DECOMMISSIONING & DEMOLITION OF A REDUNDANT UK RESEARCH FACILITY AT AWE ALDERMASTON

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ABSTRACT

The redundant two-storey, brick built research facility on the AWE Site at Aldermaston, UK is in the latter stages of decommissioning by Nuvia Limited. The facility was used for a variety of purposes up to 1995 involving the use predominately of alpha-emitting isotopes. After a period of site establishment and preparation of supporting safety case documentation, the two main areas of alpha-based contamination have largely been decommissioned with the removal of hot - boxes and fume cupboards on the ground floor and HEPA filter units and ventilation equipment on the first floor. Many of these activities have been undertaken using both airline fed suits and respirators, the former supplied from a free standing, mobile unit newly located outside the building to allow reuse on future projects. The late detection of exposed asbestos on the first floor associated with an electrostatic particulate filter caused some delay to the programme but these materials have now been removed by a specialist contractor to allow the programme to continue. At an early stage of the programme all sections of active drains running from the building to the site-based active effluent disposal system have been removed from the external drain ducts without incident using well-established techniques.

Specialist monitoring equipment is being used in order to provide confidence in the data required for disposal of the decommissioning debris. In particular a dedicated high resolution gamma scanning unit for waste drums and wrapped packages has been utilised. The final stages of the building decommissioning are in sight and the monitoring and sampling of the structure will become important milestones ahead of the development of the demolition plan. A number of useful lessons have been learnt during the operations and are set out in the main text of this paper.

1. INTRODUCTION

The Research facility at AWE Aldermaston was a multi-function building which had been used for radioactive handling and research studies from the early 1950s. Numerous operations were undertaken throughout the facilities during its operational life involving predominately alpha-emitting isotopes. All operational research work ceased in 1994, with the Facility's transferral to the AWE Decommissioning Division in 1995. Following Post Operational Clean-Out (POCO), the Facility entered a Care and Maintenance (C&M) phase to await commencement of decommissioning and demolition works.

In January 2009 Nuvia Limited was awarded a contract to decommission and demolish the research facility. This was the first project Nuvia had undertaken for the Decommissioning and Demolition Group at AWE for a number of years and required an intense period of familiarisation and training for the staff involved. This was reflected in a mobilisation, pre-works and initial decommissioning period that has seen an excellent working relationship develop. Nuvia has brought experienced nuclear workers to the AWE site and has seen them adapt admirably to meet the new challenges encountered. Working particularly closely with AWE on the Safety Management front has seen the project set high safety standards and has to date resulted in a first-rate safety performance. This integrated One Team approach which has been established has delivered many benefits on the day to day success and its value to the project cannot be over emphasised.

2. OUTLINE FACILITY DESCRIPTION

The research facility is located in the Nuclear Storage and Production Area of AWE's Aldermaston site. This is mainly a two-storey building of brick construction clad on the upper storey with overlapping asbestos concrete panels under a flat roof, (Figure 1). Historically it has comprised five main sections, namely:

- Radioactive Laboratories: This is a two-storey building of a steel-concrete construction mounted on a substantial concrete slab. The ground floor contained the lower pressurised suit area (LPSA) and four adjacent laboratories holding various items of plant and equipment. Other components on this floor included an inlet plant and control room, lobby, barrier area, small office and battery room. The first floor holds the main plant room - the Upper Filter Maintenance Area, (UFMA). The redundant extract fans (including the hot box extracts) and motors were located here.
- Office Accommodation: This is a single story building constructed of brick and is connected to the main facility via a covered walk way.
- Stack and Monitoring Unit: The original ventilation discharge stack was connected to the outlets from the extract filters via pipework from the first floor. This unit was isolated and taken out of service at an early stage in the contract following its replacement with a new temporary discharge stack and associated ventilation system.
- Non-Hazardous Materials Store: This is a single storey, modular structure located on top of a concrete slab.
- Workshop/Mess Room: This is a brick building located on the south west side of the main facility.

The ground floor provided building entry and change barrier and a means of access to the centrally located Lower Pressurised Suit Area (LPSA). This contained area included a series of five hot-boxes (sometimes referred to as glove-boxes) and fume cupboards (Figure 2). These could be accessed from inside the LPSA by operatives wearing airline fed suits via a stainless steel entry tunnel. There is also a 0.25Te goods lift used to move equipment and waste materials between the two floors.

The Upper Filter Maintenance Area (UFMA) contains the ventilation system associated with the ground floor hot-boxes and fume cupboards. This area contained 164 filter assemblies, associated ductwork, access staging and electrical services, was fully contained and in operation could only be accessed by operatives wearing respirators for inspection purposes. The filter assemblies were located in two separate banks to provide a first and second stage exhaust air filtration during the facility life. The primary filters discharged the air into a large 'Precipitron' unit, a commercially sourced electrostatic particulate precipitator, ahead of its final route to the secondary filters and then on to the stack.

