn, ^{58}Co, ^{60}Co, ^{110m}Ag and ^{124}Sb were observed in workers at the Loviisa plant. The same nuclides, except ^{110m}Ag and ^{124}Sb, which seem to be typical of Loviisa plant, were detected in workers at Olkiluoto plant. The highest contamination levels were found in workers participating in the mechanical maintenance, waste handling and decontamination. Figure 1 shows the mean activity found in employees participating in the mechanical work of opening and closing the reactor. In the control measurements made during normal operation, fewer persons were found to be contaminated and the amounts detected were smaller.

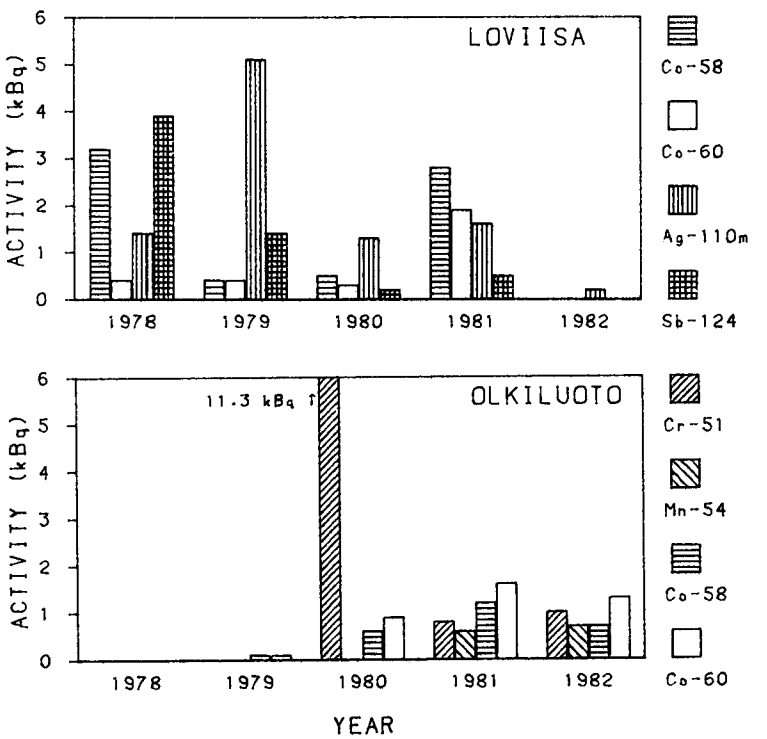

Figure 1. Mean acitivity of internal contamination nuclides detected in workers participating in the mechanical work of opening and closing the reactor during annual maintenance shutdown at Loviisa and Olkiluoto from 1978 to 1982 and at Olkiluoto from 1979 to 1982.

Table I. Mean effective dose equivalent commitments in μSv for different groups of workers at the Loviisa and Olkiluoto nuclear power plants during annual maintenance shutdown (S) and normal operation (O) from 1978 to 1982.

GROUP OF WORKERS		1978 μSv (n)[a]	1979 μSv (n)	1980 μSv (n)	1981 μSv (n)	1982 μSv (n)
LOVIISA:						
Mechanical maintenance	S	110 (36)	130 (29)	220 (16)	130 (30)	200 (5)
	O	10 (7)	110 (7)	40 (18)	74 (1)	6 (52)
Waste handling and decontamination	S	-[b] (0)	490 (5)	70 (2)	210 (3)	110 (1)
	O	-	-	15 (4)	85 (3)	19 (5)
Cleaning	S	34 (7)	150 (6)	160 (4)	110 (6)	-
	O	-	33 (1)	63 (9)	98 (2)	15 (6)
Laundry	S	6 (2)	63 (2)	92 (2)	24 (3)	-
	O	0[c] (1)	9 (2)	13 (3)	7 (2)	1 (3)
Radiation protection	S	34 (1)	85 (5)	31 (9)	24 (5)	16 (12)
	O	5 (8)	7 (8)	18 (5)	15 (9)	1 (4)
Laboratory	S	-	27 (2)	5 (1)	22 (4)	13 (11)
	O	2 (7)	3 (11)	15 (4)	9 (11)	-
OLKILUOTO:						
Mechanical maintenance	S	-	-	47 (18)	77 (22)	61 (28)
	O	-	0 (4)	24 (8)	5 (9)	13 (24)
Waste handling and decontamination	S	-	-	110 (4)	8 (5)	33 (4)
	O	-	0 (1)	30 (4)	9 (3)	48 (6)
Cleaning	S	-	-	0 (2)	-	310 (2)
	O	-	-	-	-	43 (2)
Laundry	S	-	-	5 (2)	28 (2)	36 (1)
	O	-	0 (1)	0 (2)	0 (2)	10 (1)
Radiation protection	S	-	-	15 (8)	39 (9)	37 (5)
	O	-	0 (7)	4 (9)	5 (9)	24 (7)
Laboratory	S	-	-	0 (2)	0 (1)	3 (2)
	O	-	0 (7)	0 (1)	0 (1)	0 (2)

[a] number of workers measured

[b] not determined

[c] < 1 μSv

During the 1982 maintenance shutdown at the Loviisa plant, a test with four workers was made on the influence of the shower and clean clothing on the measurement result. It was demonstrated that after shower only about ten per cent of the activity found in the first measurement was retained in these workers.

For both power plants, the mean effective dose equivalent commitments from 1978 to 1982 are presented in Table I. The highest individual effective dose equivalent commitment found at Loviisa was 1.2 mSv in a worker handling wastes and at Olkiluoto 0.50 mSv in a worker cleaning active areas.

DISCUSSION

Since the individual internal contamination variation is great, it is important that each of the groups to be measured consist of a sufficient number of workers. When the number is below ten it is best to count all of them. According to our results, special attention should be paid to persons working with mechanical maintenance, decontamination, waste handling and cleaning.

Since there were practical difficulties in arranging showers and changing facilities close to our mobile whole-body counter and since the amounts of internal contamination were small, the workers were measured in their own clothes until the end of the year 1982. At any rate, the internal doses are only a small fraction of the external doses, but they have to be determined for follow-up of the radiohygienic working conditions. Although the ALI values are secondary standards they were used in the dose calculations.

REFERENCES

1. Rahola, T. and Suomela, M.: A mobile whole-body counter for measuring internal contamination at nuclear power plants. 1982, Proceedings of the SRP, Symposium, Invernes, pp 305-310.
2. Annals of the ICRP, 1979, Vol. 2 No 3/4, 1980, Vol. 4 No 3/4, 1981, Vol.6 No 2/3, (Pergamon Press, Oxford, New York, Frankfurt).