Decommissioning at AWE

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ABSTRACT

AWE (A) has been at the heart of the UK Nuclear deterrent since it was established in the early 1950's. It is a nuclear licensed site and is governed by the United Kingdoms Nuclear Installation Inspectorate (NII).

AWE plc on behalf of the Ministry of Defence (MOD) manages the AWE (A) site and all undertakings including decommissioning. Therefore under NII license condition 35 "Decommissioning", AWE plc is accountable to make and implement adequate arrangements for the decommissioning of any plant or process, which may affect safety.

The majority of decommissioning projects currently being undertaken are to do with Hazard category 3, 4 or 5 facilities, systems or plant that have reached the end of their operational span and have undergone Post-Operational Clean-Out (POCO). They were either built for the production of fissile components, for supporting the early reactor fuels programmes or for processing facility waste arisings. They either contain redundant contaminated gloveboxes associated process areas, process plant or systems or a combination of all. In parallel with decommissioning project AWE (A) are undertaking investigation into new technologies to aid decommissioning projects; to remove the operative from hands on operations; to develop and implement modifications to existing process and techniques used.

AWE (A) is currently going thorough a sustained phase of upgrading its facilities to enhance its scientific capability, with older facilities, systems and plant being replaced, making decommissioning a growth area. It is therefore important to the company to reduce these hazards progressively and safety over the coming years, making decommissioning an important feature of the overall legacy management aspects of AWE plc's business.

This paper outlines the current undertakings and progress of Nuclear decommissioning on the AWE (A) site

1. INTRODUCTION

1. AWE (A) has been at the heart of the UK Nuclear deterrent since it was established in the early 1950's. It is a nuclear licensed site and is governed by the United Kingdoms Nuclear Installation Inspectorate (NII).

2. AWE plc on behalf of the Ministry of Defence (MOD) manages the AWE (A) site and all undertakings including decommissioning. Therefore under NII license condition 35 "Decommissioning", AWE plc is accountable for making and implementing adequate arrangements for the decommissioning of any plant or process, which may affect safety.

3. Decommissioning is the process through which a nuclear facility, system or plant is taken out of service. It can be defined as:

   "Demonstration that redundant facilities or systems have been taken out of operation and decommissioned, taking due account of and ensuring programmes are under pinned by clear, consistent and practicable strategies for the safe, efficient and effective decommissioning management of those redundant facilities or systems".

4. AWE (A) is currently undertaking a facilities upgrading programme to enhance its scientific capability, with older facilities, systems and plant being replaced, making decommissioning a growth area. It is therefore important that the company reduce these hazards progressively and safely over the coming years, making decommissioning an important feature of the overall legacy management aspects of AWE plc's business.

5. The company achieves this hazard reduction across the AWE site through its Decommissioning Group (Nuclear) which forms part of the Environmental Programme Group (EPG) within Infrastructure Directorate (DI).

6. This paper outlines the current undertakings and position of Nuclear decommissioning on the AWE (A) site

2. STAKEHOLDER REQUIREMENTS

2.1 Government Policy

7. AWE's approach to decommissioning is defined and supported by relevant government statements of United Kingdom National policy. In particular the White Paper "Review of Radioactive Waste Management Policy - Final Conclusions" (Command 2919) and the paper 'Decommissioning of the UK Nuclear Industry's Facilities. The command 2919 update sets out the principles intended to guide the strategy for the decommissioning of nuclear facilities.

8. Decommissioning operations at AWE are also subject to the provisions of the Health and Safety at Work Act (HSWA), Nuclear Installations Act (NIA), the Radioactive Substances Act (RSA), Ionising Radiation Regulations (IRR), Environmental Protection Act (EPA) and the Construction (Design and Management) Regulations (CDM).

2.2 Regulatory Requirements

9. Decommissioning is regulated by the NII, who provide the general safety requirements to deal with the risks on a nuclear site and these are shown in the conditions attached to the site licence.

10. The Company is required to comply with all 36 Licence Conditions. AWE achieves this through the application of its Company Safety Management System. There are specific Company Safety Instructions (CSI's) and Company Safety Procedures (CSP's) specific to decommissioning which define the necessary requirements to ensure that the Company is compliant with Licence Condition 35 (LC35), Decommissioning. The purpose of this Condition is for the licensee (AWE) to make adequate provisions for decommissioning in terms of programmes and plans for ongoing and future decommissioning, plus the longer term view required decommissioning the site ready for closure.

11. LC35 also gives the NII power to direct the decommissioning of any plant or process to commence or stop. The accountability for ensuring that the Company complies with each section of LC35 lies with the Head of EPG, with delegated responsibilities given to the Manager, Decommissioning Group and the relevant Decommissioning Facility Manager.

12. The Environment Agency (EA) regulates with regard to environmental issues. The main requirement for decommissioning operations being compliance with the Radioactive Substances Act and the Environment Protection Act.

2.3 MOD Requirement

13. AWE Aldermaston is a UK Government Owned Contractor Operated (GOCO) site; the UK Ministry of Defence (MoD) are the owners of the site and they have contracted AWE ML to manage and operate the site. Part of this contract requires AWE ML to decommission redundant radioactive facilities to a programme agreed by the MoD and, where appropriate, the UK Nuclear Regulator (the Nuclear Installations Inspectorate – NII).

