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Early Experiences in the Cyclic Use of Containment Boxes in the Remote Handling Wing B220

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Introduction

The Remote Handling Wing of the Process Services Division of AEA Fuel Services, located at the Harwell Laboratory, has now been in active operation for more than 3 years. This is an $\alpha\beta\gamma$ facility, principally for chemical research and development on radioactive material, with specifications aimed at being acceptable to the nuclear industry for many years to come.

The requirements for a new facility within Chemistry Division at Harwell were identified in the mid seventies; permission for the project to go ahead was given in 1980; construction started in 1982 and active material was first introduced in October 1987.

Experience has shown that in a chemistry facility, experiments last on average, approximately 2 years - hence flexibility is important. Since it was planned that investigations on high burn-up fuel would be undertaken, with the attendant higher actinides, high integrity containment was a requirement. Current International Commission for Radiological Protection codes of practice call for minimising radiation exposure, hence ALARA or ALARP principles were applied. Since it was a new construction, the Design also gave consideration to Decontamination, Decommissioning and Disposal.

From early design studies, it was concluded that all these requirements could best be met using a facility based on remotely removable containment boxes with a separate Decommissiong Cell. This would allow containment boxes to be decommissioned and decontaminated without the routine need for man intervention into a radiation environment.

The Design

Constraints of available space and budget dictated that the facility consisted of 5 cells with a Decommissioning Cell and Secondary Decontamination Area. Six containment boxes were made available.

The size of the containment box is dictated by the location and reach of the master slave manipulators and was finalised at 2.4m v 1.8m x 2.5m. The walls of the boxes are 4mm thick, the floor 10mm in 316L stainless steel. The inner surface is unprotected but electropolished, for ease of decontamination. A carbon steel structure outside the box gives adequate mechanical strength.

ALARA
ALARP

The shielding of the cell is ordinary concrete (density 2,300Kg/cubic metre) 1.4m thick, this is capable of shielding 10^4 MeV γ Ci of activity ($3.7\text{x}10^{14}$ MeV γ Bq) of mixed fission products for an external dose of $2.5\text{x}10^{-6}$ Sv/hr or 5mSv for a worker for a full working year at the cell face. The windows are lead glass (density 3,230 Kg/cubic metre) 1.05m thick.

Each of the containment boxes will fit any cell position; dimensional accuracy of ± 2mm was asked for and a better accuracy was achieved.

As well as containment by high integrity boxes, a Programmed Logic Control (PLC) ventilation control system, maintains pre-set levels of flows and depressions of individual boxes, flows in the void (secondary containment) and general flows throughout the facility.

Operation

Experiments are commissioned inactively in the Commissioning Area before being transferred to the cell line. On positioning the box on the plinth in the cell, electrical and fluid connections and the ventilation services are automatically made. Horizontal connections such as the MSM's, posting liners etc, can then be made.

On completion of the experiment, the horizontal services are withdrawn, the box lifted off the plinth and the shielding door and box withdrawn into the Transfer Area. Here the Computer Controlled Box Handling Machine connects with the box, lifts it free of the door, transports it to the Decommissioning Cell and places it on the trolley. When the Decommissioning Cell door is closed, a large door on the containment box matches a similar door in the Decommissioning Cell diaphragm. The two are joined together and removed into the Decommissioning Cell. Double door principles are used for these two doors.

Decommissioning can then be undertaken.

Experience of Operation

To date, 5 containment boxes have been through the decontamination cycle, all successfully. The experiments undertaken in these boxes have concerned:-

- Fast Reactor fuel bundle sectioning.
- Fuel dissolution and related chemical studies.
- Fission product release at high temperatures from fuel and concreted waste.

On completion of each experiment and withdrawal of the horizontally engaged services, each box has been successfully raised on the fork lift of the shielding door and the door withdrawn to the Transfer Area. Transfer of the containment box to the Decommissioning Cell using the computer controlled Box Handling Machine has proceeded smoothly.

