PREPARATION AND DECOMMISSIONING 0F HOT CELLS AT DOUNREAY

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ABSTRACT

Dounreay Nuclear Establishment was once Britain's foremost centre for fast reactor technology. On the site are four reactors the largest of which is a 250Mwe sodium cooled fast reactor. Alongside the reactors are a host of fuel processing facilities and laboratories at various states of operation and condition. With a Government decision in the early nineties to stop funding fast reactor research the site is to be decommissioned and mostly returned to a greenfield site within 60 years.

There are a vast number of projects to be undertaken on the site and already a large amount of preparatory work has been done. This paper considers two projects that are currently being implemented. The first is a project to prepare a large pulse column glovebox for dismantling. The second is for the hands on decommissioning of a shielded cell.

The two projects have been considered under one paper because although they are separate projects in different parts of the site they outline the typical methodology of decommissioning; preparation, segregation and dismantling.

The Pulsed Column Laboratory was used for the development of solvent extraction equipment and flowsheet trials. In particular for obtaining data during BNFL trials for the Thermal Oxide Reprocessing Plant and for UKAEA development work for the proposed European Demonstration Reprocessing Plant. The experimental work was completed in the late 1980s and Stage 1 decommissioning commenced in December 1991

Lab33 is a shielded cell built in 1957 within the D1200 laboratory complex at Dounreay. It has had a chequered working history with various modifications undertaken to cater for the changes in use. It was originally built to handle enriched uranium then, as the needs of adjoining labs changed, it was modified to handle plutonium. Since about 1980 the main tasks performed have been the destructive examination of PFR fuel pin sections. In 1984 the examination of this fuel lead to contamination problems in the cell and subsequent interrogation difficulties due to high specific alpha activity. Thus the laboratory could no longer be used to its full potential and it was decided to decommission the cell and associated areas.

The paper will describe the work done and the problems that beset the contracts. It will be of interest to those who are carrying out similar decommissioning activities and will hopefully be of some assistance in preparing for their own projects.

INTRODUCTION

Dounreay was the foremost centre for fast reactor technology in Great Britain. Owing to Government policy to discontinue the fast reactor programme all of the reactors on site have been shut down and defuelled and the whole site is to undergo a programme of decommissioning and clean up; eventually to be returned mostly to a greenfield site. Facilities to undergo this process include the following.

- Reactors
  - The Prototype Fast Reactor (DFR)
  - Dounreay Fast Reactor (DFR)
  - Dounreay Materials Test Reactor (DMTR)

- Waste Facilities
  - Wet Silo
  - LLW Disposal Pits
  - Shaft

- Fuel Cycle Area (FCA)
  - D1200—Chemical and Metallurgical Laboratories
  - D1201—Fuel Cycle Area Change room
  - D1202—Materials Test Reactor Fuel Element Fabrication Plant
  - D1203—Uranium Conversion Plant
  - D1204—Research Reactor Fuel Reprocessing Plant
  - D1206—Fast Reactor Fuel Reprocessing Plant
  - D1207—Low Level Solid Waste Management Building
  - D1208—High Active Liquor Storage Plant
  - D1217—Remote Handling Facility
  - D2001—Post Irradiation Examination Laboratory
  - D2670—The Marshall Laboratory
  - D2700—Dounreay Cementation Plant

This indeed is a massive undertaking planned to be completed within 60 years and to a budget of approximately £4.5B sterling. Decommissioning activities are presently in the early stages with the site licensee, UKAEA, having recently published their decommissioning program. Staffing up is currently ongoing and much of the plant is undergoing upgrades to allow the totality of the task to continue to completion.

This paper considers two projects amongst the many to be carried out. The projects are what may be termed Hot Cell decommissioning projects; both cells were used for carrying out experimental work on plutonium and they are both contaminated with Pu and other actinides, but there the similarity ends. The first to be considered is the Pulsed Column Laboratory Segregation Project, D2670, which describes typical requirements in preparation for dismantling a hot cell. The second is decommissioning of Laboratory 33 in D1200, which is a hands on cell decontamination project. This cell is heavily contaminated with fission products in addition to the actinide contamination.

PULSED COLUMN SEGREGATION PROJECT

To carry out research and development of reprocessing technology in Britain the Pulse Column Laboratory (PCL) complex was constructed in early 1980s. The PCL was used for the development of solvent extraction equipment and the flow sheet trials. In particular for obtaining data for BNFL's Thermal Oxide Reprocessing Plant and for UKAEA development work for the proposed Fast Reactor European Demonstration Reprocessing Plant. The experimental work was completed in the late 1980s and Stage 1 decommissioning commenced in December 1991. Because the equipment has now fulfilled its purpose and, due to its condition and national regulatory pressure it was decided to decommission the facility.

