NOT FOR PUBLICATION

AEEW M 1688

CONTROL OF RADIATION EXPOSURE IN WINFRITH CAVES

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Note prepared for presentation to the meeting of the "Hot Cells" Committee - Commission of the European Communities, June 19 and 20th, 1979.

AEE
Winfrith

April 1979

W12420

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FIGURE

FIGURE 1 Section through Building and Cave

1 Introduction

The Winfrith caves have been mainly used for PIE programmes in which complete fuel elements are received for examination and are then dismantled for tests on individual pins; finally, specimens are cut for small scale tests at other laboratories. The wide variety of fuel elements delivered to the caves has necessitated numerous modifications and additions. This note discusses the exposure to, and control of doses of, gamma radiation in the cave facility.

A paper (1) was presented by C A Turier to the 1978 meeting at Saclay. One of the points made in that paper was that there had been reductions in average annual dose per man, from 3.5 REM in 1969 to 1.25 REM in 1977. The reductions were primarily due to the close co-operation between the operational and health physics staff and involved, improved personnel training, modifications to equipment, and more detailed planning of operations.

It has become increasingly apparent that further reductions in the man-rem yearly total are more and more difficult to attain and it would appear that a plateau seems to have been reached. Therefore, it was decided to study how, when, and where, gamma doses are received, in greater detail than heretofore. One approach to this has been the use of method study techniques together with the issue of extra thermo-luminescent dosimeters for individual operations.

2 Exposure to Radiation

The work of a cave operator normally consists of the cave face duties, flask handling, posting in-and-out, plus a few minor duties. Less frequently he may be called upon to take part in cave-entries and assist with maintenance of equipment.

In the Winfrith cave facility there are four primary contributions to doses accumulated during work programmes:-

(i) the general chronic dose received by any operator at the cave face;

(ii) dose received during cave-entries and decontamination programmes;

(iii) dose received during maintenance;

(iv) dose received during all types of posting operations.

To study what doses an operator receives, a series of trials have been undertaken. For these, men were issued with thermo-luminescent dosimeters (TLDs) for each category of work and their work was observed by method study staff. These trials required close co-operation between the operators, health physics personnel, and the method study teams. Some of the results were reasonably predictable but others were more unexpected. The basic front face work gives rise to an annual exposure of 400-600 mrem per man. The posting in-and-out operations give a much more variable dose-rate but the annual value lies in the range of 200-500 mrem per man, and so the annual exposure of an operator, from posting, may be as high as that received from the front face work. The exposures due to flask work were much lower than predicted and probably contribute about 100 mrem, or less, per year per man.

Another task which occurs fairly regularly is the replacement of master-slave manipulators, this work is limited to fewer staff but probably adds an annual dose of ~50 mrem per man to the totals of those involved.

These recent measurements can now be compared with annual doses of groups of operators in previous years. 1977 was a busy year for work in the caves but there were virtually no cave-entries. Thus, it forms a useful basis for comparison with the method study results.

	General Operations Staff	Experimental Staff	Health Physics Staff	Skilled Men
Numbers	28	18	5	9
Total Dose (REM)	30.37	8.64	5.63	9.86
Mean Dose (REM)	1.08	0.48	1.13	1.1

The figures in this table are very much in line with the method study measurements now being obtained.

3 Dose from Cave-Entries

1978 was a year when many modifications were made to the Winfrith caves and consequently there were 544 man-cave-entries. It is interesting, therefore, to compare the annual doses received with the table for 1977.

	General Operations Staff	Experimental Staff	Health Physics Staff	Skilled Men
Numbers	22	19	5	9
Total Dose (REM)	42.89	20.22	5.21	15.78
Mean Dose (REM)	1.94	1.06	1.04	1.75

Techniques for detailed method study during the periods of cave cleaning and modification are still being evolved. However, it is possible to estimate that the total dose for all cave-entries was approximately 50 man rems during 1978.