No contamination has been found on the outside of the containment box or in the cell itself.

Each box has successfully matched up to the diaphragm of the Decommissioning Cell and the two doors latched together; no problems have been experienced in removing these doors into the Decommissioning Cell. (In one instance, the containment box door had been in place for 2½ years). The installed equipment in the Decommissioning Cell i.e. Master Slave Manipulators and 500Kg hoist, have enabled all the equipment to be removed from the containment box and into the Decommissioning Cell for disposal or decontamination and re-use.

To date, only simple techniques of decontamination have been employed in the Decommissioning Cell, i.e. pan and brush and moist swabs. This has enabled the radiation level from remaining contamination to be lowered to less than 100μSv/hr. After replacing the door, the containment box has been transferred to the Secondary Decontamination Area to complete the decontamination.

There an initial survey, using standard monitoring instruments, has been used to highlight the areas of major contamination.

The first treatment in the Secondary Decontamination process has been the application of a detergent Ardrox 17, applied as a foam; (a 10% solution of Ardrox 17 with 10% Jetform in water). This ensures a contact time of at least 20 mins before the foam collapses. The detergent is later absorbed and removed. Experience has shown this to be effective in removing the less strongly absorbed contamination.

Where are the difficult areas?

1. The posting door. Tactile contamination makes this a problem area. From an engineering viewpoint, the posting system works well, but the door itself is complicated and full of crevices which make

decontamination by hand difficult and time consuming. It is not easy to employ "general" decontamination techniques, e.g. removal of the part followed by total immersion, as the delicate nature of the elastomer seal prohibits such action. This is likely to become a point for thought in the future.

2. The mono-rail beam and hoist. Traditionally, contamination has always been assumed to be at the maximum over the bottom quarter of any cell. However, wherever a furnace is in the containment box, this seems to cause a hot air plume, contamination is taken high into the box and deposits on all horizontal surface, even at the very top of the box. These areas are readily dealt with using a detergent swab.

3. Local hot spots. In more than one case spots greater than 6mSv/hr $\beta\gamma$, were found remaining after detergent treatment. Inevitably, these arise when fuel solutions are being handled, as some of the fission products present can alloy very readily with the stainless steel surface of the box. These were removed using an electrochemical technique, treating an area $\sim$ 50mm x 50mm at a time. Treatment times of the order of 30 secs only, are required. The electrolyte is based on nitric acid to be readily compatible with the Harwell effluent treatment plant.

Further detailed hand cleaning continued in the box until levels were > 30cps $\beta\gamma$ (on a "1667" monitor by direct measurement) and > 1 cps γ (on a PAM2 monitor by direct measurement) i.e. within the limits for a controlled area laboratory.

Before the containment box was removed from the Secondary Decontamination Area for re-furbishing, airborne contamination levels were checked to ensure the area was acceptable for normal laboratory practices. This sampling continued throughout any re-commissioning phase.

Time taken and Man-dose received during Decontamination

On average, for the initial decontamination of the first 5 boxes, some 100 man hours total for the 3 man-team, were taken per box, with an average radiation dose of 0.05mSv/man/box. Theses figures are acceptable in the context of the current aim to restrict doses to radiation workers to 15 mSv/year.

Re-commissioning Experiences

Clearly, if any panel needs to be removed or replaced during the commissioning phase, e.g. electrical services plate, side port blanking plates etc, this must be done during decommissioning or only under the most stringent conditions outside the Secondary Decontamination Area.

Air sampling takes place whilst staff are re-commissioning a box; to date no significant levels of airbourne activity have been found. During re-commissioning, staff dress appropriately for a controlled area.

Conclusion

Experience to date has shown that the principle of removable containment boxes can and will work. Decontamination of boxes has been shown to be possible, and boxes have been re-commissioned after use. High usage of the highly capitalised shielded facilities is therefore possible.

Almost certainly we have difficult problems ahead; future boxes will have a greater degree of contamination than we have met to date, but I am confident that we can continue to operate this facility as the design intended.

