WINDSCALE NUCLEAR POWER DEVELOPMENT LABORATORIES

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SOURCES OF RADIATION DOSE IN DESTRUCTIVE POST-IRRADIATION EXAMINATION

by

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SUMMARY

The sources of radiation dose received by staff engaged on post-irradiation examination in UKAEA Laboratories at Windscale have been investigated. Data have been obtained from statutory body-dose films, special films used only during specific operations, personal dosimeters, works study and regular standardised radiation surveys. These data have enabled the radiation doses to be broken down into component sources and their relative importance assessed. Appropriate operational and structural modifications have substantially reduced radiation doses to personnel.

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INTRODUCTION

1. The routine destructive examination of fuel pins and other irradiated components at the Nuclear Power Development Laboratories of the UKAEA at Windscale is carried out in lines of lead-shielded tong-operated cells designed in the late 1950s to handle low burn-up metallic fuels and later extended or modified to handle more highly irradiated oxide fuels. As irradiation levels and throughputs increased, the radiation doses received by operators and service personnel began to approach 5 rems/year. This note briefly records what was done to locate and assess the relative importance of the sources responsible for these radiation doses and the steps taken to reduce them.

DOSE MEASUREMENT FOR SPECIFIC OPERATIONS

2. Special films were worn by staff carrying out specific operations and records kept of the working times involved. A summation of such dose measurements for a typical daily range of operations was compared with the average doses recorded by the statutory body films and provided a check on the accuracy of the data obtained.

3. The results of three, one-month, test periods are summarised in Table I. They showed, for example, that although only 10% of working time was spent on access operations they accounted for 70% of the dose. However the radiation dose attributed to each type of operation was of a similar order, in spite of the different times devoted to them, and it was clear that each required more detailed investigation if substantial reductions in dose were to be achieved.

4. One feature of the results was the important contribution of background levels of radiation as shown by the doses accumulated in general operations and work at cell faces. To study this in more detail the technique adopted was to take radiation readings, at waist height, at approximately two metre intervals over the whole area of the laboratory (both operating and maintenance areas). "Iso-rad" contours were then plotted on a building plan to indicate areas of greatest dose-rate and to direct attention to the sources of the radiation. A series of such 'grid' surveys at suitable time intervals, provide a means of assessing the success of measures taken to reduce the effects of established sources.

5. In operating areas the main sources of background radiation were:-

(i) Local weaknesses in the face shielding and recurrent or fixed contamination on or near all operating faces (eg on tong shafts and ball units).

(ii) Deposition of activity in inadequately shielded extract ducting.

(iii) The absence of shielding between operating and maintenance areas.

(iv) Deposition of activity in inadequately shielded drains.

6. In maintenance areas the background radiation was an order of magnitude higher than it was in the operating areas and was mainly attributable to:-

(i) Inadequate shielding of cell backs (by design thinner by 50 mm of lead than the operating faces).

(ii) Inadequately shielded extract ducts, drains and filter banks.

(iii) Fixed contamination.

7. Currently the doses accumulated during flask transfers (including waste disposal) are being investigated in more detail. Each operation has been broken down into foredetermined stages and the individual's dose, measured by personal dosimeters to 0.1 mRem, recorded at the end of each stage. Particular stages of each operation have been identified as predominant sources of radiation dose.

DISCUSSION

8. From these studies the improvements attainable by various possible engineering and operational modifications have been estimated. Those already introduced have resulted in a substantial reduction in the average dose to operators (Fig. 1), in spite of an increased throughput of specimens and without any additional staff.

TABLE I

Proportions of average individual dose attributable to different categories of operation (1975)

Task	Time %	Dose Rate Rem/year	Dose Rem/year
General duties	40	0.8	0.32
Face work	50	1.5	0.75
Flask operations	3	11	0.33
M A General	4	12.5	0.50
M A Equipment	2	27	0.54
M A Waste disposal	½	57	0.28
M A Cell access	½	150	0.75
TOTAL			3.47

M A Maintenance Area

TABLE II

Proportion of total building dose attributable to identifiable sources of background radiation

Source	Total Dose %
1. Line face	10
2. Extract ducting (Ops)	10
3. Ops/M A interfaces	10
4. Active drains (Ops)	1
5. Cell backs	10
6. Active drains (M A)	10
7. Extract system (M A)	2
8. Fixed contam (M A)	2

NOTE: Ops = Operating area
M A = Maintenance area

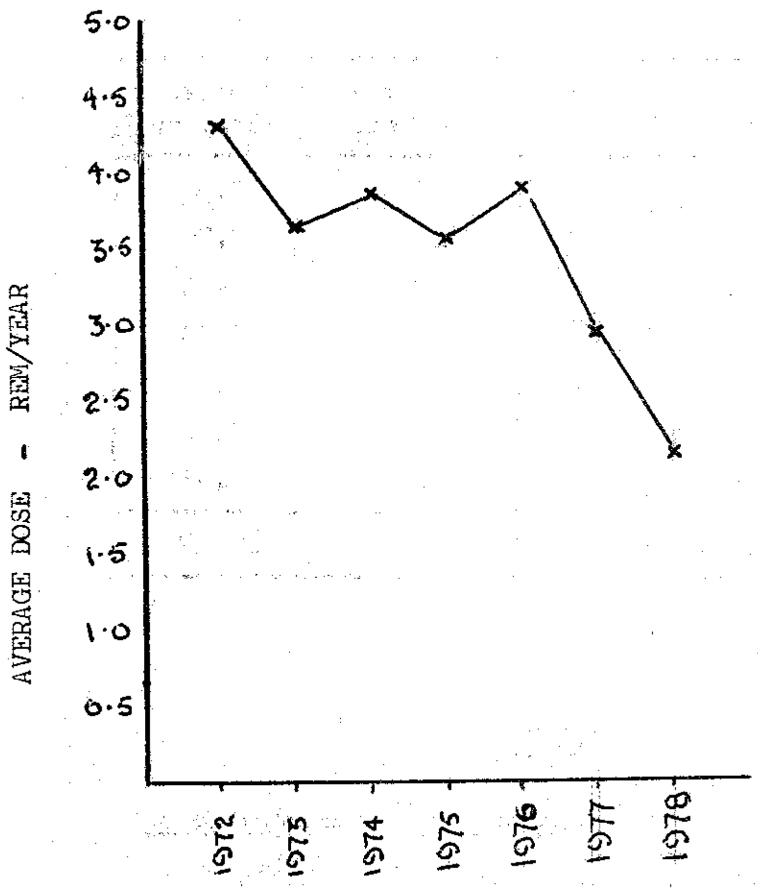

FIG. 1 VARIATION IN AVERAGE DOSE OF THE TEN MOST EXPOSED OPERATORS 1972-78

(No individual operator from this group exceeded 5 Rem in any year)

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