Refurbishment of a hot cell for decontamination of in-cell equipment

Annual Meeting of the European Working Group
'Hot Laboratories & Remote Handling'
Studsvik Nuclear AB, Sweden
June 5-6, 1997

T R Black & M S Stucke
Refurbishment of a hot cell for decontamination of in-cell equipment

Annual Meeting of the European Working Group 'Hot Laboratories & Remote Handling' Studsvik Nuclear AB, Sweden June 5-6, 1997

Reference Topic III

Confidentiality, copyright and reproduction Copyright AEA Technology plc
Distributed only on the basis of strict confidentiality. Confidentiality to be maintained. Enquiries about copyright and reproduction should be addressed to the Commercial Manager, Technology plc.

File reference G:/fp/public/hotlab/hot cell12aw.doc

Report status Issue 1

Report contact

Telephone
Facsimile

AEA Technology is the trading name of AEA Technology plc
AEA Technology is certificated to BS EN ISO9001:(1994)

<table>
<thead>
<tr>
<th>Name</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Author</td>
<td>T R Black</td>
<td>28/5/98</td>
</tr>
<tr>
<td>Reviewed by</td>
<td>R Currie</td>
<td>28/5/98</td>
</tr>
<tr>
<td>Approved by</td>
<td>M S Stucke</td>
<td>28/5/98</td>
</tr>
</tbody>
</table>
Abstract

AEA Technology have recently installed and are currently commissioning a decontamination facility within their active handling facility in Building 13 at Windscale. An existing shielded hot cell (or cave) and adjoining amber workshop have been refurbished and used to house the decontamination and associated equipment. The shielded hot cell provides the primary, remote, decontamination area and the adjoining amber workshop provides the secondary, hands on, area. The primary decontamination process involves soaking items in tanks containing a hot detergent/water mixture. Propeller type agitators, ultrasonic transducers and spray heads are fitted to the tanks. The decontamination facility will be utilised to clean contaminated equipment and materials prior to maintenance (to reduce personnel dose uptake) and prior to disposal (to reduce waste disposal costs). This paper describes the decontamination facility and its integration with the active handling facility.
Contents

1 INTRODUCTION 1
2 ACTIVE FACILITY 1
3 HOT CELL BEFORE REFURBISHMENT 2
4 WORKSHOP BEFORE REFURBISHMENT 2
5 CLEAN UP AND STRIP OUT 3
6 DESIGN LIMITATIONS 3
7 REFURBISHMENT IN THE HOT CELL 4
8 REFURBISHMENT IN THE WORKSHOP 6
9 DECONTAMINATION PROCESS 7
1 Introduction

Over the last few years, Building 13 at Windscale has undergone considerable refurbishment and rationalisation. This work has been necessary to upgrade the facility to meet modern standards and also to align and equip the facility to accommodate changes in work type. The refurbishment and rationalisation programme has left a significant amount of contaminated equipment and materials. The changes in work type have been towards shorter term programmes requiring more frequent in cell modification and retooling; generating increased amounts of contaminated equipment and materials.

An integrated decontamination facility is recognised as an important part of the active handling facility; minimising operator dose uptake during maintenance and waste disposal costs.

2 Active facility

The active facility in Building 13 is mainly used for the post-irradiation examination of thermal reactor fuel and waste processing nuclear materials.

The facility is composed of a line of thirteen hot cells (or caves). The basic shielding is provided by reinforced concrete with in built zinc bromide or lead glass viewing windows. In cell operations are performed using master slave manipulators and in cell cranes, manipulators and equipment. See figure 1.

Material is received into the facility via flask stations within the two end cells, flask posting ports on the cell end faces or flask posting ports on the cell roofs. These flask stations and posting ports are also used for the despatch of materials. All the cells are connected by a shielded corridor, fitted with a transporter system for moving materials within the facility.
3 Hot cell before refurbishment

The hot cell (cave 12 on Figure 1) to be converted to a decontamination facility was originally designed for decontamination work but had been used for a variety of post irradiation operations and for the handling of Co60 sources over many years.

