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Decontamination and Re-furbishing of PIE Caves at Winfrith

by

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Introduction

The Active Handling Building at Winfrith contains a suite of 7 connected caves used to carry out PIE of CAGR fuel on behalf of the CEGB. During 1984 the need was identified to replace 2 viewing windows and to update some of the equipment used in Caves 1 and 2; this equipment is described in a separate paper presented at this Conference by Dr G F Hines.

Installation and commissioning of new equipment required staff to work inside the caves for significant periods. Therefore it was necessary to reduce doserates inside the caves to an acceptable level, and a figure of 250 mr/hr was adopted as a target. The decontamination task is the subject of this paper.

Caves 1 and 2 are shown in Fig 1. There is no partition wall between them, so they can be regarded as a single enclosure 6.4 m x 3.6 m x 4.3 m high. A bench made from stainless steel sheet is supported about 1 m above the floor on a steel framework. Adjoining Cave 1 is a transfer chamber into which equipment can be posted from Cave 1. Contamination in the caves consisted of irradiated UO_2 dust arising from pressure testing pins to destruction in Caves 1 and 2, and cutting fuel samples in the adjacent Cave 3.

Decontamination

The door between Caves 2 and 3 was closed so that normal operations in Caves 3 to 7 could continue. Next, as much equipment as possible was moved remotely into the transfer chamber for decontamination followed by re-furbishment or disposal. Remote cleaning using vacuum cleaners operated by manipulators was carried out in Caves 1 and 2; after 15 hours a remote survey of radiation dose was carried out, showing 15 - 20 R/hr at 0.3 m above the bench. Remote cleaning continued, the remaining small items of equipment in the cave were removed, and manipulator gaiters were replaced. In parallel with this, two viewing windows were replaced by new ones.

After 54 hours had been spent in remote cleaning, monitoring 0.3 m above the bench showed residual doserates in cave in the range 2-2.5 R/hr. The corresponding doserate at 1.5 m above the bench was $\sim$ 1 R/hr, and it was decided that man entry to carry out more intensive decontamination could be justified provided that further reduction in doserate could be achieved rapidly. It was assumed that most of the accessible contamination would be found on the stainless steel bench, and this was confirmed subsequently. The traditional decontamination method has been to clean the bench manually by wet swabbing; this is unattractive because it is a slow process carried out in a high dose field. Additionally, handling swabs can lead to unacceptable β -doses to the hands.

It was resolved to test an alternative technique, in which a small volume of chemical reagent is converted into foam and applied to the surface to be cleaned. The equipment used is illustrated in Fig 2. Reagent solution is forced by compressed air into a 'mixing' gun, where a separate supply of compressed air produces a foam, which is delivered from a lance onto the surface to be cleaned. After about 10 minutes the foam begins to collapse, and it is retrieved using a special vacuum cleaner. An anti-foam reagent is added to the catchpot, and the foam collapses to the original small reagent volume.

A series of entries into the caves were made by pairs of Operators wearing pressurised suits. The primary task was to decontaminate the bench using foam. Entry was made via the transfer chamber; the bench was quickly covered in foam (fig 3), and the Operators returned to the relatively low dose area of the transfer chamber to allow the foam to react with the bench surface. The foam was retrieved using the vacuum cleaner. Whilst these operations proved to be straightforward, the foam collapsed more quickly on the greasy and contaminated cave bench that had been noted in non-active trials.

After cleaning, the bench had a brighter and cleaner appearance, and significant activity (10's of mCi) was found in the retained reagent. Bench cleaning continued until doserates 1.5 m above the bench levelled out at 200-300 mr/hr. The walls of the cave were cleaned, also by foaming, and repainted. Installation of new equipment then began.

Personal Dosimetry for Cave Entry

Whole body radiation for each Operator who entered the cave was assessed by a Standard Winfrith Badge worn on the chest, under the PVC pressurised suit. This badge consists of a thermoluminescent dosimeter (TLD) with 2 elements: it has 1000 mg cm^{-2} filtration for penetrating dose, with an open window for skin dose. To confirm that the TLD on the chest assessed the dose over the whole body adequately, a second TLD was worn at the waist. The two TLD's generally agreed within 10%.