Figure 1: The Facility showing the Ground Floor Access

Figure 2: Typical Hot-boxes at the Project Start

3. THE DECOMMISSIONING PLAN

The decommissioning plan has been arranged into four work paths, each with clear objectives and responsibilities. This approach enables good control and communication with each work path having a dedicated operational team. Initial decommissioning operations have focused on removing high hazard areas to reduce the facilities hazard category and the need for hazardous condition working operations. The four main project stages are:

Stage 1 Preliminary Works

Mobilisation; Production of initial safety documentation;

Installation of a new breathing air system; Installation of decommissioning power supplies; Installation of new a Ventilation system**;** External Active Drains Removal

Stage 2 Decommissioning

Ventilation Systems (UFMA); Lower Pressurised Suit Area (LPSA)

General Area Decommissioning; Decontamination of Facility

Waste Processing Operations

Radiological End Point (REP)

Stage 3 Data Quality Objective Process

Strategy and Justification; Survey & Sample

Report; Sanction

Stage 4 Demolition

Above Ground Structures; Floor Slabs

Making Good Grounds

All the above stages are self-explanatory but to date Stage 1 is complete and good progress is being made with Stages 2 & 3 in parallel. An outline plan for Stage 4 has also been prepared but has not yet been implemented. The end state will be a backfilled excavation to allow possible future re-development of the site.

4. OPERATIONAL PLAN AND PROGRESS

Nuvia's objective from the start of this project was to undertake the facility decommissioning using qualified and experienced staff derived mainly from its Winfrith and Harwell teams. The objective was also to utilise practical and successful methods for the decommissioning that had been gained from earlier projects at other nuclear sites. It was by these means that Nuvia was confident of meeting the client's objectives in a safe and efficient manner and to deliver a commercially successful outcome for both parties. Later in this paper the outcomes against these objectives will be considered up to the point that the programme has reached at the time.

The opportunity was taken in the early stages of operations for Nuvia to integrate their experienced operational staff into the AWE culture and to understand the unique approach required for working in alpha-contaminated facilities. The work has allowed a number of key Nuvia personnel to gain valuable hands-on experience in Pressurised Breathing Air-Suit Operations (PBASO) by mixing these operatives with seasoned AWE Health Physics and Decommissioning Operatives.

The overall approach adopted was, following the completion of the Preliminary Works, to have four teams of operatives working in parallel on the UFMA, LPSA, Services and Maintenance and Waste Processing. This concept had been successfully utilised during the decommissioning of the Secondary Containment of the Winfrith SGHWR [1] and a good number of the operatives involved had participated in that programme. There was thus considerable confidence in the application of this approach to the current decommissioning project. An additional facet of the plan was to utilise modular containment systems (MCS) to create an enclosure around the two main contaminated areas, each with a dedicated entry/exit tunnel made from the same materials. The operations would be focused first on clearance of the ground floor LPSA facility where it was judged the greater contamination hazards were located. This would be undertaken in PBASO conditions until the hazards had been reduced sufficiently to allow use of powered respirators. In the UFMA areas it was judged that the hazards were sufficiently well-defined to permit entries using respirators unless there were specific reasons not to permit this such as in the removal of a 'Precipitron' unit and Hot Box Filter Systems which will be described later.

4.1 PRELIMINARY WORKS STAGE 1

A qualified safety case writer undertook the task of developing and obtaining approval for the decommissioning plan that Nuvia prepared as part of its tendering process. During this period the mobilization was also undertaken with operatives completing training and other familiarisation tasks such as those already mentioned. A novel approach was then adopted concerning the installation of a new free-breathing air system to replace the redundant installed system. To provide greater flexibility and to minimise disruption, a stand-alone trailer containing a commercially sourced free breathing air system (figure 3) was purchased and installed outside the main building. This system was connected to new supply pipe-work installed by Nuvia within the facility to provide the required PBASO conditions that would be required in the two main areas to be decommissioned. This approach significantly reduced the potential waste burden as the mobile unit can be redeployed on completion of its duty. The establishment of replacement electrical supplies for small power and lighting units within the building was also undertaken over this period. This is a commonly met requirement when decommissioning older facilities to provide confidence in the safety and reliability of any supplies used during operations. In this case mainly 415v three phase and 110v supplies were provided for power and lighting purposes.