14. The strategy, policy and priority for decommissioning redundant radioactive facilities are described in section 3 and also in several AWE ML documents agreed by the MoD. Using these documents the MoD Decommissioning Technical Sponsor works closely with the contractor assessing and agreeing the short, medium and long term programmes and plans put forward by them for decommissioning; this results in a yearly incentivised management fee for decommissioning activities based on performance against set deliverables (short term), a 10 year decommissioning plan (medium term) and a plan which

encompasses all known radioactive facilities that will eventually need to be decommissioned (long term).

15. Openness and the sharing of information from both the MoD and the contractor has resulted in the development of a good working relationship and this has led to objectives on both sides (both shared and individually owned) being achieved. Continued openness and sharing of information is regarded as key to the future success of short, medium and long term programmes and plans to ensure that they are carried out safely and cost effectively.

16. The MoD also encourages participation of its decommissioning technical sponsor and contractor in national and international forums where they can keep up to date with developments in the decommissioning arena as well as sharing their own experiences with others

2.4 Public Expectations

17. AWE places a great deal of emphasis on being a good neighbour, demonstrating the ability of the site to function in a safe manner to the people living close to the sites. For this reason, an 'open door' information policy has been adopted to provide authorities and members of the local community with details on AWE activities whenever security considerations allow. AWE publishes an annual report and detailed technical data on every aspect of safety and environmental performance. Additionally, there is an AWE website to provide information to the public.

18. It is in everyone’s best interests to have an open and honest approach concerning communications between the local communities and local authorities. AWE are committed and to this and actively encourage dialogue and interaction within the local community. AWE is one of the major employers in the local area and makes a significant contribution to the local economy.

3. DECOMMISSIONING

3.1 General

19. AWE is a nuclear licensed site and as such the work undertaken must comply with the requirements of the 36 Nuclear Site License Conditions.

20. LC 35 Decommissioning is the most relevant for Decommissioning Group and to facilitate compliance with this licence condition, AWE has a Company Safety Instruction (CSI 1535) which set out the top tier arrangements in place to demonstrate compliance. It identifies the responsibilities the Company places on individual post holders to implement the arrangements and refers out to other relevant documents.

21. Currently the Decommissioning Group (Nuclear) is involved with a number of decommissioning projects across the AWE site. The majority of the projects undertaken are Hazard category 3 - 5 facilities, systems or plants which have

the potential for on site / off-site release. Operations in most of the facilities ceased in the 1980's and 1990's, all of them contain various combinations of redundant contaminated gloveboxes, process areas and engineering services /plant systems.

22. The safety record to date is very good and there has not been a lost time accident in the over 1 million hours worked. Team work is actively encouraged as is a rigorous approval process all of which contribute to an excellent safety culture and safety record.

3.2 Decommissioning Strategy

23. AWE's decommissioning strategy is determined by consideration of 'health and safety', business and environment parameters. It forms part of a hierarchical process that describes AWE's general and specific plans for decommissioning. The requirement is to decommission and dispose of redundant facilities, system or plant to defined radiological and engineering endpoints, in a safe and cost effective manner, for which no future use is foreseen, as soon as is practicable subject to safety and cost effectiveness

24. The strategy chosen will demonstrate that the decommissioning approach is underpinned by clear, consistent and practicable methods that safe guard the workforce, adjacent areas and the environment.

25. In order to achieve this decommissioning is undertaken in 5 defined phases and follows the principles of progressively and systematically reducing the Hazard (radiological and other conventional hazards) from the facilities, systems or plant, whilst protecting people and the environment. These phases can overlap or run in parallel on larger decommissioning projects.

26. The 5 Phases of decommissioning are defined as

- **Phase 1: Post-Operational Clean-Out**;

  POCO is normally carried out as soon as practicable, usually immediately following the end of a facility's operational life. POCO involves the physical removal of reasonably accessible, radioactive and toxic materials and liquors based on an ALARP risk assessment. The amount of effort required will depend upon the type of work performed, the materials and processes involved and the programme requirements for decommissioning. The assessment of requirements for an effective POCO regime will be judged against the net gain in terms of risk reduction, future programme efficiency and cost effectiveness.

- **Phase 2: Post-Operational Care and Surveillance**;

  The objective of C&S is to maintain the facility in a safe condition during any deferral period. This requires that a planned regime of inspections, maintenance and housekeeping is carried out.

- **Phase 3: Disassembly and Removal of Contaminated Plant, Equipment and Structures (Planning, Pre-Works and Operations);**

  Dismantling may be conducted in several stages and includes:

a) Preparation of the detailed Decommissioning Plan containing work packages, method statements, safety case, estimates of waste arisings and resource requirements.
b) Implementation of any required preparatory work such as erection of modular containment systems, change barriers, upgrade of ventilation and electrical systems and the establishment of waste transfer routes.
c) Removal of all contaminated materials, plant, equipment etc. to the agreed radiological and engineering end points.
d) Decontamination of the building structures to allow for conventional demolition and material 'sampling and analysis' to confirm that the required level of decontamination has been achieved.

- **Phase 4: Building Care and Maintenance**;

  The objective of C&M is to maintain the building structure in a safe condition during the deferral period. This requires that a planned regime of inspections, maintenance and housekeeping be carried out.

- **Phase 5: Building Demolition**

  Building demolition is ideally undertaken using conventional demolition methods. However, as the demolition proceeds it will be necessary to conduct a regime of sampling and analysis on the demolished building rubble, etc to assess the available disposal routes. The vast majority is usually suitable for re-use or land burial but if any material is found to above the level of 'below UK regulatory concern' it will have to be disposed of in accordance with the requirements for the particular radioactive waste category.