Other TLD's were worn on the head, ankle and fingers.

When a cave entry is in progress it is necessary for the Operator to carry an integrating dosimeter which can be read at frequent intervals as work proceeds. This need was met using a quartz fibre electroscope (QFE) attached to the outside of the pressurised suit. It was found that this QFE overestimated the dose to the Operator's body by a factor of 2, and this was taken into account in controlling cave entry times.

The total whole body dose incurred to empty and clean the caves was 17 man rems.

Results

The doserates in caves 1 and 2, measured 0.3 m above the bench, are shown in Fig 4 plotted against time spent in bench cleaning. The curves show the rapid removal of fuel dust by vacuum cleaning, followed by a further small but significant reduction in dose levels as a result of foam cleaning. It is clear from the curves that no further reduction in dose was possible by repeated foam cleaning. At this equilibrium state, doses measured 0.3 m above the bench were around 1 R/hr. Whole body dose to Operators, which depends on the doserate at 1.5 m above the bench; was around 250 mr/hr.

Discussion

The objective was to decontaminate the caves as rapidly as possible so that Operators installing new equipment in cave would be subjected to doserates not greater than 250 mr/hr. This was achieved.

Predictably, fuel dust settles on horizontal surfaces; the walls of the caves were found to be comparatively uncontaminated. The only major area on which gross contamination was found was the bench. Visual indications were that the bench surface was effectively cleaned by foaming, but dose levels measured 0.3 m above the bench were reduced during foam cleaning by a factor of only 2. The source of the "background" dose of 200-300 mr/hr was not identified conclusively. The stainless steel bench surface in Caves 1 and 2 is not continuously welded; it consists of a series of plates butted together. It is certain that contamination is lodged in the gaps between plates. Also it is believed that contamination had accumulated on the supporting structure under the bench, and on the cave floor, during cell operation. More contamination could have been washed through the bench during foaming, but this is not believed to be a serious problem since foam has a low density and a high film strength. The cave floor is not accessible for cleaning without removing the bench. This is a major undertaking, and was not carried out.

Because of the high background doserate in this cave therefore, it was not possible to establish decontamination factors for the bench. It is believed however that foam cleaning gave a DF for the bench surface in the range 5-10.

The advantages of foaming compared with manual swabbing are:-

a The Operator remains upright and uses a lance. Therefore he avoids high doserates close to the bench or to contaminated equipment.

b Both application and retrieval of foam are quick and straightforward.

c The Operator can check that the whole area has been cleaned.

d Potentially, foam cleaning can be carried out by machinery, offering the opportunity to clean a cave without man entry.

The technique however has some disadvantages. The equipment used for foam application and retrieval is bulky, and becomes contaminated in use, creating a secondary decontamination and storage problem.

X An unforeseen problem was that the foam used attacked the manipulator gaiters, which are made from polyurethane. The foam is a proprietory material, ARDROX A17, containing phosphoric acid. It is compatible with PVC. An alternative foam which is compatible with polyurethane has now been formulated.

Foam cleaning will certainly be used again at Winfrith for in-cave decontamination work. Further work will be directed towards:-

a Measurement under controlled conditions of decontamination factors achievable on stainless steel surfaces contaminated with fuel dust.

b Selection of reagents which can take up contaminants either in solution or suspension, to suit a variety of disposal routes.

c Quantitative measurement of activity removed by foam cleaning.

d Development of remote foam cleaning, using a powered manipulator or a robot.