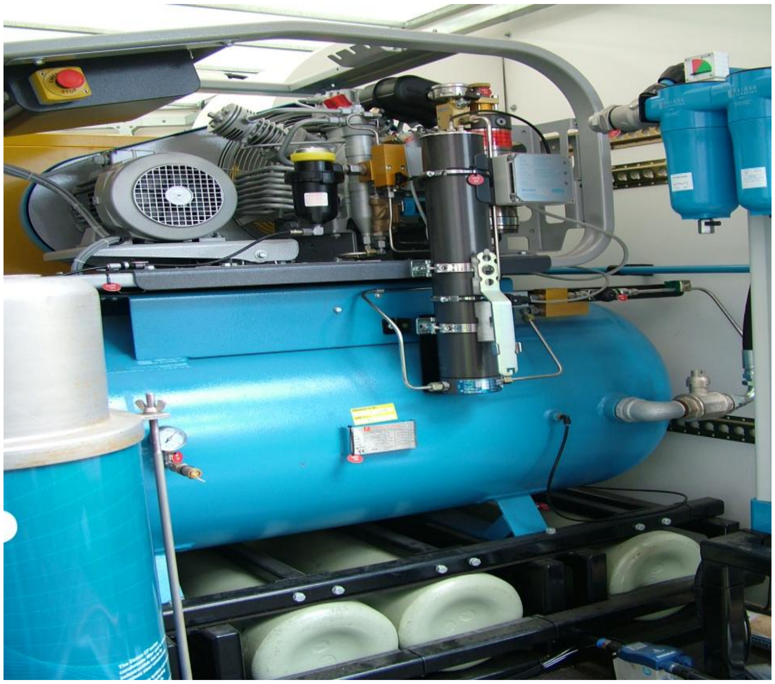


Figure 3: Free Breathing Air System

The ventilation system for the main facility was originally intended to be reused during the early stages of the decommissioning although plans had been made to install a replacement system during the final stages of the decommissioning works. However it became apparent that the requirement for the extract system to provide a minimum velocity of airflow (0.7m/sec) across the entry position into the two alpha-contaminated areas could not be met as the building filters were blinding. As a result, the installation of the new ventilation extract system and discharge stack was brought forward allowing the original system to be shut down at an earlier stage in the programme. This separated the now redundant extract filter units and original ventilation stack from the newly-installed working system.

The new extract ventilation system is based upon use of two large capacity, double HEPA-filtered air-movers at each floor level to support the decommissioning operations in the building. At each working position the air-movers are located outside the man-entry position and draw air from within the adjacent active facility through a primary HEPA filter and flexible metal ductwork; the arrangements are shown in Appendix 1. In order to maintain the necessary airflows across the man-entry openings but to provide a balance of within-building air-flows, one air mover discharges to the new ventilation stack whilst the second discharges locally into the building atmosphere via a 'diffuser sock'. This issue will be discussed in more detail later in the context of the work undertaken in the LPSA and UFMA areas. The introduction of Nuvia's ModuCon^{TM} Containment Panels (MCPs) around both facilities will also be described.

Another operation undertaken at this stage concerned removal of the original air-inlet system and plenum. Monitoring showed that this system was not contaminated and could thus be removed routinely using standard equipment and techniques. The system occupied a large ground floor area and several tonnes of exempt steel waste were produced during this operation. The four air-inlet ducts were sealed where they entered into the main part of the building ground floor through two of the separation walls. This removal and the later shut down of the original ventilation system also permitted the adjacent ventilation control room to be cleared and space created for alternative uses. The large area created by removal of the air-inlet plant was subsequently used to store waste drums and handling equipment.

During the course of the preparatory work the opportunity was taken to decommission and remove a number of sections of redundant active drains running in concrete ducts from the outer boundary of the building towards a collection point in the on-site active effluent disposal system. The team had plenty of experience of such operations and many of Nuvia's methods from previous projects were replicated here. Sections of the concrete ducts had their covers removed in turn enclosed within a moveable tented structure. This provided access to lengths of the discharge pipework under carefully controlled conditions. A shallow drip tray was placed below the exposed length to provide a means of retaining any spilt liquid or other debris that might be released from the pipes. Each length of pipework was treated in the same manner by drilling a number of holes at the top surface and filling the interior with expanding foam to seal and encapsulate any contaminated debris or retained liquid. The lengths were then cut with hand held power tools into suitable lengths and disposed of into drums as Low Level Waste (LLW). After appropriate local monitoring, the concrete covers were replaced and the tented enclosure removed. This process proceeded without incident to a successful conclusion and the adoption of a tried-and-tested method for the removals gave confidence that this outcome would be achieved. The empty concrete ducts will be recovered for disposal at the building demolition stage after appropriate monitoring to confirm their radiological condition.

4.2 DECOMMISSIONING OPERATIONS STAGE 2

4.2.1 Lower Pressurised Suit Area (LPSA)

A plan of the ground floor of the facility is shown in Figure 4. The LPSA is a centrally located containment servicing the glove boxes and initial work in this area required the adoption of pressurised breathing air-suited (PBASO) operations. The objective for this area is to reduce the radiological hazard through decommissioning the five hot-boxes to permit the adoption of less onerous respirator-based man-entry operations. This whole area was originally contained within a steel clad enclosure mounted from a steel framework with a number of roof penetrations through which ventilation ducting passed. This enclosure was originally entered from the external corridor through a 3m x 1m tunnel about 3.5m long made from stainless steel. A specially designed entry position was created into the LPSA using this tunnel through an approximately 1m x 2m opening from the external corridor using ModuCon™ panels, Appendix 1a. This view also shows the close proximity of the two air-mover units to the entry position and the pipework locations both inside and outside the working area. The exterior sections of the hot-boxes within Lab 1 were also enclosed within more MCP sections to allow these units to be completely removed from inside the LPSA facility. Operatives wearing airline fed suits made entries into and out of this area using well-established techniques designed to minimise the risk of cross contamination. The airline fed suits were covered with disposable 'crash suits' that can be cut away and disposed of before the operatives prepare for monitoring out of the controlled area.