The Pulsed Column Laboratory contains a large "shop window" glove box some 11m high, 6.5 m long and 1.2 m wide constructed from a stainless steel framework in four modules, one on top of each other, with Lexan windows of dimension 1.5m by 2 m. The glovebox was operated from four different floor levels. It contains six pulsed columns, several storage tanks for make-up of active feeds, storage of feeds to the columns and collection and storage of raffinates. It also contained an evaporator for processing of fissile material solutions as well as pipework linking the various columns and process vessels. Following an options study by UKAEA to determine the best way to dismantle the glove box, two options were finally considered:

Option A

This option proposed that the integrity of the Govebox is maintained while the internal contents are removed. All items that are to be removed will require size reduction in the Glove box before posting out via the installed posting ports. Operators will work on the existing platforms, possibly wearing respirators. When all the internal components have been removed it is proposed that a full containment is erected around the Glovebox while the main structure is dismantled.

Option B

This option proposes that a full containment will be erected around the entire structure of the Glovebox and, after an initial programme of decontamination, the windows are progressively removed. Operators working in pressurized suits will be able to enter the containment via four engineered access points to dismantle the internals. All the waste will be bagged and posted out via a size reduction facility allowing any necessary size reduction and packaging. On completion of dismantling, the containment will have any contamination re fixed and removed using a sprayable, peelable coating.

Following a matrix analysis of the advantages and disadvantages of each method UKAEA decided that Option B would be the best solution (1).

It is notable that each option requires at some stage the construction of a containment to seal off the area for the safe dismantling of the glove box and its contents. To minimize disruption to other areas of the building it was decided that the area should be fully segregated. Thus a project for the separation of the laboratory from the rest of the building was established namely the Pulsed Column Segregation Project for which NUKEM Nuclear Limited was awarded the contract.