– phosphoric acid (passivating action)

| airborne contaminated PuO_2 | decont factor x 100 |

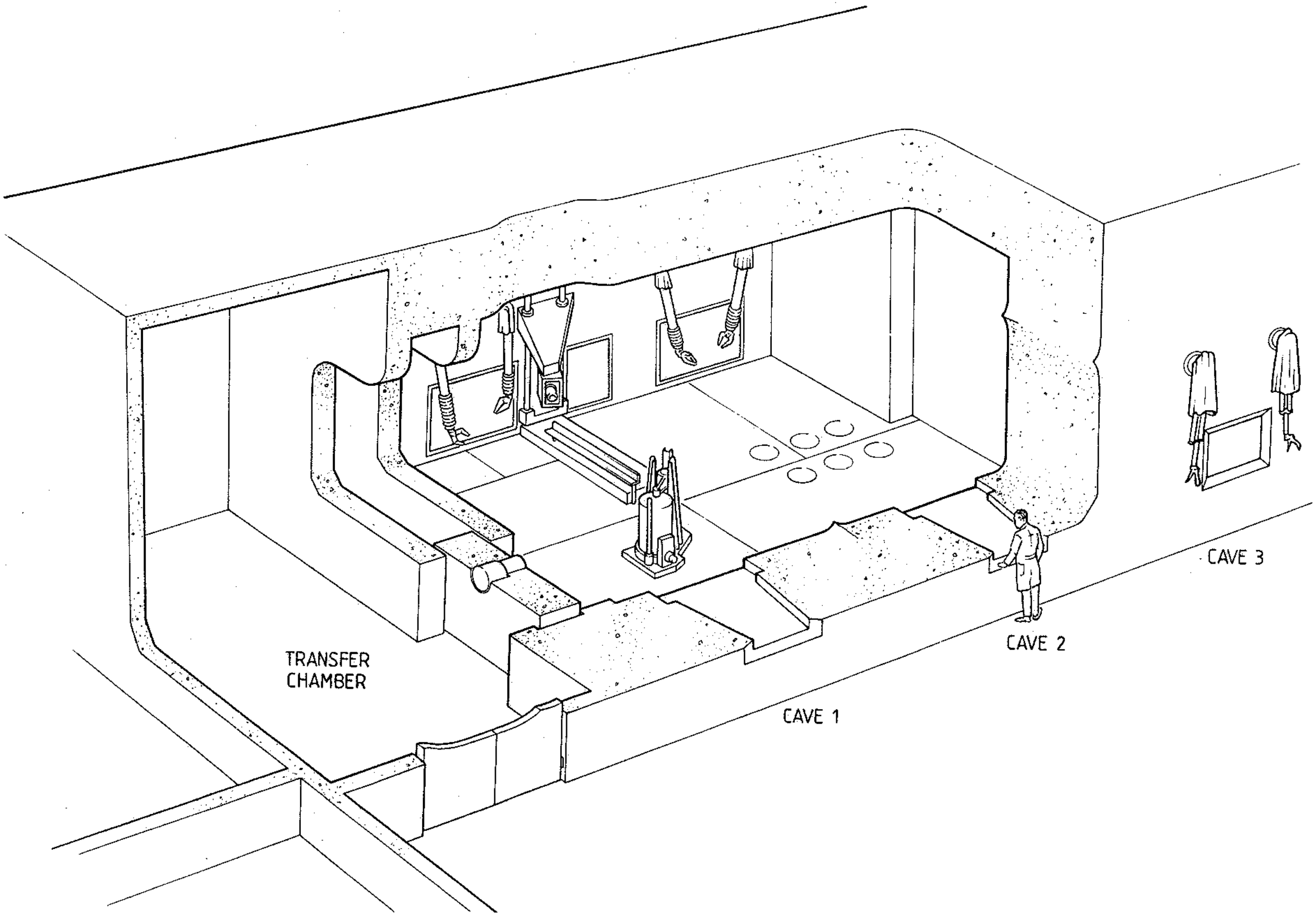

FIG.1. CAVES 1&2 ACTIVE HANDLING BUILDING