The hot cell consists of a shielded concrete cell. The operating face wall thickness is 1.37 metres. The cell roof has two layers of concrete shield blocks (1.25 metres total thickness).

The operating face has two viewing windows and two master slave manipulators are located above each window for light lifting/handling duties within the cell. A crane was installed for heavier duties. The cell is fitted with a drive mechanism to interface with the transporter system and allow items to be remotely transferred to/from the cell using trays.

The cell had a drain connected to the active (liquid) drain system. Two primary air filter housings were located in the cell and connected to the building red extract ventilation system.

The cell contained a cobalt counting castle and associated source keep and lift gear, bench and service console. Two steel bulkhead shield doors were fitted to divide the cell from an active workshop and there was provision to fit similar bulkhead doors to divide the cell from the transporter corridor.

4 Workshop before refurbishment

The active workshop is built onto the west end of hot cell 12 and is divided from the cell by a concrete shield wall and two bulkhead shield doors. The bulkhead shield doors can be raised/ lowered, using the building crane, to allow the hot cell crane to be driven into the workshop. The north and west walls of the workshop are not shielded and are constructed of brick.

Man access into the workshop is through a door on the west side which leads to a small entrance area with a wash hand basin and a clothing change barrier. Double doors are located on the north side to allow the transfer of larger items to/from the
operating face area. There is an opening in the workshop roof to allow transfer of items to/from the hot cell roof area.

The amber workshop has a bunded floor area with stainless steel cladding and a drain channel which connects to the active drain system. Six primary air filters were housed at the south end of the bunded area and are connected to the building amber extract system.

5 Clean up and strip out

Prior to starting any modifications, the hot cell was emptied of all loose waste via the transporter system and the bench area was remotely cleaned and decontaminated using the master slave manipulators. Although the cell had been in operation for many years and was heavily contaminated, decontamination to very low levels was achieved remotely by conventional means in a relatively short period. Shield doors were installed to divide the hot cell from the transporter corridor before roof blocks were removed from the hot cell to allow man access for manual clean up and decontamination. Following complete strip out of all in cell equipment unlimited working times were achieved in the cell, although respiratory protection was worn in the cell throughout the work.

The active workshop was manually cleaned out, loose items were removed and the area was decontaminated. After decontamination of the hot cell, the workshop clad area was tented and the shield doors were then removed to provide man access to the hot cell via the workshop. All equipment and fittings were removed from the basic concrete structure of the hot cell except for the encast liners and supports, crane rails and drain catch pot.

6 Design limitations

Several methods of decontamination were considered during the design phase of the project. The following design requirements were important limiting factors on the final choice of decontamination method (See section 9 for details):
- no strong acids or bases could be discharged down the active drain and therefore aggressive methods of decontamination were discounted
- the space available was the existing hot cell and workshop boundaries and therefore the installed equipment had to be compact
- the existing transporter system provided the interface with the active facility and this set the size and weight of items that could be transferred for decontamination
The resulting design was a compromise but it offered a workable solution that could be integrated relatively easily. The decontamination tanks within the cell were designed so that their removal could be carried out remotely in the future should other decontamination techniques become available. Details of the decontamination tanks and their ancillary equipment are shown in figures 2, 3 and 4.

7 Refurbishment in the hot cell

The basic structural modification within the hot cell involved cutting out a section of the concrete floor slab to cast in a stainless steel tank well for the decontamination tanks.

New primary filter housings have been fitted and a new bench and support steelwork has been installed in conjunction with new under bench services, instrument cables and pipework. A new drive mechanism and supports have been installed to connect to the transporter system.