Many individual measurements have been made but the results have not been fully analysed. Examples are:-

Description	Time in Cave	TLD	Left-hand TLD	Right-hand TLD
	hours	mrem	mrem	mrem
1 Removal of furnace component	0.8	14	650	747
2 Trolley repair	1.2	90	456	692
3 Removing wall-mounted equipment	5	84	715	600
4 Survey of cave floor	2	110	370	280
5 Cleaning cave	2	120	1300	1800

4 Repair and Maintenance

The unexpected breakdown of cave hoists, bridge manipulators, window leaks, etc, together with jobs such as filter changing, fall into this category. Information related to these activities is still being collected and consequently the results and analyses are not yet available. Nevertheless, preliminary results indicate that, during a normal year, about 10 man-rems are expended during repair and maintenance and the skilled men usually receive most of this total.

5 Background Dose from Active Waste

During the various cleaning campaigns active waste may be removed from the caves in concrete-lined drums. When the effort is concentrated on cave-entries, barrier control, etc, it is easy to forget to organise the speedy removal of these drums of waste and to leave them standing close to operational positions. In the past this has given rise to a background dose as high as 10 mrem per hour. With more attention to planning this source of dose has been almost eliminated.

6 Spurious Dose

The entrance foyer of the Winfrith Active Handling Building is separated by a wall from the operational areas, but is situated directly opposite to the manipulator ports (see Figure 1). On rare occasions there are vertical transfers of fuel into, or out of, the caves and this can give a gamma shine into the foyer. The level of radiation is not high, but if there is any doubt the area is cleared for the few seconds of the transfer. There is, however, a second problem; the wall at X (Figure 1) is a very convenient position for notices and for a rack containing TLDs awaiting collection or exchange. If fuel is stored in certain positions in the cave the dose rate at X can reach 100 mrem per month. The rack has now been moved and fuel is stored in alternative positions.

7 Further Reductions in Dose - Objectives and Strategy

At the present time the exact interpretation and implications of ICRP26 are still under discussion. It is perhaps more realistic to choose local targets and then examine what must be done to achieve them.

In a normal year the average dose in man-rems can be held to approximately one. Looking at the values for 1977 the only significant reduction could have been in total of 30.27 REM received by 28 men. One practical method of achieving a significant cut in these exposures is to improve the posting facilities, and this is now receiving attention.

In an abnormal year, eg 1978, when intensive effort is put into cave modifications, maintenance, etc, a different strategy is required if exposures are to be reduced. There are, perhaps, three possibilities:-

(i) avoid contaminating the caves in the first place; or,

(ii) significantly reduce contamination of the caves by using remote cleaning methods; or,

(iii) reduce the number of man-entries by new designs and techniques.

In practice the best solution may be a contribution from each of these techniques. At Winfrith the initial approach to the cave-entry-dose problem was to reduce contamination in the caves by decrudding fuel elements (1) before they enter the cave and this technique has been very successful. However, there are frequent demands for specimens to be cut from the fuel pins. During the cutting operations fuel particles escape and may cause serious contamination. It is now proving necessary to look at cutting methods, with the objective of localising the contamination. Ideas on remote decontamination will, no doubt, be discussed in a paper by Nayler (2). Finally, a reduction in the numbers of man-entries is an attractive idea but would be very difficult to achieve in an existing facility. In future, it should be possible to design and operate new facilities which would have special facilities for decontamination, and for storage of contaminated equipment, etc.

References

(1) C A Turier and A G Kerswell AEEW M 1631
"The Treatment of Active Waste from a PIE Facility."

(2) S L Nayler and P B Reade AERE Harwell
"Current Techniques and Future Trends in Decontamination of Hot Cells and Ancillary Equipment in the UK." (Paper to be presented at the Hot Cells Committee meeting, Risø 19 and 20th June 1979.)

