

## MEAN AND INDIVIDUAL RADIATION EXPOSURES OF THE STAFF OF THE KARLSRUHE NUCLEAR RESEARCH CENTER, 1969 - 1978

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### INTRODUCTION

At the Karlsruhe Nuclear Research Center, radiation protection monitoring of the staff by far exceeds the stipulations of the Radiation Protection Ordinance of the Federal Republic of Germany. In order to obtain an overall view of the radiation exposure of the staff due to external radiation, for instance, not only occupationally exposed workers, but all members of the staff are monitored with solid state dosimeters (glass dosimeters).

### AVERAGE ANNUAL DOSE

The aggregate dose including natural background, measured between 1969 and 1978, amounts to 50 man-Sv. Calculating the average of the annual radiation dose of 0.82 mSv received by persons not exposed occupationally as natural external background, a radiation dose of approximately 26 man-Sv is obtained in ten years, which is due to handling radioactive substances and ionizing radiation at the Karlsruhe Nuclear Research Center. This is an average annual occupational dose to radiation workers of 1.6 mSv.

Occupational external exposure follows a logarithmic normal distribution (Fig. 1). The line determined by the least squares fit indicates an average radiation dose due to occupational exposure of 1.59 mSv/a, which is in good agreement with the 1.6 mSv/a value calculated from the total dose.

### DOSE DISTRIBUTION OVER DIFFERENT WORKING AREAS

A detailed insight into the radiation exposure of the staff is obtained by an analysis of the annual dose distribution according to individual areas of work. Table 1 very clearly shows that the members of services responsible for the treatment and final conditioning of radioactive waste - the waste treatment plant of the Karlsruhe Nuclear Research Center proper but also that of two prototype nuclear power plants ( $D_2O$ , 50 MWe; LMFBR, 20 MWe) and a reprocessing plant (40 t/a) - are exposed to a higher radiation burden. The staff working in these services, although they make up but 5% of the total staff, received 42% of the whole occupational radiation dose over the years 1969 to 1978. It is not very surprising that the Health Physics staff rank second on this list - 2.2% of the staff, 8% of the dose - since this group of persons always work in the very front line. Further details are given in a recent paper (1).

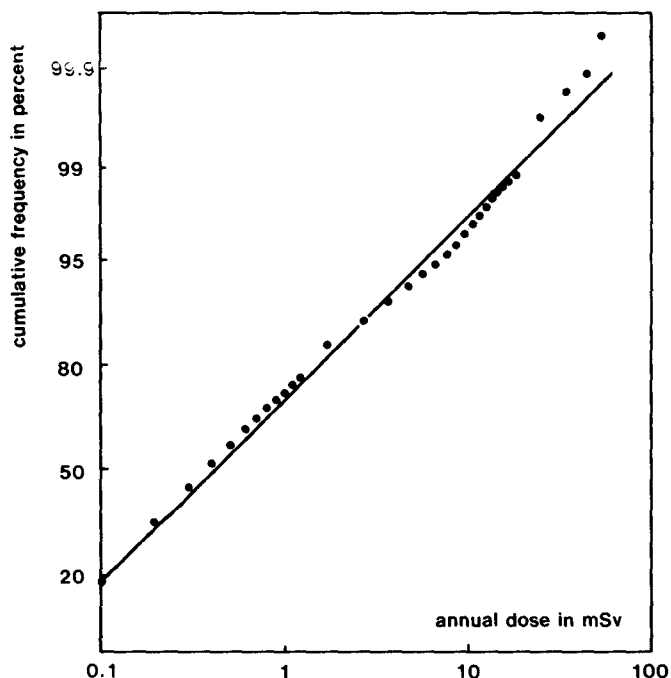


Fig. 1: Log-probability plot of annual doses (without background)  
Karlsruhe Nuclear Research Centre, 1969-1978

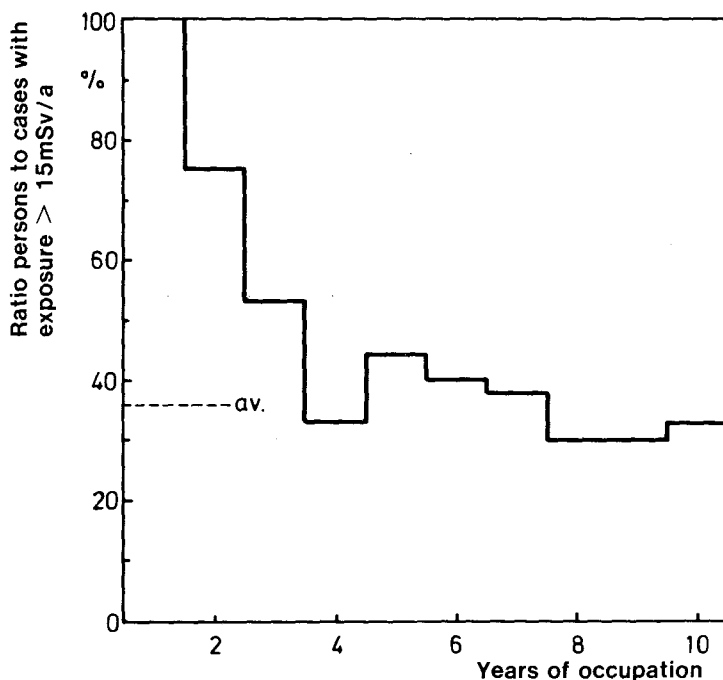
Table 1: Percent of dose and staff for different areas,  
Karlsruhe Nuclear Research Center, 1969-1978