3.3 Aims, Drivers and Objectives

27. The overall aim of Decommissioning is to achieve facilities for refurbishment and re-use as nuclear facilities where practicable or where required for site development purposes the generation of brown field site suitable for re-development .The following drivers are listed below:

- Safety - The facilities, plant and systems contain radioactive and toxic contaminants. They fall below modern standards of construction for radioactive facilities. Safety to the public and workers will be better assured once decommissioning is undertaken.
- Technical – If the facilities, plant and system are not decommissioned and dismantled, ongoing Care and Surveillance will still need to be provided resulting in the existing plant, equipment and building fabric deteriorating and further risking breakdown in primary containment systems. Likewise, waste generation will continue until such time as it is decommissioned.

- Financial – The building and support structures will continue to incur maintenance and running costs (i.e. heating, maintenance etc).In some instance (Category 5 facilities) this can be expensive with significant sums of money involved. This overall expenditure will reduce as the facilities, plant and system is decommissioned.

- Environmental - The AWE Site Development Strategy Plan details a strategy to improve the appearance of the site through investment and redevelopment, to create a more attractive place to work in and lessen the physical impact on the local area. The majority of the facilities being decommissioned are over 50 years old, unpleasant to work in and are aesthetically damaging to the image of the AWE site. Left untouched, it does little to support the Company's vision of the future.

28. The overall objectives of the group being
    - to reduce the overall environmental impact and achieve where appropriate a brown field site suitable for re-development.
    - to safely decommission redundant nuclear facilities, systems and plant to agreed cost and timescale. Ensuring safety of site personnel and the general public
    - to meet regulator requirements along with the stakeholders expectations
    - to minimising waste from decommissioning operations through the use and development of appropriate techniques and studies
    - to develop long term effective strategies and accurate estimates for cost effective and safe decommissioning across the AWE site
    - to investigate alternative technologies and promote innovation to aid decommissioning
    - to identify, train and maintain skill levels required to undertake the various decommissioning tasks

3.4 Decommissioning process

29. Detailed planning begins when a decision has been taken to proceed with the project. Decommissioning operations require formal Company approval and can require endorsement from the HSE-NII. This regulatory approval is obtained on the basis of a robust Decommissioning Plan (DP) and Decommissioning Safety Case (DSC). The level of detail contained in the DP and DSC for a specific facility is commensurate with the complexity of the work and the hazard presented

30. The DP's and DSC's are important components in meeting the requirements of the NII, in particular Licence Condition 35. Separate documentation will normally be produced to address final demolition (Phase 5 of decommissioning) as this may be carried out as a separate project

31. A DP is produced for each facility and contains the decommissioning strategy for the Project. The DP will normally separate the decommissioning of the

facility into a number of discrete stages, each of which may require separate internal approval as well as possible endorsement by the NII. After each stage, technical "lessons learnt" are incorporated into the next package of work. The DSC addresses the overall safe operating envelope.

32. For the decommissioning of large complex, high hazard facilities, AWE manages and leads the operations using a combination of AWE staff and contracted in, non-AWE staffs, which are integrated into the decommissioning project teams under the management of AWE. When a decommissioning project or task is deemed to be less hazardous, either because the facility presents a low hazard or because the source of any significant hazard has been removed by previous decommissioning, the work can be carried out by AWE-approved contractor organisations. The contractor organisation is selected following a competitive tendering exercise. However, in all circumstances, AWE retains overall control of the project, facility management and responsibility for project safety.

33. The decommissioning of high hazard equipment, such as contaminated gloveboxes, is carried out within an engineered containment system with operators using hands-on size reduction techniques and wearing appropriate levels of protective equipment, up to and including Pressurised Breathing Air Suit's (PBAS).

34. Decommissioning operations have the potential for producing an impact on the environment. Radioactive and toxic wastes are produced that require treatment and disposal. For aerial discharges each facility has to comply with the discharge authorisation(s) set by the EA. The objective being to minimise all discharges and arisings of solid and aqueous wastes, subject to safety considerations.

35. Intermediate Level Waste (ILW) is size reduced and packaged into 200-litre drums for collection by Waste Management Operations and onward transfer to the ILW stores complex.

36. Low Level waste (LLW) is packaged into either 200-litre drums or half-height iso-freight containers dependent on the quantities generated within a particular project. LLW is also collected by Waste Management, who make arrangements for the transfer to the LLW repository.

37. Aqueous / liquid waste is usually stored and sampled within the facilities pending the RA/Chemical analysis results. Once the analysis results are known, waste is sentenced into an appropriate waste stream or stored waiting the introduction of an appropriate waste stream.

38. AWE keeps at the forefront of decommissioning technology through a series of information exchange agreements and working parties that involve representatives from the USA and the British nuclear industry.

39. Research and Development is also undertaken to enable decommissioning activities to be performed using the latest available technology. Currently, the majority of decommissioning operations are associated with size reducing contaminated plant and equipment which is undertaken using hands-on

techniques by PBASO operatives. The future approach is to minimise the amount of “hands on” operations by the application of technology wherever practicable.

4. DECOMMISSIONING PROJECT

4.1 Decommissioning principles

40. The majority of decommissioning facilities to date were built in the 1950’s when asbestos was a commonly used material. Although some work had been undertaken to replace the asbestos with less hazardous alternatives, much asbestos remains within the plant especially in the less readily accessible areas.