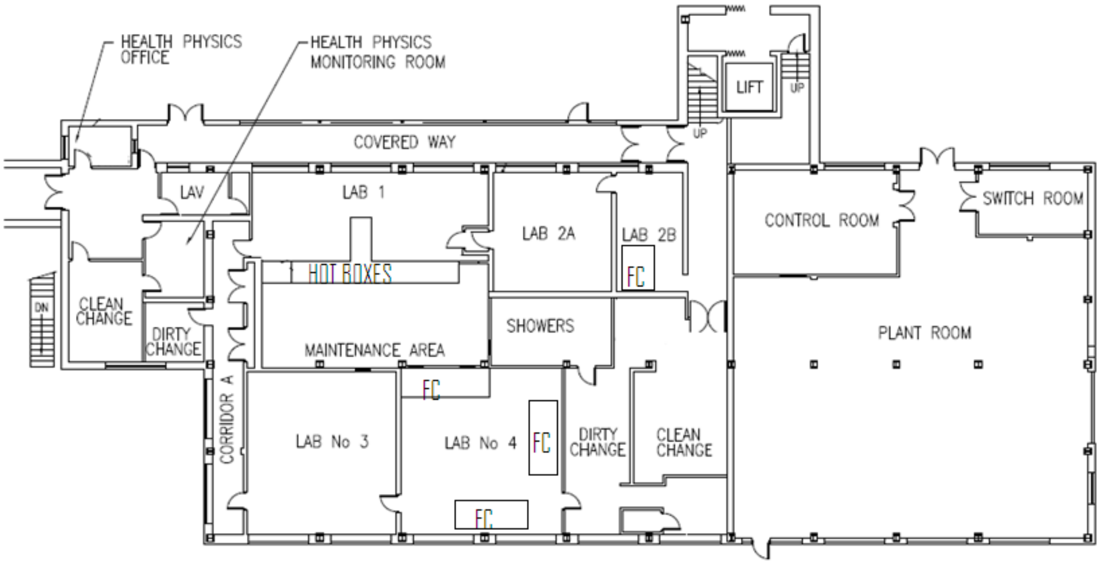


Figure 4: A Plan of the Ground Floor of the Research Facility

This technique provides for the 'swabbing' of the airline fed suits and radiological checks made on these items to demonstrate the absence of surface contamination. Dry swabs were used here owing to the preponderance of alpha-emitting contamination.

Inside the LPSA the hot-boxes were each cleared of any residual items, partially decontaminated and then size-reduced using standard hand-held power tools. Due to the levels of alpha contamination the waste generated during the initial stages of the work was predominantly Intermediate Level Waste (ILW) and was drummed as such. This required a significant level of size reduction to be undertaken to minimise the volume generated. All waste was posted out of the area using a dedicated port provided within the MCP structure using standard 'bagging-out' techniques. These operations included the removal of the steel support structure used for each box. Once removed, the linoleum floor covering was lifted and removed to expose a contaminated 60mm thick concrete screed laid on top of the base of the steel sheeted enclosure surrounding the whole LPSA area. The floor screed was then removed and the steel surface painted to contain any residual contamination until later in the project. About 20 x 200 litre drums of low level waste were recovered from the floor and these materials, after bagging, are to be transferred into a half-height ISO container for disposal along with other debris. Removal of the steel roof, side and base sheets of this enclosure was undertaken with operatives wearing powered respirators since the levels of airborne contamination throughout the area had been sufficiently reduced to permit this change in respiratory protection equipment (RPE). The dismantling process proceeded to a conclusion with the removal of the steel supporting framework including the floor. This latter part of the structure had been secured to the concrete base of the building and was supported above it by shallow steel frames. Removal of the stainless steel access tunnel followed and is almost complete. This has revealed the presence of a concrete lined sump to one side about 1m deep which originally held pumps used with the original adjacent showering facility. Almost all of the waste materials have been disposed of as wrapped packages of LLW.

Outside the main LPSA containment there were three fume cupboards located within Lab 4. These units were not connected directly into the LPSA area and the extract ventilation was effected through separate ducting leading to the UFMA facility on the first floor. Since the levels of contamination were much lower in these units they were first enclosed by a number of MCP panels with man-access through one panel by operatives wearing powered respirators. This allowed these three units to be cleared and size-reduced for disposal into drums as LLW. Afterwards the floor and external surfaces of the LPSA were monitored for contamination and the MCP panels replaced to provide an external containment for the original LPSA structure.

4.2.2 Upper Filter Maintenance Area (UFMA)

A diagram of the first floor of the facility is shown in Figure 5. Once the new HEPA-filtered ventilation system and stack had been installed and commissioned a new man-entry point was constructed close to the top of the stairwell ahead of the original entry tunnel using more MCP panels as shown in Appendix 1b.