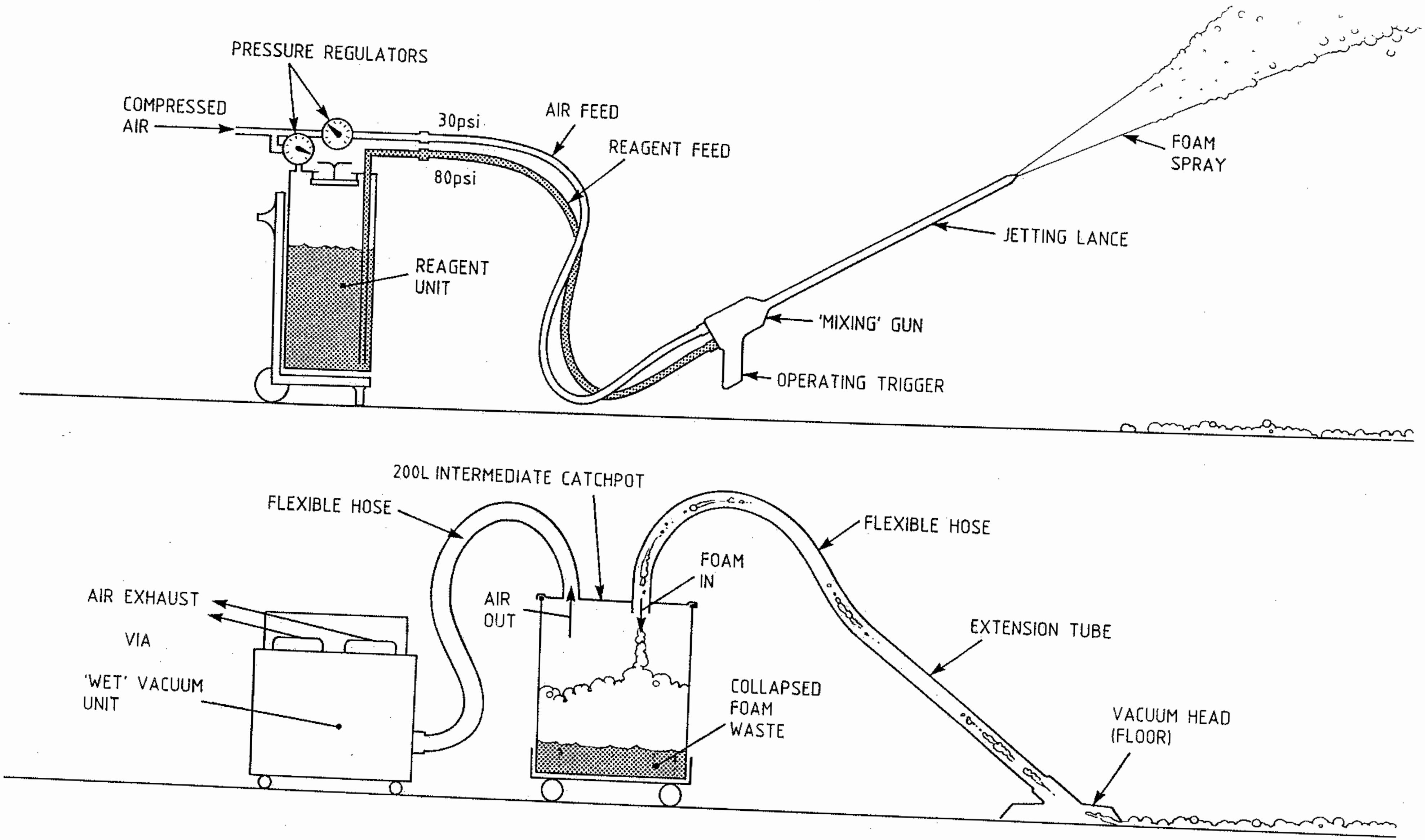

FIG. 2 THE FOAMING EQUIPMENT

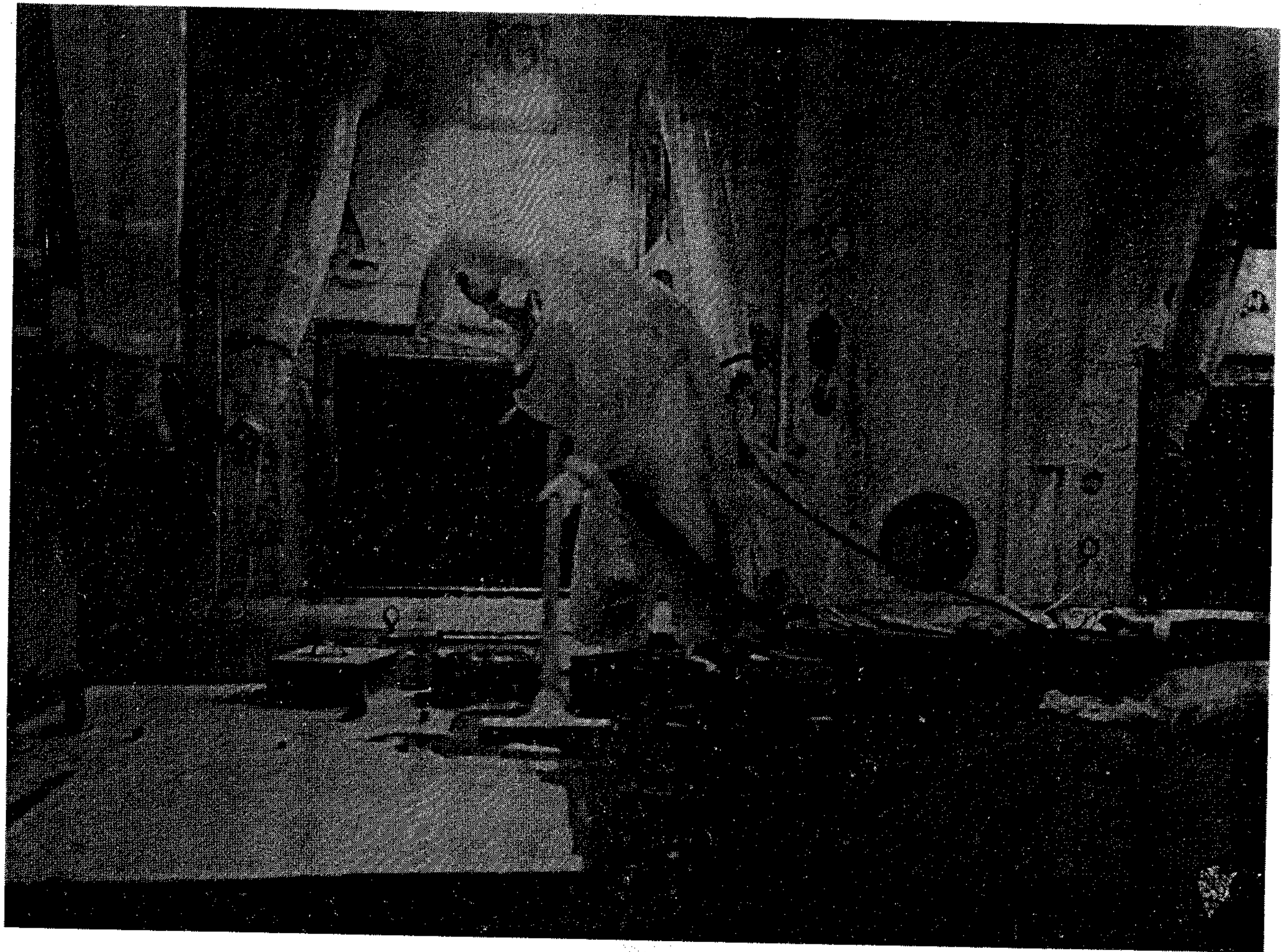