41. At the onset of the decommissioning planning process it is recognised that significant engineering preparatory works can be required to bring the facilities and the building services up to suitable standard for the performance of the work. Typical engineering and building fabric improvements are: -
    - Building fabric Review and Upgrade as required.
    - Electrical Review and Upgrade as required.
    - Building Ventilation System Review and Upgrade as required.
    - Containment & Ventilation Systems Provided for Decommissioning as required.

42. Because of the complexity of some projects the importance of adequate resources at the early planning stage is essential to the future success of the Projects. Significant effort can be expended over a period of 2 –3 years, particularly in the identification and consideration of potential technical/financial risks. This enables robust risk mitigation strategies to be formulated. The early planning phase includes the development and approval of : -
    - Option Studies
    - Decommissioning Strategies
    - Decommissioning Plans
    - Programme and resource profiles
    - Waste estimates
    - Budget estimates

43. Decommissioning facilities have usually undergone numerous changes to plant configuration in their operational phase. Much of this work was well recorded and drawings show the extent of the modifications. Unfortunately there are always modifications carried out within the facilities for which few records were available at the time of its closure. This makes planning and assessment work more difficult and it is always assumed that the drawing could be wrong and follow up checks are needed.

44. Prior to the commencement of any decommissioning operations on gloveboxes, the glove box is subjected to a criticality assessment, review and approval procedure. Each assessment defines the boundaries of the affected area as well as providing details any critical factors that may affect criticality (e.g. "free liquids", oils, water, tie-downs coating (water based) on fissile material. When the assessment and approval process is complete, a Criticality Clearance Certificate (CCC) is issued detailing the conditions to be adhered to and implemented whilst decommissioning that particular glove box.

45. To date decommission gloveboxes and fume cupboards have been carried out in Modular Containment Systems (MCS) which are built around a group of boxes that are then progressively size reduced. The waste that is generated is carefully monitored before it is placed into 200 litre drums. The fissile content of each filled drum is confirmed before it leaves the facility using appropriate counting techniques. The movement of waste within the facility is carefully managed at all times to void potential criticality issues

46. The regular application of a tie-down coating to the gloveboxes and all newly exposed surfaces greatly reduces the local levels of airborne radioactivity during the size reduction operations.

47. MCS panels and ventilation units are (in most cases) decontaminated and re-used.

48. Up front training and re-evaluation programmes are introduced at the onset of decommissioning and play an essential part in communicating the risks and safety control measures to the operating staff. These measures, combined with the supervisory arrangements operated in the Facility, have meant that no significant incidents or personal injuries have occurred to date

49. Where appropriate, the use of cameras complete with zoom facilities is used to help identify / improve ways of working and enable the inspection of problem areas without the need to expose operators to potential risk.

50. The following paragraphs give an overview of the current decommissioning Projects being undertaken or are about to enter phase 3 decommissioning.

4.2 Research and Development Decommissioning Project

Facility Description

51. This facility was designed to provide AWE with a facility for the R&D of plutonium and its alloys. The building is located within the Nuclear Storage Processing Area (NSPA), and was constructed and commissioned in the late 1950's. Operations ceased in 1978, at which point the facility entered decommissioning.

52. The main building comprises 3 floors with a mezzanine for maintenance and ventilation equipment. The first floor mainly houses office accommodation, stores and toilets. Also located on this floor are fans and filter rooms which are located within the contamination controlled area. The ground floor is occupied by 13 laboratories, Frogman Maintenance Area, change room and plant rooms. The most part of this floor is under contamination control. The basement is mainly a contamination controlled area containing active drains.

53. There are a number of minor buildings associated with this facility. They include the air compressor house, water tank and stack monitoring area, drum stores and an emergency assembly building and a number of supporting cabins

Radioactive Inventory

54. The bulk of the radioactive materials within the facility are Plutonium (Pu) and Uranium with some Beryllium within gloveboxes, fume cupboards or process areas including ventilation plant and effluent pipe work. There were also contaminated chemicals, oils, mercury and lead shielding slabs within the facility

55. The bulk of the estimated total inventory of (non-process) Pu was held up in the various gloveboxes, with the remaining material present as particulate on filters or as deposits within transit tunnels, pipe-work, ducts and drains.

Decommissioning Progress To Date

56. Since the commencement of decommissioning operations all gloveboxes and 87% of fume cupboards have been removed and size-reduced, the remaining fume cupboards now provide space extract to Lab G05. A number of the gloveboxes contained substantial machine tools and equipment. The Lower FMA, which is the only permanent exclusion area, has had all processing equipment removed and size reduced which included a hydraulic press, rolling mill, handling equipment and water tanks with its associated pipework.

"Froggers" at work

57. The focus of current works in the removal of building services. Two sets of lead safes were broken out, packaged and consigned from G02 and G04. These operations were completed, together with the removal a concrete plinth in G01, using the Brokk 40 demolition machine.

Brokk 40 breaking out concrete plinth

58. All accessible drain pipework has been removed from the controlled area basement. High Pressure Extract (HPE) and Cell Extract ductwork, filter banks and fan sets have been removed and size reduced, with only redundant

embedded sections of ductwork remaining. Ceilings have been removed to enable access to embedded services. Filtered extract ductwork has been removed from Labs G01 and G02 back to the filter plant room header. A new temporary leg of ductwork, fed from the filter plant room header, has been installed in G02 to provide space extract for these labs. This process is being repeated in labs G03, G04 and G05.