Two decontamination tanks are positioned in the tank well. The tanks are similar but one is used as the process tank for decontaminating items and the other is used as the holding tank for the decontaminant i.e. the water and detergent mixture. Each tank is fitted with a thermostatically controlled heater, a propeller type mixer, a level indicator and level switches, a basket and a lid with rinse nozzles. The process tank is fitted with ultrasonic transducers. All the tank fittings are remotely removable/replaceable.

An air driven recirculating pump is installed on the drain cover plate to complete all the necessary in hot cell pumping operations.

A filter housing and sub-micron cartridge filter are located on the bench for use in conjunction with the recirculating pump; to filter the decontaminant. The cartridge is enclosed by an integral bag to contain the particulate. The housing is fitted with a compressed air line to allow the liquid between the bag and the filter to be expelled prior to remotely changing the cartridge. A small ultrasonic bath is positioned on the bench and is fitted with an ultrasonic transducer, basket and lid. The bath will be used to decontaminate small and fragile items.

The tank well, tanks, bath, pump, filter and service console are all fitted with quick release type self-sealing couplings. The pumping route for the decontaminant is made by fitting hoses between the specified couplings with the master slave manipulators. Eight decontaminant hoses and four compressed air supply hoses are required.
Lead glass viewing windows are fitted and replace the zinc bromide type, which are prone to leak. New roof and window lights are fitted.

A mobile, hot spot, gamma probe is installed in the hot cell with a display unit on the hot cell face. The monitor cable passes through a shielded wall plug adjacent to one of the viewing windows. The probe/monitor is used to detect the dose rates on items as they are being decontaminated and also the build up of radiation in filters and sumps.

An air temperature detector is installed in the cell with a display unit on the cell face. The cable to the detector passes through a shielded wall plug between the viewing windows. The detector warns the operators of high cell temperatures.

A new crane complete with hoist is installed in the hot cell. Crane control stations are provided at the external cell face console adjacent to each viewing window and also in the workshop. A camera is fitted to the hoist trolley to view down into the tanks. The viewing monitor is mounted on the cell face wall between the viewing windows.

Four master slave manipulators are fitted through existing liners in the cell face wall, two above each viewing window. Wall rings are fitted to the inside of the liners and sealed gaiters are used.

A bulkhead seal door has been installed, at the east end of the cell, in the existing bulkhead between the cell and the transporter corridor. The door has a man entry door and also a counterbalanced flap door to allow the transfer of trays to/from the corridor.

The existing bulkhead shield doors, between the cell and the active workshop, have been modified to interface with a new shielded transfer and monitoring enclosure in the workshop. The doors have had a section cut out and machined to allow the transfer of trays to/from the workshop.

A new external console has been fitted to the cell face wall, below the viewing windows, to house the controls and under bench services to the cell. An alarm panel, marshalling box and ultrasonic generator box have been located adjacent to the external console.
8 Refurbishment in the workshop

The cell was generally refurbished before the workshop. However, it was necessary to drill two stepped holes through the concrete shield wall between the workshop and the cell; to insert shield plugs containing the supply, return, drain and vent lines for the sampling enclosure. The workshop ventilation filters and the workshop cladding were also removed, during the cell modification, to allow the new concrete plinth to be cast to support the shielded transfer and monitoring enclosure and the shielded sampling enclosure.

The shielded transfer and monitoring enclosure is installed above cell bench height, extending into the workshop. It is manufactured from steel sections and each end is fitted with a steel fabricated, lead filled, sliding door. Each door is powered by an air cylinder and slides horizontally on ball castors. The roof of the enclosure is fitted with a gamma monitoring probe and a lead glass viewing window. A sliding tray, with ball castors, is located on 'v' grooved plates within the enclosure and is powered by a telescopic air cylinder. The tray slides horizontally into the hot cell when the cylinder is extended; to enable items to be placed on the tray and retracted into the shielded enclosure for monitoring. Interlocks are provided to only allow one door to be open at any time, to only allow the tray to be extended when the inner hot cell side door is fully open and to only allow the inner door to be closed when the tray is fully retracted. A radiation interlock also prevents the outer workshop side door opening when the dose level is above a set value. After opening the outer door the tray can be detached from the air cylinder and manually pulled out of the enclosure to allow the item to be removed.