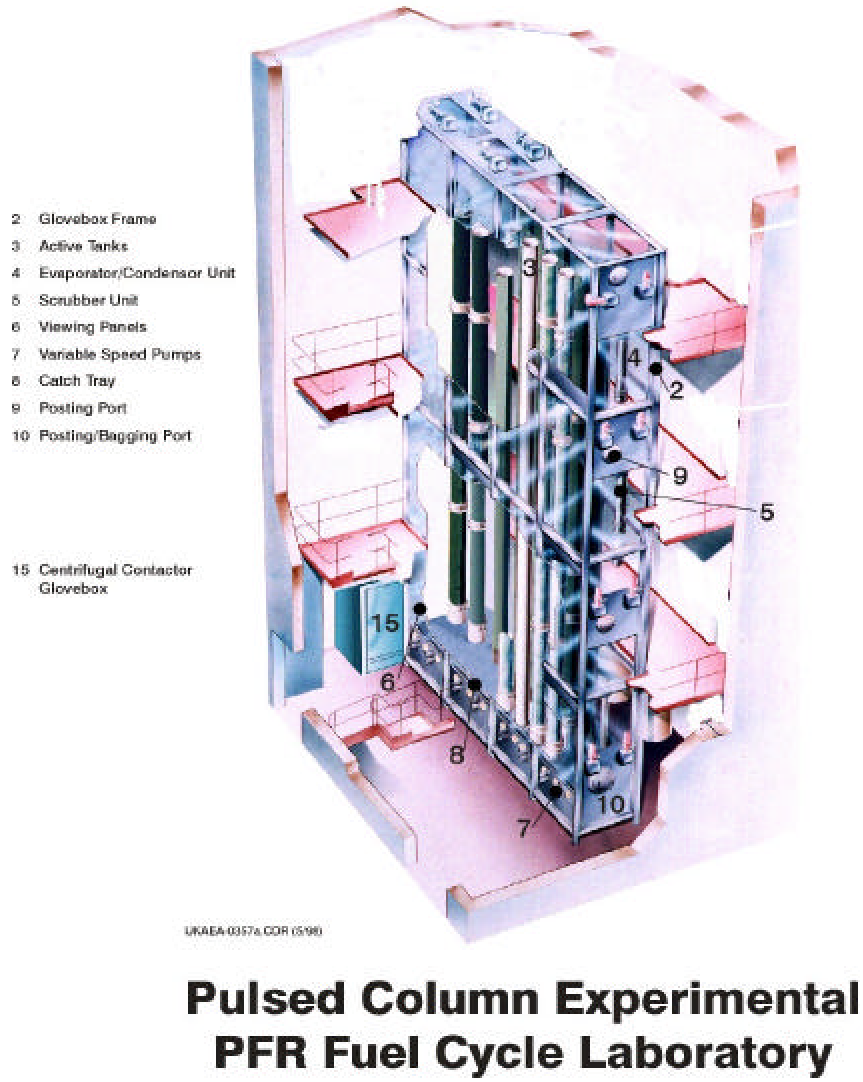

Fig. 1. Pulsed Column Glovebox

Description of Wrks

As mentioned above, the project objective was to segregate the PCL, which incidentally is the largest glove box of its kind in Europe, from the rest of the laboratory complex. This would entail the provision of a new changing facility, linked directly to the PCL area, a new ventilation system, a decontaminable containment system fixed to the walls of the PCL area and a new posting out facility. Associa ted with these works are the removal of the many existing services whilst maintaining the fire alarm and Environmental Monitoring System (EMS) In place of the old systems linked to the existing building systems, there will be a new electrical distribution system, new fire detection, alarms, EMS, security, CCTV and control systems. There will also be a dedicated breathing and compressed air system and towns water supply for an emergency shower. The layout of the external facility is shown in Figure 2.

The contract was let to NUKEM under the New Engineering Contract (NEC) with pricing under a defined activity list against mostly lump sum prices but with target pricing for strip out of the existing ventilation system. Preliminaries and project management costs were treated as an item and payments were against predetermined milestones.

Design Issues

Prior to the contract let there were the inevitable pre contract discussions regarding various options for pricing and technical details. The contract was essentially for procurement and installation with some design detailing. However at tender stage NUKEM believed there could be offered more preferable options to the contract design particularly with respect to the ventilation system. These options were put forward in the tender and following contract award they were considered in a design review and were adopted for the project. These changes had a profound effect on overall project design as they interfaced with many other design elements.