G01, 2001

Lab 1

59. The amounts of both Intermediate Level (ILW) and Low Level (LLW) Radioactive Wastes that have been generated between 1996 and 2007 has steadily increased as the project has progressed and the actual amounts are broadly in agreement with those predicted at the project-planning phase.

4.3 Fuel Research Decommissioning Project

Facility Description

60. This facility is also located within the Nuclear Storage Processing Area (NSPA) of the Atomic Weapons Establishment Aldermaston (AWE (A)). It is a Hazard Category 5 facility and undertook the manufacture of fuel pellets and fuel elements in support of the UKAEA Fast Reactor programme until the mid-1970s. Subsequently, new glovebox lines were installed for the pyrochemical recovery of plutonium from plutonium residues using a variety of processes. This remained the primary function of the facility during the 1980s and early 1990s. The facility entered decommissioning in 1999 and continues to the present time.

The facility consists of 3 floors, the ground, mezzanine and upper floors. The ground floor contains the main production line a series of laboratories with interconnecting. The Quads contained gloveboxes and was mainly used for wet chemistry, The Horizontal and Vertical suites contained more gloveboxes and were used in the support of the UKAEA Fast Reactor programme. The last major area of the ground floor also housed gloveboxes and was used for the recovery of plutonium from plutonium residues using a variety of processes.

61. The remaining ground floor areas include a change room and barrier, various workshops, offices, ventilation plant rooms, service plant rooms, electrical switch-rooms and stores

62. The mezzanine floor is predominantly duct and service voids, whilst the upper floor is plant rooms and service areas.

63. The decommissioning strategy and plan adopted for this facility was to divide the work into nine packages, given below:
    - Package 1 – Quads A to D and Station 37 & 38
    - Package 2 – Engineering pre-works in support of decommissioning
    - Package 3 – Horizontal and Vertical Suite
    - Package 4 – Removal of legacy fissile material from the safes
    - Package 5 – Unfiltered Extract Plant Room
    - Package 6 – Reprocessing Area (RpA) box line
    - Package 7 – Redundant ventilation, stacks, services and drains
    - Package 8 – Radiological End Point (REP) monitoring
    - Package 9 – Crated Gloveboxes

64. Currently there are 26% of the original gloveboxes remaining.

65. The amount of waste generated has steadily increased as the project has progressed and the actual amounts are broadly in agreement with those predicted at the project-planning phase.

66. Work will continue to size reduce the remaining gloveboxes until the end of 2013. Other operations are scheduled on this basis of the programme established during the planning phase. Currently, the programme end-date is 2017.

Radioactive Inventory

67. The bulk of the radioactive material within the facility is Plutonium (Pu). Uranium and Beryllium may also have been present during the early operations, but the records from the 1950s were unclear on this
    - The Pu inventory within the facility was predicted from a combination of measurements and estimates based upon operating records.

68. The majority of the inventory was located within the various gloveboxes, with the remaining material present as particulate on filters or as deposits within transit tunnels, pipe-work, ducts and drains.

69. AWE has recently agreed with the MOD to decommissioning numerous crated gloveboxes as part of the ILW legacy programme. With the facilities own gloveboxes planned to be completed by 2011 and the crated gloveboxes by 2013. The programme end date has moved to 2017.

Engineering Upgrades

70. Following an engineering review of the facility it was found that the engineered systems and services were not in sufficiently good condition to support the planned decommissioning operations. Therefore in order to meet the requirements of decommissioning it was decided to upgrade the ventilation and electrical systems.

- The ventilation upgrade involved the design; build and commissioning of new dedicated decommissioning ventilation extract system compliant to modern standards. For easy of installation and to maintain certain operations within the facility, the new system was designed to be install as an independent system complete with its own plenum and extract legs.
- The electrical modification involved the introduction of a new switch room and a general re-wire of the facility to accommodate future decommissioning demands
- Conversion of all gloveboxes from nitrogen to air
- Upgrade and replacement of breathing air system, together with the replacement of the breathing air system compressors and receivers
- Design and provision of a Frog Evacuation Assembly building with the potential to accommodate 2 Pressurised Breathing Air Suit (PBAS) operatives and their support teams

Decommissioning Progress to Date

Package 1

71. This package covers the removal of gloveboxes from within the areas of the facility know as the Quads. Decommissioning commenced in 1997 with the award of a fixed price contract to a decommissioning contractor.

72. Initial pre-works were undertaken in Quad A leading to the building of the first MCS around 4 gloveboxes. This MCS was compartmentalized to accommodate each glovebox singularly. This was a requirement of the criticality section until justification could be provided to have more than one glovebox within a single MCS. Size reduction commenced in 1999 with the completion of size reduction operations with MCS decontamination and removal in October 2001. During 2000 the fixed price contract was dissolved with AWE taking responsibility for all decommissioning operations. During decommissioning operation in Quad A, pre work activities were being under taken in Quad B for MCS 2 and MCS 4 and in Quad C for MCS 3. MCS 2 was erected around 1 unique process glovebox. Size reduction was then completed, the MCS decontaminated and removed in November 2000

73. Similarly MCS 3 and MCS 4 were erected and once size reduction was completed, the MCS's were decontaminated and removed in August 2002 and March 2003 respectively.

74. It was then planned that the Hazard Walls between Quads A and B and between C and D would be removed. The Hazard wall was basically a service casing that went from floor to ceiling and was the dividing line between a pair of Quads. It contained all the glovebox services for the gloveboxes within the Quads along with a transfer tunnel located at its base. Removal commenced and was completed between April 2002 and January 2004.