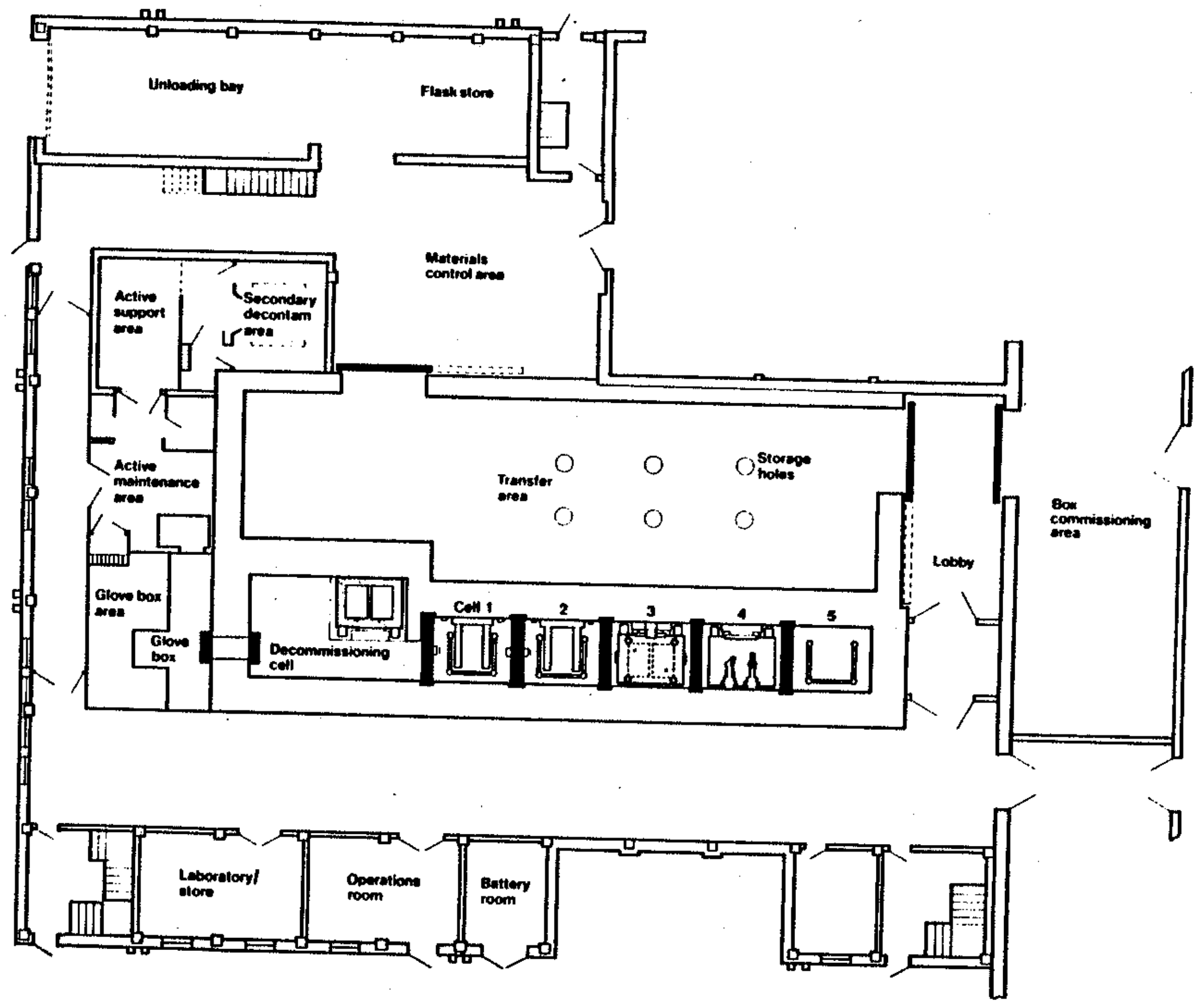

FIGURE 1 - Plan view of the Facility