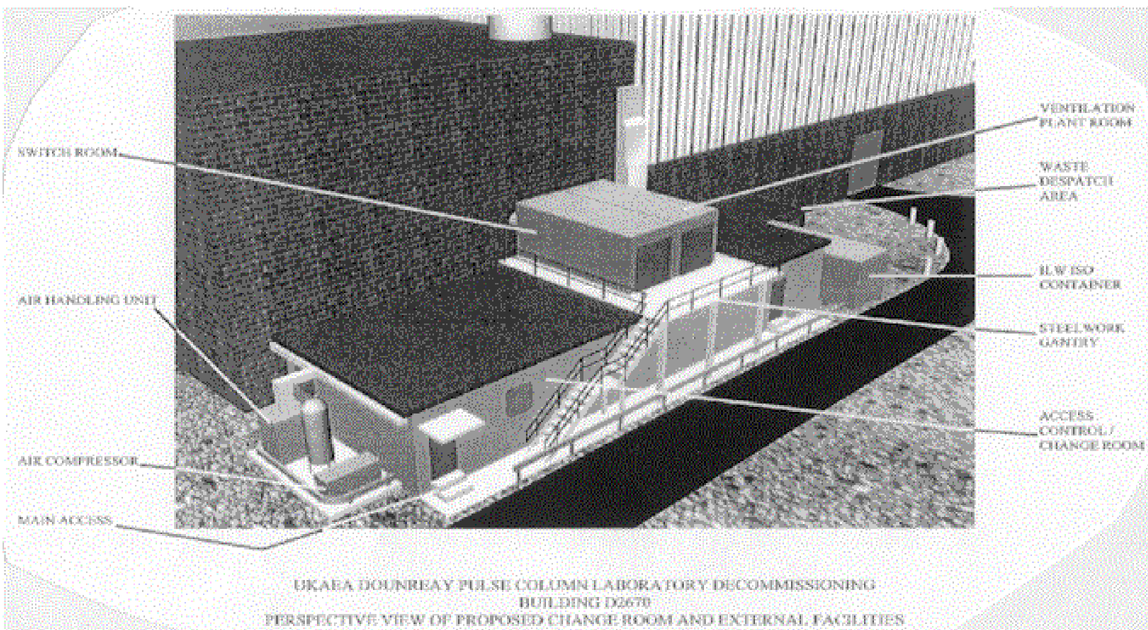

Fig. 2. PCL New External Facilities and Plant Rooms

The main area of concern for the tender design was the ventilation system. The proposed design relied on a well sealed PCL in that all the air is drawn through into the PCL. NUKEM were concerned that the depression required to generate the correct infiltration flow rate, could create a conflict with the existing glove box extract system. NUKEM were also concerned with the Mobile Filtration Unit (MFU) design which included 8 axial fans, four in series per filter unit. The initial design supplied air to the change rooms at 1.1 m^3/s via an Air handling Unit and cascaded to PCL ground floor. The extract air was to be supplied at 1.88 m^3/s using 2 No 100% duty MFUs with booster fans running in series. The discharge was to be to the existing facility flue stack.

The problems with this system were:

- The 4 No fans per filter bank were in series, were insufficient for the purpose and it was generally not good practice for operation.
- An axial fan will not pull against pressure.
- The unit pulls only 1.88m^3 /s which would require a level of Building tightness incompatible with decommissioning activities.

There were further requirements from the Client that affected the changes required from the above:

- Access was to be from each of four levels and not three as originally anticipated
- A true double HEPA filtration system was required
- Discharge to the existing stack was deemed unsuitable.

The solutions to the above were:

- Provide 2 No 100% extract fans of 3m^3 /s capacity
- Provide air to all levels that would be filtered and heated
- Provide a stand alone stack system

There were some further refinements considered. The proposed system extracted from the glove box was deemed unsuitable for the interim period between segregation and decommissioning as the glove box and lab would be at the same relative depression resulting in the lab being classified as C4. During decommissioning, extract from the Glove box is not required therefore this part of the system was designed out. Also, during the HAZOP of the ventilation system as redesigned, it was mooted that 100% redundancy on the PCL filters was overkill, and these were reduced to 12.5 %. Improvements in the duct routing were also undertaken and modifications in duct sizes were done to allow the ductwork to pass through the various levels without major building alterations.

The second major design modification was the change from the Moducon system of containment to a product called Platicol. The Moducon system provides a very tight containment with each panel joint flange bolted. Standard panels can be assembled to form modules suitable for the strictest of containment standards. However the configuration of the PCL area, with its stair cases, structural steel and other protrusions, meant that a modular system would need to be purpose manufactured and built and would very costly. The space needed to bolt it all together would mean there would be less space for PCG dismantlement. It was therefore proposed that a system of plastic coated sheet steel panels be fixed to the walls of the PCL area and jointed simply by a modern silicon sealant. Catering for the many undulations in the building walls would be addressed on site by cutting and bending (2).

Safety Documentation

Although there had been a Preliminary Safety Report (PSR) written prior to contract award a number of other required safety documents had not been considered. The UKAEA Specification for Safety Cases requires that for major modification works a PSR, Pre- Commencement Safety Report (PCSR), Pre Commissioning Safety Report (PCmSR) and Pre Operational Safety Report

(POSR) are written and approved. The PCSR had been written and approved but due to the ventilation design considerations it was deemed that the PCSR should be revised to account for the modification. The PCSR together with a requirement for a SAM document, described below, delayed the project further.

Start of Site Works

The civil and building works were implemented without problems but the internal work began with problems that continued for approximately 6 months. Firstly it was found that cabling routed through the Head End area had to be stripped out. This work required a Safety Approved Modification (SAM) document due to its effect on existing operations. The electrical strip out was originally in the NUKEM scope of work but the UKAEA believed that as there were so many interfaces with existing equipment it would be safer for their own labour to do this activity. However, due to an unforeseen shortage of labour, delay was incurred to this critical path activity. During this time intermittent working mitigated delays, where possible, on the mechanical strip out and internal building works.

Before completion of the strip out, the site suffered from Radon gas entering the PCL area and setting the air-sampling monitors to alarm condition. The radon was seeping from the ground through the construction joints and minor cracks of a below ground concrete pit constructed beneath the PCL area. Various options to control the radon were considered and temporary ventilation of the area stemmed the problem. It is noted that Radon had been a problem over the years and tended to be a seasonal occurrence. The problem delayed the project some 8 weeks.

Going to press the project had recommenced following these delays and work on the Plasticol sheeting was underway.

Completion of the project was rescheduled following the radon delay and a new completion date of April 01 was established, that is eleven months after the original completion date. Negotiation of costs for these delays was based on a revised programme showing the effect of individual delays on the critical path.