75. Following removal of the hazards walls within the Quads MCS 6 and 9 were erected. Both MCS's included half of the interconnecting transfer tunnel. Size reduction then commenced with completion and MCS decontaminated and removed by April 2007. The removal of theses MCS's then allowed the final gloveboxes in the Quads to be prepared for decommissioning. Pre-works commenced in August 2006 and MCS 12 was erected around the remaining gloveboxes. Size reduction started in May 2007.

Package 2

76. The work within this section is described in the engineering upgrades above.

Package 3

77. With the experience gained from undertaking operations within the Quads it was decided to have another parallel decommissioning operational work front by commencing pre-works activities within the Horizontal and Vertical suites package 3.

78. Initial pre-works were undertaken in May 2002 in the Horizontal suite leading to the building of MCS 5, with size reduction being completed, the MCS decontaminated and removed by September 2003. This allowed enough space to start on the next suite of gloveboxes within the Horizontal suite. Pre-works started in November 2003 allowing MCS8 to be erected. Size reduction of these gloveboxes was completed and the MCS decontaminated and removed by January 2005.

Froggers at work within an MCS

79. Finally within this package pre-works were undertaken and MCS 11 was erected making up the Vertical suite. This MCS was the tallest MCS built on site at over 5 m. Pre-works started in January 2005 with size reduction operations commencing in October 2005. This area is currently delayed due to an operational constraint in June 2006.

Package 4

80. This involves removing the stored material from within the facilities safes, ensuring compliance, re-packing into conforming conditions and forward transfer to AWE main storage facility. This package has been ongoing since 2000 with completion planned for March 2008.

Package 5

81. This is fall back work front and therefore a non-critical task. It covers the removal of the old unfiltered extract duct work and fans, which provided space extract up to 1996. Decommissioning commenced in March 1999 and currently 80 % of the unfiltered extract ducting and fans has been removed, currently held waiting structural assessment of adjoining stacks

Package 6

82. Since the delays on package 2 decommissioning has moved onto the decommissioning of the RPA line. Currently pre-works are being undertaken in preparation of building MCS14. Work front in progress.

Package 7&8

83. No progress to date has been made on these packages

Package 9

84. This covers the decommissioning of crated gloveboxes currently stored on the AWE site. A unique MCS has been designed and erected within the Quads to deal with the crates, incorporating a ventilated airlock / receipt unpacking area and an adjoining size reduction area

85. The first batch of crates was received into the facility in October 2007 with size reduction activities planned to commence in November 2007

Internal view of MCS for crated glovebox size reduction

4.4 Production Decommissioning Project

Facility Description

86. The buildings designated as the facility are located within the NSPA of the Atomic Weapons Establishment Aldermaston (AWE (A)). It is a Hazard Category 5 and formed the principal plutonium fabrication facility at AWE (A). It produced components for service weapons and for trials. Other related activities included the recovery of plutonium from oxide residues and electro-refining of both impure plutonium metals from in-house recycling and the metal recovered from oxide. The facility entered decommissioning in 2000

87. The ground floor contains the Lower Pressurised Suit Area (LPSA) (a Controlled Contamination (Exclusion) Area), the main production line, an electro-reprocessing laboratory and a number of other laboratories and areas containing gloveboxes of varying sizes. A glovebox suite is also located in the LPSA together with the facilities required to maintain these gloveboxes.

88. The remaining areas include a change room and barrier, various workshops, offices, ventilation plant rooms, service plant rooms, electrical switch-rooms, laboratories and stores.

89. The major area of the first floor is taken up by the Upper pressurised Suit Area (UPSA) (a Controlled Contamination (Exclusion) Area); the new ventilation

plant room which houses the various filter banks and the extract fans for the facility, and the extension service void. The extension service void contains a glovebox transfer system inter connecting numerous gloveboxes along with a connection to the LPSA.

90. As is typical for a building this age, changes to plant configuration have occurred over the years. Much of this work was well recorded and drawings show the extent of the modifications. Unfortunately there were a number of modifications carried out within the facility for which few records were available at the time of its closure.

91. In 1997 the facility reached the end of its operational life and it was replaced with a newer building. With no alternative use identified for the facility a decision was made to commence decommissioning, in accordance with the overall AWE Decommissioning Strategy as soon as it was practicably safe to do so.

92. The decommissioning strategy and plan adopted for this facility was to divide the work into nine work stages, given below

- Stage 1 – Lab 1 and 2b
- Stage 2a – Box bay line
- Stage 2b – ER and Assembly labs
- Stage 3 –Line gloveboxes
- Stage 4 – Lower Pressurised suit area
- Stage 5 – Gas plant room
- Stage 6 – Upper Pressurised suit area
- Stage 7 – Transfer tunnel
- Stage 8 – General areas
- Stage 9 – Decontaminate to Limited Structural Access

93. With decommissioning operations progressing within the facility, and the resulting decommissioning of gloveboxes from a number of areas within the facility, currently there are twenty nine of the original sixty nine gloveboxes remaining.

94. The amount of both LL and IL waste generated has steadily increased as the project has progressed and the actual amounts are broadly in agreement with those predicted at the project-planning phase.

95. Work will continue to size reduce the remaining gloveboxes until the end of 2019. Other operations are scheduled on this basis of the programme established during the planning phase. Currently, the programme end-date is 2027.