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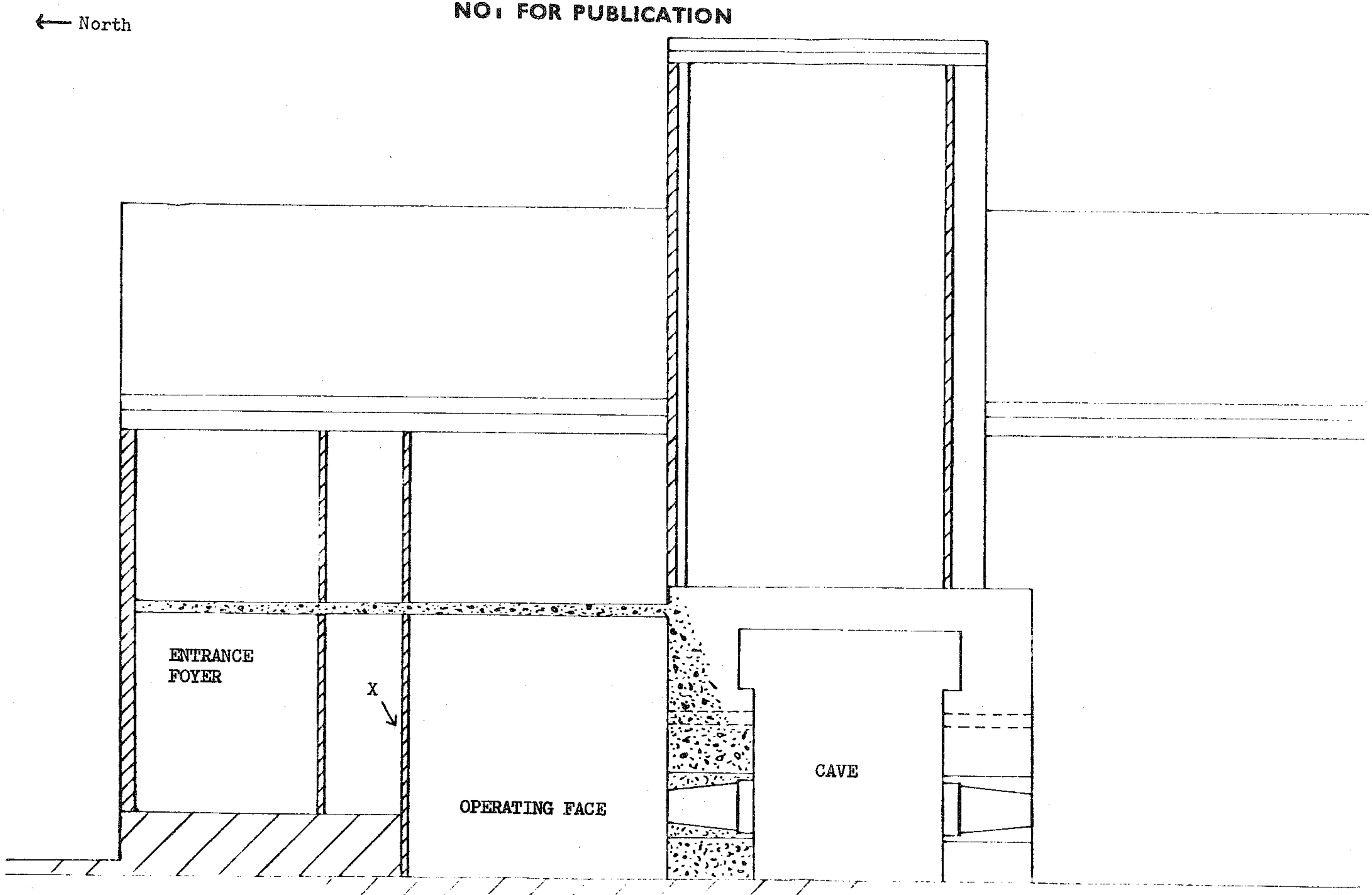

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Figure 1 - Section through Building and Cave

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