The Pulse Column Segregation Project was essentially a contract for preparing an area for decommissioning an active facility. Fundamentally providing containment, ventilation and a change facility. The next part of this paper will describe the activities required in decommissioning of a heavily contaminated cell within the Chemical and Metallurgical Laboratories.

D1200, LAB 33

Lab33 is a shielded cell built in 1957 within the D1200 laboratory complex at Dounreay. It has had a chequered working history with various modifications undertaken to cater for the changes in use. It was originally built to handle enriched uranium then, as the needs of adjoining labs changed, it was modified to handle plutonium. Since about 1980 the main tasks performed have been the destructive examination of PFR fuel pin sections. Operations in the main cell area involved cutting, grinding, acid etching and polishing sections of fuel specimens that were then passed on to an adjoining blister cell to be examined by optical microscope and macroscope. In 1984, three pinlets containing oxides of curium, americium and mixed curium, americium and lanthanides were cut up inside the cell for examination. This operation created in-cell contamination problems and subsequent waste interrogation difficulties due to the high specific alpha activity associated with these elements.

As part of the overall Dounreay decommissioning strategy coupled with the above problem of continued use and regulatory pressure it was decided to decommission the laboratory. NUKEM were awarded a contract to decommission Lab 33 to a level that will enable the structure of the cell to be demolished with minimal radiological hazard.

Cell Description

Figure 3 is a simplified plan of Lab 33 showing the cell within the main lab room. The internal dimensions of the cell are 2.7m north to south, 3.2m east to west and 3.5m high.