Radioactive Inventory

96. The bulk of the radioactive material within the facility is Plutonium (Pu). Uranium and Beryllium may also have been present during the early operations, but the records from the 1950s were unclear on this

- The Pu inventory within the facility was predicted from a combination of measurements and estimates based upon operating records.

97. Approximatley 75% of the estimated total inventory of (non-process) Pu was held-up in the various gloveboxes, with the remaining material present as particulate on filters or as deposits within transit tunnels, pipe-work, ducts and drains. This estimate assumed that removal of all process material from the gloveboxes was completed as part of the limited POCO. However there is no estimate of the plutonium held up within the LPSA legacy waste / equipment (excluding the gloveboxes) or for the UPSA within the filter banks.

Engineering Upgrades

98. Following an engineering review of the facility it was found that the engineered systems and services were not in sufficiently good condition to support the planned decommissioning operations. Therefore in order to meet the requirements of decommissioning it was decided to upgrade the ventilation and electrical systems.

- The ventilation upgrade involved the design; build and commissioning of a new ventilation extract system compliant to modern standards. For ease of installation and to maintain certain operations within the facility, the new system was designed to be install behind the existing system.
- The electrical modification involved supplying three new supply cables for the facility; the introduction of 2 new switch rooms and a general re-wire of the facility to accommodate future decommissioning demands
- Conversion of all gloveboxes from nitrogen to air
- Upgrade and replacement of breathing air system, together with the replacement of the breathing air system compressors and receivers
- Design and provision of a Frog Evacuation Assembly building with the potential to accommodate 4 Pressurised Breathing Air Suit (PBAS) operatives and their support teams

99. During the course of this early decommissioning activity the ventilation replacement/upgrade and electrical upgrade projects had been progressing with the completion of the electrical upgrade in February 2002 and the completion of the Ventilation replacement/upgrade project in May 2003. Whilst the decommissioning and upgrade projects had progressed independently there was a period where the decommissioning operations in MCS3 and MCS5, together with the MCS build activities of MCS4 and MCS6 were stopped during the 3 month ventilation replacement/upgrade project commissioning period prior to the formal handover of the system to the Facility in May 2003.

Decommissioning Progress To Date

Stage 1

100. This stage covered the removal of gloveboxes, a transfer tunnel and fume cupboards from three process laboratories

101. Decommissioning commenced in 2000 with pre-works leading to the building of the first MCS within Laboratory 1 East. These gloveboxes were deemed to be the most suitable gloveboxes upon which to start size reduction operations as they contained low hold up and were of a construction similar to previous gloveboxes decommissioned on site. The size reduction operations were duly completed in May 2001 with the decontamination and removal of the MCS. This allowed the commencement of the pre-works leading to the building of MCS 3 in laboratory 1 West around gloveboxes, a transfer tunnel and fume cupboards.

102. With the experience gained from undertaking operations in MCS1 (Lab 1 East) it was decided to increase decommissioning operational work fronts by commencing pre-works activities and MCS build programmes for MCS2 in laboratory 2, covering a glovebox and fume cupboards.

Operational face of MCS 4

Diamond wire machine MCS 4

PBAS size reduction of glovebox and transfer tunnel

103. The size reduction operations for MCS3 (Lab 1 West), and MCS2 (Lab 2b) were subsequently completed, with the removal of the MCS's, in November 2003 and June 2002 respectively. Completion of MCS 2 allowed the commencement of pre-works for the last MCS in Stage 1 MCS 4 around 2 experimental gloveboxes with the start of size reduction operations commencing in April 2005. The first of these gloveboxes was size reduced using conventional cold cutting techniques, however it was decided that once

the superstructure of the second glovebox had been removed that the MCS would be modified to allow the introduction of Diamond Wire Cutting technology to be trailed on the glovebox internal equipment (lathe). The completion of removal of the box superstructure was achieved in October 2006 and works commenced on the pre-works to enable the introduction of the Diamond Wire machine. This was duly completed and diamond wire operations commenced in June 2007

Stage 2b

104. This stage covered the removal of gloveboxes, a transfer tunnel and a fume cupboard from the Assembly and Electro-refining laboratories.

105. In parallel with operations within Stage 1, pre-works activities commenced and subsequently MCS 5 in the Assembly laboratory was built. Upon the completion of the MCS5 size reduction operations, the MCS was decontaminated but unlike previous MCS's it was not removed as it was deemed to be a suitable containment to carry out LLW size reduction operations in the future. It currently remains in service.

106. Once MCS2, stage 1, had been completed pre-works and MCS build works commenced for MCS6 (ER Lab) with the start of size reduction operations commencing in May 2003. This MCS covered gloveboxes and a transfer tunnel, with size reduction operations being completed and the decontamination and removal of the MCS in July 2004.

Size reduction operation on glovebox

Typical pre-works and MCS build

Stage 2a

107. This stage covers the Box Bay Line. The line consists of interconnected gloveboxes of heavy construction with equally sized process plant and equipment. It is housed within the Lower Pressurised Suit Area (LPSA), with an operational face within the operations corridor. Pre-works activities were undertaken in September 2003 within this area to allow an MCS (15) to be erected over the operating corridor and the LPSA interface connections. However the commencement of decommissioning operation on this line was delayed by AWE's desire to introduce Plasma Arc technology to decommissioning. In addition to the actual installation of this specialist equipment much development work was required to prove the technology and safety concerns before being authorised for use.