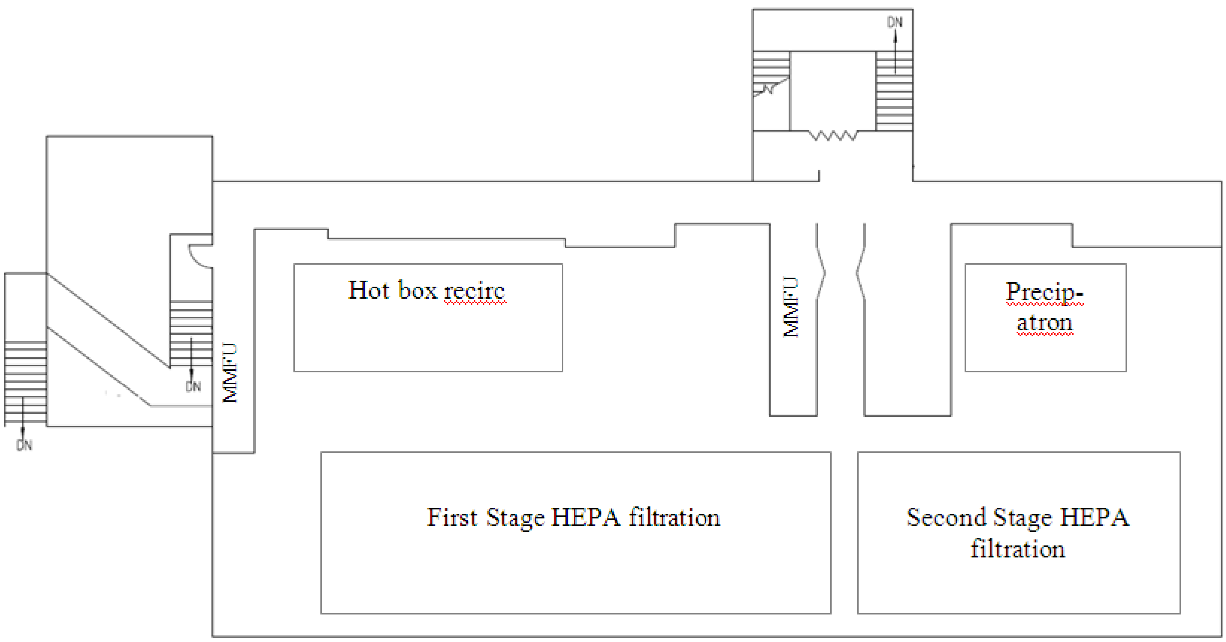


Figure 5: A Plan of the First Floor of the Research Facility

Appendix 1b shows the two HEPA-filtered air-movers to be widely separated in this case owing to the very restricted space at the top of the stairway and access position. Additional MCP panels were used to provide power supply inlets, HEPA-filtered air inlets and a drum bagging out facility for waste.

At this point in the programme it was possible for operatives to undertake the strip-out work using respirators and disposable 'crash suits' rather than airline-fed suits. The phasing of the work to deliver this outcome formed part of the original strategy for the decommissioning. A picture of the general scene of the extract filter strip-out is shown in Figure 6.

Figure 6: A View of the UFMA Extract Filter Bank during Strip-Out

Work in this area required the removal, size reduction and packaging of 164 filter assemblies, associated ductwork, services, support structure and access staging. These operations have now been completed except for removal of a few sections of heavy steel support structure. The extract filter units were removed in record time by separating them at the mounting and support plate positions and bagging them up for disposal as LLW. The 84 Stage 1 primary filter units were a slightly different construction to the 64 Stage 2 secondary filters but the methodology applied was common to both sets.

Considerable care has been taken during the removal phase of the support structure and access platforms to try to maximize the potential for 'exempt' disposal of these structural components. Components which had their original paint were thoroughly decontaminated with a household cleaning agent (Cillit Bang) and this allowed 4200Kg of metal to be disposed of as exempt waste.

The application of an ALARA tie-down coating [3] to surfaces is routinely utilised to ensure that any contamination is contained within the working locality. This coating is a water-based, strippable adhesive that can be used on steel, aluminium and other metal or painted surfaces. It is best applied thinly by airless-spray and dries within 24 hours of application. All lengths of ventilation ducting have been accessed after removal of the filter assemblies and cut away using hand tools after spraying with a tie-down coating. As before, the recovered materials were size reduced during removal to assist with waste volume minimisation.

As a separate operation, the opportunity was also taken to remove the extract fan motors which were mounted outside of the UFMA enclosure using standard conditions and methods. Many of these items were identified as further candidates for 'exempt' disposal and in a later section this issue will be discussed further.

After passing through the primary filters, the extract air was directed to an electrostatic 'Precipitron' unit and then out to the secondary filters and on to the discharge stack. There was also a bypass available to isolate the 'Precipitron' when required. The removal of the 'Precipitron' (Figure 7) was originally thought likely to be undertaken under PBASO conditions due to its size, operational intent and uncertain internal condition. However, recent monitoring has shown very low levels of internal contamination such that powered respirators could be used instead. The commercially-sourced 'Precipitron' operated by electrostatic attraction of particulates in the extract air to a wire network within its body. The interior can, when required, be flushed with water to remove the particulates through an opening in its base that discharges to the site effluent system. The unit is then dried out by heating with steam passed through external pipes fed from site services through locally lagged pipes. Some of the lagging, which had been painted to seal it, was seen to be damaged and tests showed the presence of asbestos fibres. A specialist asbestos contractor was utilised to remove the lagging on the former steam pipes such that the decommissioning of the 'Precipitron' could then proceed. The dismantling of the 3m tall 'Precipitron' has just commenced and will be carefully size reduced for disposal using hand tools. Care will be taken when exposing the drain as this location may be holding a quantity of residual alpha contaminated debris.

Figure 7: A View of the Precipatron Unit before Strip-Out

There was a separate stand alone recirculation filtration system for the hot boxes which was highly contaminated and was decommissioned in PBASO within a tented enclosure the waste from this operation was sentenced as ILW and LLW SCO2.