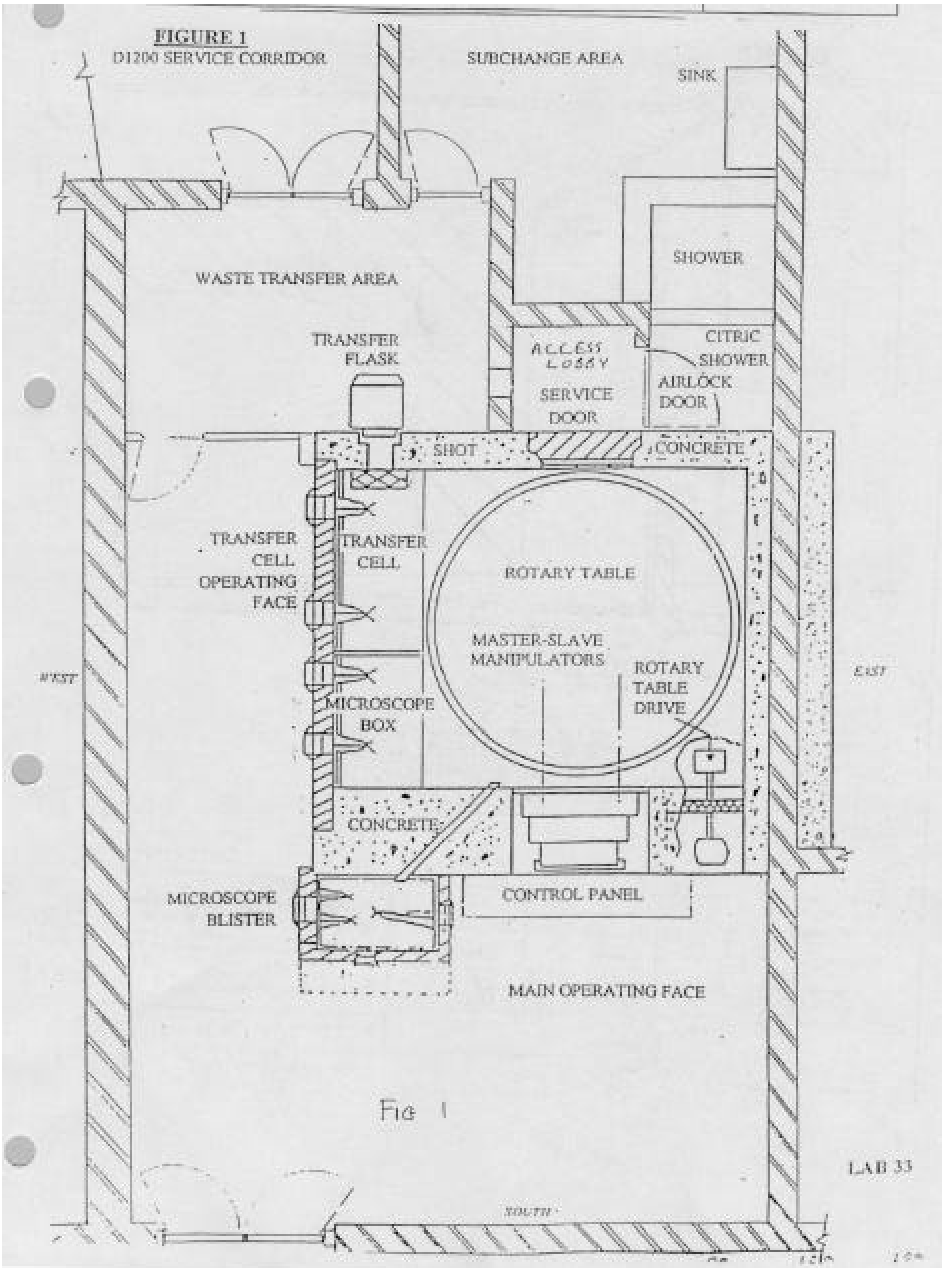

Fig. 3. Plan of the Laboratory and Cell

The walls have been formed from various shielding materials and thicknesses. The east wall is constructed in 225mm thick steel shot concrete cast against the external building wall, the north wall is 350mm thick steel shot concrete and the south wall is a plain concrete 900mm thick. The west wall is a composite structure of 1120mm thick at its base and top and from 760mm above the floor comprises of 225 mm lead bricks with a number of penetrations to take viewing windows and tong ports. The roof is constructed from 300mm steel shot concrete.

The west wall configuration forms the transfer cell and the original microscope cell where samples were examined and posted out. In the north wall is a shield door that hangs on two lifting beams. Inside the shield door are sealing plates in two halves, lower and upper, bolted tight to the wall. Outside the shield door is an airlock and shower all in a fairly tight configuration. In the south wall are a lead glass window and two manipulators that can reach to the middle of the cell. The cell is lined in 1.2mm stainless steel.

A unique feature of the cell is a heavy steel circular rotating table, clad with stainless steel forming a greater portion of the working floor level. The function of the table was to bring objects under examination within reach of the tongs and manipulators. The gap between the perimeter of the table and the stationary portion of the cell working floor level is sealed by a mercury dip seal. Below this there is a framework supporting the drive mechanism. From the middle of the turntable rises a steel column containing power supplies.

The cell is connected to the building ventilation system that required some local modification prior the commencement of POCO to allow easier and more frequent filter changes when decommissioning.

Cell content

Radioactive samples have long since been taken away but there still remains a larger volume of contaminated equipment and items such as lead and concrete shielding blocks, polishing machines, angle grinder, power sockets, cabling, aluminium waste cans and trunking and air filters.

Additionally there is approximately 218kg mercury, forming the seal to the turntable, which is contaminated with alpha; <10 Bq/g, Beta;<50Bq/g and Gamma;<50Bq/g. The interior surfaces of the cell and all items within it are contaminated. There are significant amounts of Am and Cm present in the swarf and powder debris within the cell, which although assumed to be within the ILW category may, when collected, lead to possible low heat generation problems. Fissile material was also present in the lab containment (3).

Following the initial stage of canning up waste items in the cell a fingerprint analysis was carried out and the results are shown below.

D1200/L33 Swab Analysis Results

The results below are Bq/sample, except the gamma result, which is GPS/sample, and the alpha which is %.

Table I.

				Alpha Spec						
Swab No.	a	b	g	**%5.15 MeV**	**%5.5 MeV**	**%5.8 MeV**	**^{90}Sr**	**^{137}Cs**	**^{241}Am**	**^{242}Cm**
6	5.2×10^{4}	8.5×10^{5}	6.6×10^{5}	38	46	15	5.3×10^{4}	7.3×10^{5}	1.4×10^{4}	5.8×10^{3}
7	2.6×10^{5}	3.1×10^{6}	1.9×10^{6}	39	48	11	2.5×10^{5}	2.1×10^{6}	7.0×10^{4}	2.2×10^{4}
8	8.1×10^{3}	1.2×10^{5}	7.6×10^{4}	44	34	22	1.4×10^{4}	7.8×10^{4}	2.3×10^{3}	2.1×10^{3}
9	2.7×10^{4}	1.1×10^{5}	9.8×10^{4}	35	28	37	3.6×10^{4}	1.1×10^{5}	7.9×10^{3}	1.0×10^{4}

The ^{90}Sr result has been calculated for the date of measurement (10/8/00), but can be decay-corrected to the date of sampling.