FIG. 3 FOAM APPLICATION

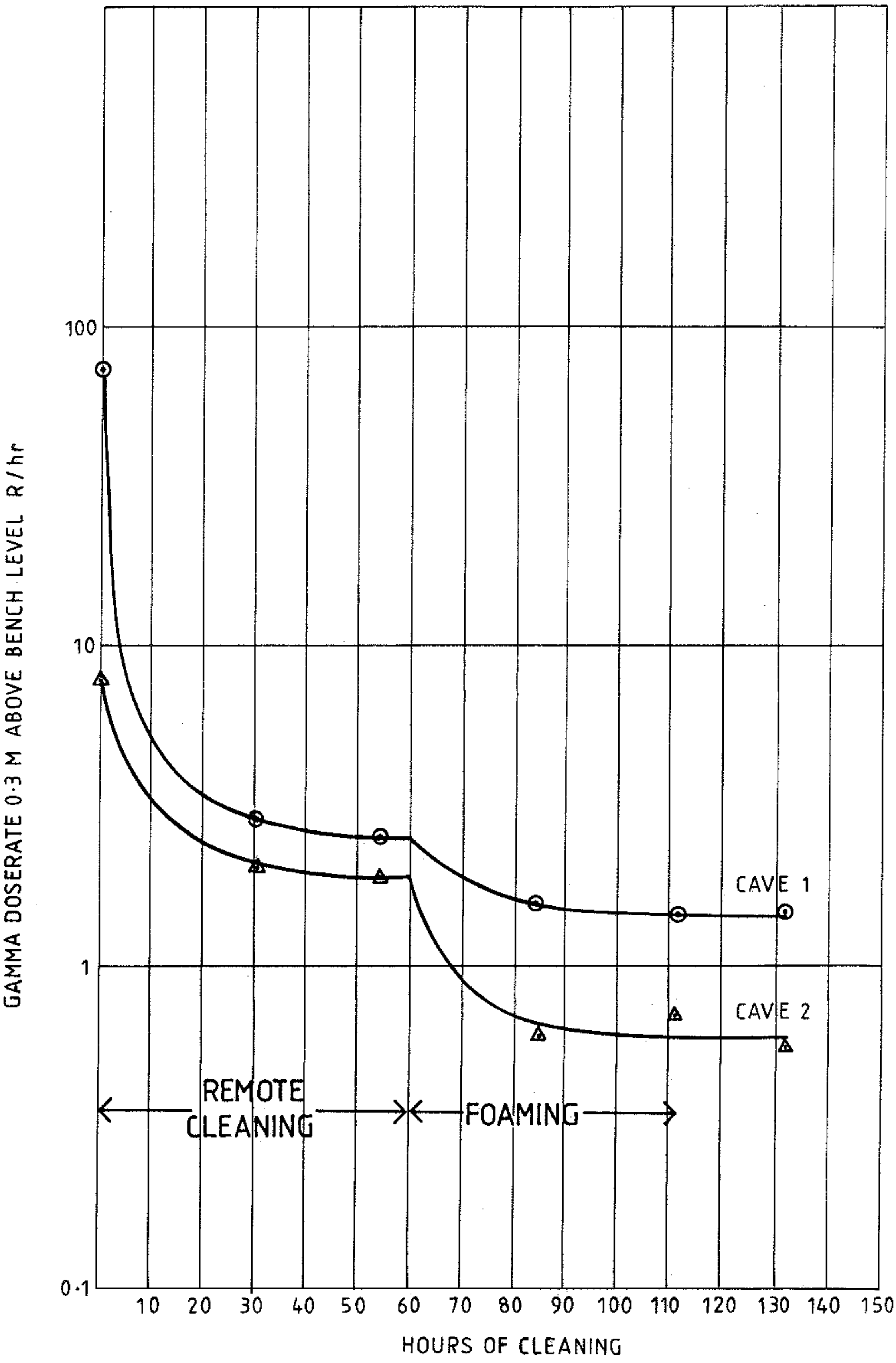

FIG 4 RADIATION LEVELS IN CAVES 1 AND 2