Working area	Occ. dose man-Sv 1969-1978	Percent of dose	Percent of staff	<u>Dose</u> <u>Staff</u>
Waste Handling	10.8	42	5.0	8.4
Health Physics	2.0	8	2.2	3.6
Cyclotron	1.4	5	1.8	2.8
Reactor	5.7	22	9.1	2.4
Chemistry	4.2	16	9.1	1.8
Supply Service	1.4	5	8.9	0.6
Physics	0.5	2	16.4	0.1
Biology	0	0	2.1	0
Other	0	0	45.4	0

## ANALYSIS OF DOSES > 15 mSv/a

Analysis of all data for the decade from 1969 to 1978 indicates a number of 29,578 persons monitored by personnel dosimeters at the Karlsruhe Nuclear Research Center. 1903 cases had doses higher than 5 mSv/a, and only 349 cases had doses above 15 mSv/a. This means that, under the Radiation Protection Ordinance, only 6.4 % of the total staff of the Karlsruhe Nuclear Research Center would have to be classified as occupationally exposed persons, 5.2% of them falling under category B - annual dose, 5 to 15 mSv - and 1.2% falling under category A - annual dose, > 15 mSv.

The 349 cases of doses higher than 15 mSv/a in the period 1969 to 1978 are distributed over 124 individuals (see Fig. 2). On the average, these individuals were employed at the Karlsruhe Nuclear Research Center for 7.7 years. The mean annual occupational dose to these individuals amounts to 12.7 mSv. The highest average annual dose to anyone of these persons was 33 mSv (monitoring period: 5 years). In 19 cases involving 12 persons, annual doses were higher than 50 mSv, with a maximum of 68 mSv. Most of these cases occurred in 1972/73 during intervention and repair work at the facility for handling liquid radioactive wastes.



**Fig. 2: Ratio persons to cases with exposure > 15mSv/a as a function of years of occupation, Karlsruhe Nuclear Research Center, 1969-1978**

## DATA OF BODY COUNTER AND LUNG COUNTER MEASUREMENTS

In addition to extensive personnel dosimetry all persons handling unsealed radioactive materials are monitored on a routine basis at six months intervals as the minimum either in the whole body counter or lung counter or by excretion measurements for incorporations. In the decade between 1969 and 1978, a total of 24,012 persons of the Karlsruhe Nuclear Research Center were monitored for incorporation in the body counter and the lung counter. Including multiple recordings in successive measurements, incorporations were found in 1628 persons. This is 6.8% of all persons measured. This figure includes the staff of two experimental nuclear power stations and the reprocessing plant. These facilities are located on the premises of the Karlsruhe Nuclear Research Center, but operated by independent companies. The 1628 measurements with positive findings yielded a total of 2147 incorporations (incorporations of one or more nuclides). Cs-137, Co-60, Ru-106/Rh-106, Co-58, I-131 and Mn-54 make up 90% and are the most frequent radionuclides in body counter measurements. In 96% of all cases the activity incorporated was below 1% of the MPBB values specified by ICRP (ICRP Publication 2). Only in five cases values above 100% MPBB were recorded. Incorporation monitoring by excretion analysis is performed by the Medical Department. Results have been published in a recent paper (2).

The radioactivity incorporated is not routinely converted into the body dose and added to the personnel dose determined by personnel dosimeters, since this is not generally required under the Radiation Protection Ordinance of the Federal Republic of Germany. However, it is evident from the data given that the dose statistics described in the preceding chapter is not substantially altered by an inclusion of the values of these measurements.

## CONCLUSION

Our experience in radiation protection and monitoring at the Karlsruhe Nuclear Research Center and the data presented can be summarized as follows:

- ICRP recommendations on dose equivalent limits for workers are met in general.
- The average annual occupational exposure of radiation workers is remarkably low, 1.6 mSv.
- The number of persons with annual exposures > 15 mSv is about 1%. Only a few of these individuals exceeded the 15 mSv/a value repeatedly over the decade 1969 - 1978.

1. Koelzer, W. (1979): IAEA/NEA-Symp., Los Angeles, 18-22 June 1979, paper IAEA-SM-242/04
2. Schieferdecker, H. (1979): KfK 2799 B, July 1979, Kernforschungszentrum Karlsruhe