The main species detected by gamma spec was ^{137}Cs. Other detected species were at levels of the order of $1/100^{th}$ – $1/1000^{th}$ of the ^{137}Cs level, and with much greater uncertainties. These values are available.

Table II.

	Uranium (Weight Percent)				**Plutonium (Isotopic Abundance)**				
Swab No.	**% ^{234}U**	**% ^{235}U**	**% ^{236}U**	**% ^{238}U**	**% ^{238}Pu**	**% ^{239}Pu**	**% ^{240}Pu**	**% ^{241}Pu**	**% ^{242}Pu**
6	0.069	5.505	0.262	94.164	0.307	72.306	25.034	1.550	0.804
7	0.281	28.351	0.661	70.708	0.253	72.709	24.767	1.495	0.776
8	0.064	3.634	0.351	95.952	0.219	73.052	24.510	1.466	0.753
9	0.352	37.111	0.730	61.806	0.139	82.737	15.956	0.774	0.394

It will be necessary for a further assessment to be made by Health Physics to determine the detailed radionuclide inventory for the cell. In addition to actinides and plutonium, significant fision product contamination is also present. General levels of dose rate vary but are in the order of between 20 mSv/hr ($2rh^{-1}$) and 80mSv /hr ($8rh^{-1}$) inside the shielded cell.

Dose limits in Britain have recently been reduced from 50mSv/yr ($5ry^{-1}$) to 20mSv/yr ($2ry^{-1}$). Practically before the statutary reduction in dose limits most organisations worked to a 20mSv/yr limit with an investigation level set at considerably lower dose level depending on the work undertaken and company policy. The Dose Restraint Objective for Lab 33 decommissioning was:

Whole Body:3mSv (0.3r) for duration of the project
Extremity (hands,forearms, feet and ankles):30mSv (3r) for duration of the project.

Levels of activity present in the cell fabric after decommissioning were set in the contract at $< 0.4Bq/cm^2$ alpha and $<4Bq/cm^2$ beta-gamma. Following the next stage of decommissioning ie demolition of the cell, the limit set for disposal of waste as free release is that for each $0.1m^3$ of material there shall be less than 400 kilobecquerels (kBq)(0.04Bq/g) of beta/gamma activity(5). In Britain this is classed as Very Low Level Waste (VLLW). Low Level Waste(LLW) is set at material not exceeding 4 gigabecquerels per tonne(Gbq/te) of alpha activity of 12 Gbq/te of beta gama activity.

Figure IV shows the cell interior prior to any POCO and it can be seen the extent of initial clean out that was necessary. The decommissioning program was split into 2 stages each preceding the drafting of a decommissioning report to assess the work carried out and liabilities remaining.

Fig. 4. View through the Cell viewing window, Lab 33

Stage 1 decommissioning

The objective of stage 1 decommissioning is to remove loose items, size reducing when necessary and to decontaminate to allow man entry. The specified success criteria are as follows:

- All surfaces will have been decontaminated such that as much loose contamination as possible has been removed, whilst maintaining doses ALARP
- Levels of in-cell fixed activity are such that the follow on stage can be done within the dose restraint budget
- Stage 1 decommissioning dose budgets are not exceeded and are ALARP
- The external cell airborne contamination levels are maintained within current derived air concentration levels
- All Stage 1 waste will have been packaged, assayed and transferred to downstream waste handling facilities.
- External cell areas shall be of less than previous contamination levels. The mild steel cladding to the cell walls shall not be more contaminated than previous
- There shall be no increase in the liquid inventory of the cell
- No unusual occurrences should occur greater than Category 1
- There should be no regulatory intervention during the course of the project
- Man entry for stage 2 decommissioning can be gained (3)

Initial activities carried out on site were part of the Post Operational Clean Out (POCO) which included a general clean up, size reduction, canning and posting out of the "easy" items. This activity suffered a delay, described later in the text, that the project to date has not recovered from.

Undertaking a project of this type is technically demanding at certain stages. At others it is at best slow and laborious. Half of the cell cannot be reached by the existing manipulators therefore a different method had to be adopted to reach those areas. Because of the length of time most items have been in the cell it is considered that they are heavily contaminated. Thus attempting to decontaminate them would not be worthwhile. Simple vacuuming, swabbing and wiping of loose material, canning it and posting it out via the 6" port is the quite simple way of initial clean up.