Two workshop filter housings have been fitted and a damper installed in the ventilation extract duct on the hot cell roof. The damper is motorised and interlocked to close when the low flow setting is reached in the extract system from the cell. This prevents air being drawn from the cell into the building extract system.

The shielded sampling enclosure is built on a new concrete plinth in the workshop. It is fitted with a manual sampling system utilising a sample bottle, an air actuated supply line valve, gamma probe and hinged shield door. Interlocks are provided to ensure that the door cannot be opened unless the supply line valve is closed and the radiation within the enclosure is below a set level. A control panel for the sampling, transfer and monitoring and the amber extract damper is mounted on the adjacent wall.
The workshop floor was excavated around the drain entry point and a new filter housing and catch pot has been positioned and welded to the drain line below floor level. The excavated area was filled with concrete and the workshop floor skimmed with concrete and cladded to slope towards the catch pot. Pipes are installed, under the cladding, to the catch pot from the mixing tank drain and overflow, the spray glove box drain, the workshop shower and hand basin drain.

The decontaminant mixing tank is installed in the workshop. The tank is fitted with a thermostatically controlled heater, a propeller mixer and level indicator switches. The tank is connected to the building water supply and decontaminant powder can be added through a hinged lid. An air driven pump and cartridge filter and housing are mounted adjacent to the tank to supply clean decontaminant to the workshop or hot cell. A control panel for the mixing tank and equipment is mounted adjacent to the tank.

A glove box is installed in the workshop. The glove box is used in conjunction with a pressure spray washer to further decontaminate items. The glove box is fitted with a drain line connecting into the amber workshop drain filter housing.

A crane with an air powered hoist and cross travel is installed in the workshop on the existing crane rails.

The entrance area and the west side doorway were repositioned to allow a personnel shower, wash basin, personnel monitoring equipment and clothing change barrier to be fitted. Beta in air and gamma monitors and alarms have been fitted in the workshop with a repeat alarm positioned outside the entry door to the workshop.

9 Decontamination process

The basic decontamination process involves:

- preparing a batch of the decontaminant in the mixing tank and pumping it in cell to the decontamination process tank
- placing the contaminated items into the process tank and soaking the items at temperature with ultrasonic cleaning
- pumping the decontaminant from the process tank to the holding tank via the filter
- rinsing the items in the process tank with clean decontaminant from the mixing tank
- removing the items from the process tank and monitoring them with the gamma probe
• undertaking further decontamination if necessary e.g. repeating the soaking/ultrasonic cleaning process or using mechanical tools in conjunction with the master slave manipulators
• transferring the items to the workshop via the shielded transfer and monitoring enclosure
• undertaking secondary, hands on, decontamination if necessary for maintenance, storage or disposal of the items

The filtered decontaminant will be reused where possible. It will eventually be sampled in the sampling enclosure and discharged to the active drain.

The effectiveness of the primary decontamination process will be evaluated during active commissioning and operation. More aggressive mechanical methods of decontamination are being developed based on a variety of techniques, including needle guns, high pressure water jetting, abrasive wheels, etc; used in conjunction with other supplementary techniques e.g. sponge-jet and foam sprays. These techniques will be deployed when the water soak techniques prove ineffective.
Figure 1: Ground Floor Plan - B13 Windscale Active Handling Facilities.
Figure 2: Plan of Decontamination Cell and Workshop.
Figure 3: Sections through Decontamination Cell and Workshop.
Figure 4: View of Decontamination Cell Operating Face.
Figure 6: View of Agitators, Filter Assembly and associated pipework through Cell Window.
Figure 7: Active Workshop showing Shielded Transfer System, Sampling Unit and Decontaminant Mixing Tank.