Within the confines of the UFMA there were also 14 'Torpedo Filters', forming legacy waste that needed to be removed for disposal. Each filter was about 0.3m in diameter and 1.3m long. The filter medium was asbestos and each unit was internally contaminated by alpha-emitting isotopes. Careful monitoring of these units established that 11 of them were suitable for disposal as LLW. These were carefully wrapped, removed from the area and placed directly into an ISO container. For disposal of the remainder as Intermediate Level Waste (ILW), it was necessary to cut them into two sections to enable them to be placed into a 200 litre waste drum. The key challenge here was to stabilize the internal contents of the filters such that they could be safely sectioned for disposal. The technique adopted was to pour a fluid epoxy resin into the filter body such that the internal contents were stabilized to enable the sectioning to be undertaken without spreading any contamination. This is a technique used by AWE and shared with Nuvia as part of the one team approach. This procedure worked well and the six sections was disposed of as planned into a number of 200 litre drums, each supplied with a PVC container and special lid.

Figure 8: Legacy Torpedo Filters

Work in the UFMA has now reached an advanced stage with only the 'Precipitron' and a stainless steel entry tunnel, like that in the LPSA below, to cut be away and removed. Once this has been completed the internal surfaces of the whole area will be painted with ALARA strippable coating and the material allowed to dry. These coats will then be removed and the exposed surfaces monitored for residual activity. If necessary this process can be repeated until free breathing conditions are established throughout.

4.2.3 General Area Decommissioning

As the upper and lower floor areas become cleared of the various items of contaminated equipment and services it becomes possible to commence the removal of redundant services within the general work areas outside the LPSA and UFMA. In time the modular panels used to surround the originally contaminated areas on both floors will be removed and the access barriers gradually moved inwards as monitoring confirms that the newly exposed surfaces are not contaminated. In time free breathing conditions will be established throughout both floors, allowing all surfaces to be monitored ahead of any sampling and demolition planning. This will mainly concern the original research facility but other areas such as the adjacent workshop, office accommodation and materials store together with the original stack, access staircase and goods lift will be included in a controlled and orderly manner. The issues concerning the sampling and monitoring of all the facilities that have been decommissioned ahead of demolition and disposal of the debris are considered in a DQO study [2] discussed later.

4.2.4 Waste Handling & Monitoring

The contaminated waste produced from the decommissioning operations falls into the two main radiological waste categories LLW and ILW. The ILW is sentenced mainly due to the presence of high active alpha particulate debris and the ILW containers (200 litre drums) are configured differently to those used for LLW as was described earlier. The waste materials are initially sentenced at source through provenance and probe and surface smear readings. This is then confirmed following analysis by use of the High Resolution Gamma Spectrometry System (HRGS).

During the process of decommissioning the research facility it was clear that mainly surface contaminated items would be experienced together with small quantities of more active debris. Significant quantities of debris have thus been placed into LLW drums depending upon the local levels measured using standard instruments. Supporting this approach has been the dedicated drum gamma scanning facility currently installed within the original control room on the ground floor. This calibrated facility is used to monitor all drummed and packaged waste and to provide a detailed isotopic record of drum or package contents ahead of disposal. The use of high resolution gamma scanning is not common practice on the AWE site for this type of activity and will be described in more detail later.

Figure 9: High Resolution Gamma Spectrometer

In the UK exempt materials currently refer to items with a specific activity below 0.4Bq/g. However, the exemption limit that will be used here is 0.1 Bq/g. This is taken from the limits within the Environmental Permitting Regulations 2010 (EPR '10). Although it is known that the exemption values vary for different radionuclides, a single limit has been chosen for this study. This is based on the most restrictive value within the facility's radionuclide fingerprint. It is however recognised that the limit for one specific alpha emitter is 1 Bq/g, and therefore there is some flexibility here. By working to this level across the facility, we can ensure that the residual risk of exceeding clearance limits is as low as reasonably practicable (ALARP). Further, it is understood that these new exemption limits will not come into effect until October 2011. However, because the wastes resulting from decommissioning/demolition activities will not be disposed of until after this date (potentially in 2012), it has been decided that use of the amended values is most appropriate.

Outside the main building the original vertical steel ventilation stack has been inspected and monitored and found to be uncontaminated. This unit is a 30M tall fully welded construction 13,000Kg unit, which should be capable of disposal as 'exempt'' waste suitable for recycling. It will be hot cut into three roughly 10m long sections and lowered by crane to the ground. Approval for this process, which will replicate one already achieved on the Winfrith Site by Nuvia, has been obtained.

Figure 10: Ventilation Stack

4.3 DECOMMISSIONING STAGE 3 – DQO

As a matter of standard procedure, AWE undertakes a Data Quality Objective (DQO) process to support the release of a former active building or facility for demolition. Nuvia is thus required to undertake this process to support the demolition of the complete research facility. A key feature of the process is the creation of a history file of the operations and preparing a technical report justifying the approach to the monitoring and sampling programme. Nuvia has wide experience of both processes and indeed is recognised as having specialized knowledge and expertise in monitoring techniques. During the various stages of decommissioning, waste materials are routinely monitored and assayed with the HRGS system to a very high standard.

A detailed DQO report has been prepared to cover all required aspects of the building clearance, monitoring and the basis for the sampling matrix developed, [2]. Space does not permit more than a brief description here of the main features of this analysis and outcomes. As noted earlier, the research facility has four key areas which require monitoring and decontamination to an extent commensurate with the nature of the activities carried out in each area. The purpose of this monitoring regime is to confirm that the activity of the bulk material from each area remains below a limit of 0.1 Bq/g. This will ensure that the resultant demolition rubble is exempt from regulatory control and therefore suitable for reuse elsewhere on site, or disposal at an appropriate offsite facility under UK regulations that will come into operation in October 2011.