With little information regarding the decontaminability of the surfaces one can only consider the methods available before using them and then try them out. The last attempt at decontaminating the cell was carried out in 1969 when three-shift working went on for four weeks. Cell clean up used a combination of vacuuming and application of clean up fluids by manipulator. The fluids used in this attempt were Detex, Orcene 585, citric acid, teepol and SDG3 nuclear detergent and water. These were used in conjunction with steel wool. Radiation levels at hot spots after cleaning were recorded at around 6-8mSv/h with a high of 40mSv/h. Following this recorded attempt many surfaces were overpainted thus entrapping the remaining contamination and further contamination will be present on these surfaces. The efficacy of using wipe down techniques is therefore questionable.

NUKEM's proposed method of surface decontamination is a combination of vacuuming, swabbing, abrading, scraping, cutting, grinding and using proprietary water based strippable coatings applied by brush. To reach all areas of the cell requires either a remote controlled devise or, as chosen, a larger more dextrous manipulator. This was found in a VNE 80 (converted to a 90) manipulator that was to be installed during stage 1 decommissioning. Specialist tooling in the form of a Die-grinder, "Beltit" linisher and a centrifugal vacuumn cleaner, all modified to be remotely operated (4).

Stage 2 Decommissioning

This stage is further split into 2 substages;
2A-Equipment dismantling;

- In-cell equipment dismantling and removal.
- Removal, treatment and disposal of the mercury.
- Radiological survey to confirm that the containment structures can be removed.

2B-Containment Structures Dismantling

- Dismantling of the west wall and the Transfer Cell
- Removal of the cladding form the turntable and from the cell
- Removal of the turntable and the below table drains
- Removal of the Blister Cell
- Decontamination (3)

Stage two decommissioning poses some of the greater challenges such as man entry, the removal of mercury, dismantling of the west wall, removal of cladding, removal of turntable and the blister cell.

Man entry can only take place when radiation levels are at ALARP level. Most of the loose contamination will have been removed by this time along with the potential for release. Once the man entry doors are opened, containment of the cell is effectively breached and ventilation through the new filters installed in the west wall is unlikely to be capable of providing the required flow rate to ensure that high air counts do not occur outside the cell. Before man entry doors are opened a portable HEPA filtration extract unit will be installed to boost the cell extract

It is believed that the mercury has an oil topping to minimise evaporation. It is also contaminated to an unknown level. After considering the options of dealing with the mercury it was determined by UKAEA that after its retrieval from the cell it should be decontaminated and declared as free release material for further industrial use. The main factor preventing this will be the level of contamination and political considerations of re-use.

On gaining man entry after modifying the ventilation system further decontamination of the cladding is to be done using NUKEM's Blastrack system. Removal of the cladding will be done using grinders, saws, nibblers and jacks that will be standard off the shelf items but modified where appropriate to gauge the exact depth of cut etc. The panels will be marked for size to ensure that the cut sections will fit into C bins or other approved containers.

Project Suspension

As mentioned briefly earlier in the text, the project was delayed during POCO due to a lack of waste route. On letting the contract the UKAEA had realised that there may be a delay in getting the active waste handling facility on stream following operational safety case approval. Several contract clauses note the possibility of the occurrence but do not indicate any timescale. Due to the unavailablility of the waste route all that could be done in the cell was to can up a certain amount of wastes. A total of 45 cans were filled before the queue was too large to carry out any further work. The project was therefore contractually and practically suspended. To date the contract is still suspended and a date for re-start is awaited.

SUMMARY AND CONCLUSIONS OF THE TWO PROJECTS

This paper has described two of the many hundreds of projects that are ongoing at Dounreay. The projects were chosen because they typify the stages of many decommissioning projects, i.e., separation from the outside atmosphere, containment within the area under decommissioning, difficult techniques and working conditions for operatives and stringent safety issues and standards. This paper had good intention to report how the works were carried out and the problems that beset the projects as they happened. This could only be done to a limited degree due to the major delays that effected the site operations. The PCL was delayed by design changes, safety case work, radon gas and extended strip out time. Lab 33 was drastically affected by the non-availability of a waste route.

One can take a jaundiced view to the management of projects such as the two described above in that if it is going to happen it will happen. On a site with many projects being prepared, operational facilities undergoing review, changes in priorities and funding it is to some extent inevitable that delays will be incurred. Contractors working on such projects have to view these circumstances philosophically and address the implications of such delays solely under the contract in a logical, reasonable and honest manner. In this way the contractor will get paid for his out of pocket costs plus margin and the Client will feel that the situation is, at least, financially under control albeit with an increased final figure.

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