All major structures such as hot-boxes, fume cupboards, tanks, sinks and drains etc. within these areas will have been removed leaving only the building shell. For this reason, the only surfaces to be sampled include the walls, ceilings, floors, windows and doors. The base slab and surrounding soils/sub-soils will be assessed as part of this study on completion of the removal of the base slab. The total surface area of all the rooms selected for sampling is about 6,000 m^2

This study lists contaminants of concern, (alpha emitting isotopes particularly) and identifies areas of concern such as where spillages have occurred or local monitoring is incomplete. An action level of 0.1Bq/g is set for all the rubble from the demolition, noting that the achieved level target is to be introduced in October 2011 as a result of changes in the UK exempt waste disposal regulations. A null hypothesis is used which makes the assumption that all wastes exceed 0.1Bq/g and must therefore be shown to be below this action level and not vice versa. Various scenarios are also explored to cover issues such as the consequences of any false claim that the building is uncontaminated due to incorrect or poor quality monitoring and sampling of the structure. The number of samples required is also determined to include a statistical variation limit for the results and a well defined sampling matrix.

Numerous performance parameters (such as standard deviation, confidence limits and willingness to falsely accept or reject the null hypothesis) were derived through review of historical information, collection of preliminary data and close liaison with both former and current facility staff. These parameters were used in the derivation of a statistically robust sampling plan that recommends a total of 33 samples is required to be able to confidently determine whether the average residual activity of the bulk material of the building is above or below the specified action level.

5. WASTE MONITORING FOR DISPOSAL

High Resolution Gamma Scanning

A major objective for the decommissioning teams was to reduce the amount of ILW generated throughout the project, taking into account that much of the contamination comprised alpha-emitters. This effectively ruled out the use of neutron measurement techniques since the sensitivity is insufficient for any waste to be designated as LLW by the client.

Using High Resolution Gamma Spectrometry (HRGS) it is possible to detect the 59.5 keV emissions from ^{241}Am. This is a relatively low energy emission which is easily attenuated by the waste matrix. The overall process required a system capable of providing the activity of ^{241}Am with an associated realistic uncertainty and a low enough Minimum Detectable Activity (MDA). The measured value or MDA plus the uncertainty can be used to provide an upper estimate of the ^{241}Am activity at the 95% confidence threshold. This can then be combined with the nuclide fingerprint to generate an upper 95% confidence value for the total activity.

Establishing the nuclide fingerprint was an early activity within the programme and involved the taking of samples from a variety of materials and locations. One of the issues in this campaign was to provide sufficient activity for analysis as this facility had already undergone significant Post Operative Clean Out (POCO). Although an issue for nuclide fingerprinting, this actually assisted in the calibration of the HRGS as there were few centres of extreme activity accumulation. This meant that it was unlikely that there would be extreme localisation of activity within waste drums / packages. Nevertheless the calibration had to take into account the potential for non-uniform activity distribution within the package. The type of waste package most commonly used was the client's LLW drum (approximately 200 litre capacity).

The HRGS employed was a Canberra BEGe 2825 mounted on a 'Big MAC' cryostat. The calibration was undertaken using Canberra's ISOCS modelling code including the ISOCS Uncertainty Estimator (IUE). Using this code it is possible to generate a calibration that takes into account the size of the drum, the degree of fill, activity distribution, waste materials, and waste density. In practice, for a commercial decommissioning project, the activity distribution is not precisely known; however it is possible to run many models with varying activity distributions and see the effect this has not just on the computed efficiency, but the variation of computed efficiencies i.e. the uncertainty. This combined with variations in drum dimensions, degree of fill, waste materials, measurement position, bulk density, and counting statistics enable the derivation of a Total Measurement Uncertainty (TMU). It is this TMU that is used to generate the upper estimates of activity. The MDA for a 15 minute count where the detector is positioned 50cm from the drum and the drum is continuously rotating at 1rpm was 7 Bq/g total activity. The system was calibrated in a similar manner for varying drum types as well as 'flat pack' packages within limitations determined by the detectability of ^{241}Am emissions.

6. LESSONS LEARNT

At the commencement of the decommissioning the drums of waste were gamma scanned on the ground floor in Lab 2b and then removed from the building on one side using a UNIC crane. Then a trolley was used to move it around the building to another area for holding and disposal by AWE. This process was very cumbersome and time consuming and later a process flow review was undertaken, and a new lean process proposed and agreed, that with a new opening cut through an adjacent internal wall, drums could quickly be transferred to the former control room adjacent to the now cleared plenum area. This revision, which included relocation of the drum scanning unit, might have been introduced at an earlier stage so that the impact upon the programme could have been reduced.

The late detection of asbestos in the UFMA area was an unwelcome development and, as might be expected, caused some unplanned delays to the programme. In all older facilities where any form of steam heating has been used it is important to look for evidence and expect the presence of asbestos since this was in common use until relatively recent times. In the event the presence was quickly recognised and suitably qualified specialists employed to undertake its stabilisation and removal.

The introduction and use of modular containment panels throughout the facility during this work greatly assisted with the control of contamination. There were almost no examples of activity being detected outside of the working area and the flexibility of these units greatly assisted with making progress with the decommissioning. Such panels are to be recommended to others involved in similar operations. In a similar vein, the introduction of modern HEPA filtered air-movers in place of the obsolete ventilation system and discharge stack greatly streamlined the ability to progress with reducing the building hazards such that respirators could be used in place of full airline fed suit operations.

Following on from a trail in another AWE facility, the use of household cleaning products was trialed in this facility to investigate their potential to reduce the waste category. This process was successful with levels being reduced from several hundred counts per second, down to single figure levels with one cleaning cycle/treatment. Following on from this good work AWE are currently implementing new waste arrangements in decommissioning to place greater emphasis on decontamination of decommissioning wastes. These processes should lead to a reduction in the levels of LLW generated.

As part of the One Team approach a number of Review Learn and Improve sessions have been held over the project duration. This included edge protection trails, resin filling torpedo cutting trails and the Breathing Air installation.

Finally, the creation of an integrated co-operative working environment between the client and contractor (One Team) has seen the project set high safety standards and has resulted in a first-rate safety performance. There have been no lost time accidents or OSHA reportable events in two and a half years of work. The value of a One Team approach to the project cannot be over emphasised and is commended to others engaged in similar operations. One Team, One Goal.

7. CONCLUSIONS

- A new mobile free-breathing air unit has been supplied and installed outside the former research building to support airline fed suit entries into alpha contaminated areas.
- All the hot-boxes and fume cupboards in the LPSA have been removed and size reduced for disposal
- A total of 164 HEPA filter units have been removed from the UFMA along with all of the ventilation ducting and fan motors.
- Some exempt waste has been identified but the vast majority of the waste is LLW and has been placed into 200 litre drums for disposal or packed and loaded to a Half Height ISO. If treatment of wastes had been introduced earlier the level of LLW may have been reduced.
- A total of 11 'Torpedo' filters, part of legacy wastes in the building have been sealed and have been placed into an ISO container for disposal as LLW. Three further units have been stabilised with epoxy resin, sectioned and placed for disposal as ILW in specially prepared 200 litre drums.
- A dedicated high resolution gamma scanning unit has been used to monitor wastes in drums and as wrapped packages ahead of their disposal.
- The final stages of the building decommissioning are in sight and, after careful monitoring and sampling of internal surfaces, the demolition phase will shortly follow.

8. REFERENCES

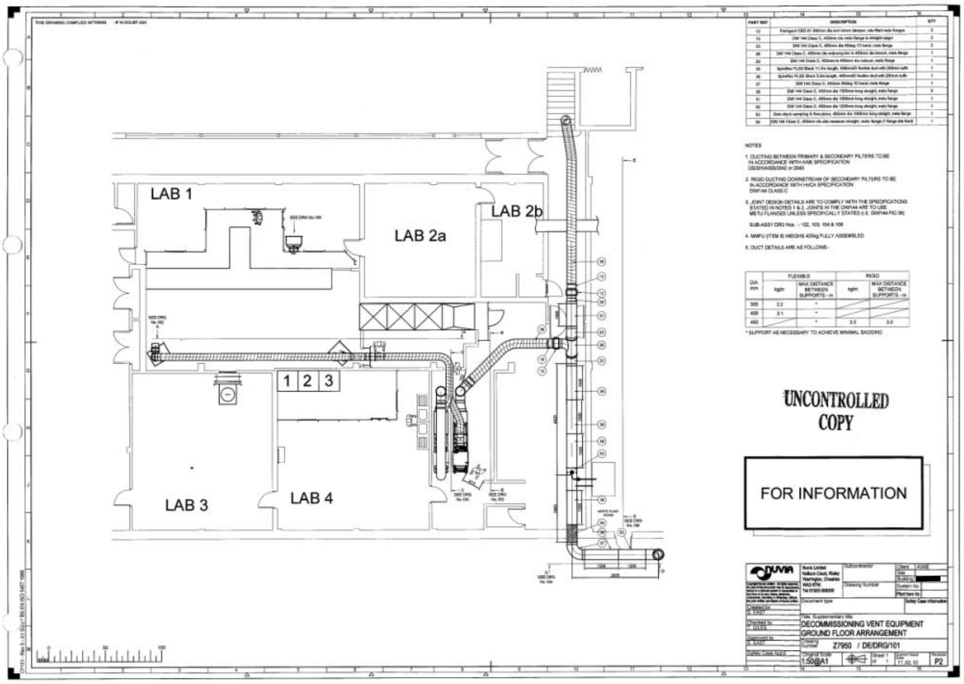
[1] Miller, K.D., Cornell, R.M., Parkinson, S.J., McIntyre, K and Staples, A. Decommissioning of the Secondary Containment of the Steam Generating Heavy water

Reactor at UKAEA Winfrith, Proceedings of the Waste management WM'07 Conference, Tucson, Arizona, USA, March 2007.

[2] Data Quality Objectives Summary Report for Research Facility at AWE Aldermaston: Decommissioning and Demolition Project. Nuvia Internal Report, Z7950/DE/TR/020 Issue B, V Nesbitt, March 2011

[3] ALARA 1146: Carboline Product Data Sheet, Carboline Inc, St Louis, Missouri, USA.

APPENDIX 1a: VENTILATION LAYOUT FOR LPSA AREA



APPENDIX 1b: VENTILATION LAYOUT FOR UFMA AREA