PBAS operative undertaking Plasma arc cutting

108. PBASO pre-works operations commenced in March 2006 with the size reduction operations subsequently starting in September 2006 and to date 60% of the gloveboxes have been completed.

Stage 3

109. Covers heavy duty gloveboxes of which 89% were designed to be interchangeable. All of the gloveboxes interconnect with an overhead transfer tunnel system. In June 2003 decommissioning operation moved on to these larger and higher hold up gloveboxes. Decommissioning operations commenced with the pre-works operations and erection of MCS7 around a glovebox (an X-Ray Cell) with the subsequent completion of size reduction and MCS decontamination and removal in June 2004.

Typical glovebox ready for size reduction

Typical MCS

Glovebox partially size reduced

PBAS operatives working at height

110. This paved the way for the start of pre-works activities for two further MCS's (MCS9 and MCS 8). These MCS were the largest MCS's built to date. Decommissioning operations commenced in MCS 8 in January 2004, with all gloveboxes having been size reduced by August 2007. MCS 9 commenced size reduction operations in November 2004 with currently 60% of the gloveboxes having been completed.

Stage 4 to 9

111. Currently no decommissioning operations have been undertaken on the remainder of the stages.

4.5 Decommissioning Process facility Project

Facility Description

112. Shortly after the Second World War, a need was identified for the handling of tritium at AWE (A). A building that was used as an aircraft control tower during the war was modified to become a tritium handling facility. For over forty years, the facility was the main "tritium" facility at AWE (A). It was however recognised in the 1970's that a more modern facility was necessary to maintain safety standards. A purpose built facility was designed and built throughout the 1980's. At the turn of the century the "New" tritium handling facility was operational and the facility was transferred into decommissioning in 2001.

113. The facility was the principal tritium handling facility at AWE (A) until it was taken out of operation in April 2001. The facility produced gas mixtures for weapons systems/component experiments. Other related activities included the purification of hydrogen isotopes/ helium 3 and experiments on various metal hydrides for the storage of tritium.

114. Throughout that time it has carried out research and development for the Defence Nuclear programme on a large number of tritium related activities. Tritium gas has been stored and processed on a number of purpose-built lines. Much work was also carried out from the 1950s to the 1980s on air-sensitive solid tritide materials in a specially designed glovebox. Another task was the shape-destruction of thousands of classified tritiated components over many years until the late 1990s. Each task has left some legacy in the form of inevitable contamination. A quantity of tritiated water on molecular sieves is a legacy from the argon plant, which was used to remove tritium from highly contaminated gas discharges from gloveboxes 7 and 8. Much of the primary containment is contaminated by gas absorption into metals, plastics, oils etc. and some parts of the facility have residues of tritiated dust, which can be highly mobile.

115. The original part of the facility is a two-storey building, with a solid, concrete-rendered, double-thickness external brick wall and a flat reinforced concrete roof. The building was extended in the 1960s to provide further laboratory space and to allow for the incorporation of a ventilation plant. Throughout the building, the floors and roofs are of reinforced concrete and the roof finish to all levels is of bituminous roofing felt

116. The ground floor contained two laboratories, one for tritium processing and the other for mass spectrometry analysis. The tritium laboratory contained three negative pressure “Air boxes” which were modified over the years and 2 fume hoods which were also modified to incorporate a “Press” for crushing classified components. Calorimetry work was conducted in a side room of the main laboratory. All these areas were classed as controlled/contamination

117. The first (top) floor contained two laboratories and a “Health Physics” room. One laboratory housed air boxes similar to those on the ground floor. The other had a positive pressure inert gas (Ar) box for handling materials that were sensitive to air or moisture. This was also the only box with a gas clean up system. Every other air box within the facility was reliant solely on the operators and procedures (unlike the modern facility) to control discharges

118. The remaining areas include a change room and barrier, various workshops, offices, ventilation plant rooms, service plant rooms, electrical switch-rooms, laboratories and stores.

119. As with most old buildings, changes to plant configuration have occurred over the years. Similarly some changes are recorded and some are not

120. In 2002 the facility reached the end of its operational life and with no alternative use identified decommissioning commenced, in accordance with the overall AWE Decommissioning Strategy.

121. The amounts of both Intermediate Level and Low Level Radioactive Wastes that have been generated between 2000 and 2006 are given in the table at the end of this section. The amount of waste generated steadily increased as the project has progressed and the actual amounts are broadly in agreement with those predicted at the project-planning phase.

122.

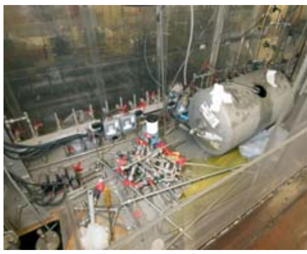
Radioactive Inventory

123. The radioactive inventory is almost exclusively tritium (half-life 12.3 years). Tritium is no external hazard (low energy beta) and only presents a problem if it is inside the body. Primary containment vessels accounted for the bulk of the inventory with the residual hold-up within boxes and the building being 0.1% of the estimated inventory.

Decommissioning Progress To Date

124. Decommissioning work began in 2002 and finished in 2006, with the facility now ready for demolition

125. Between 2002 – 2004, decommissioning involved the removal of many high inventory items such as LiDT vessels which were responsible for 85% of discharges to the local area. When these vessels were transferred to another more modern facility with a gas clean-up system, discharges dropped dramatically. Other work undertaken was the rationalisation of tritium stocks to enable some vessels to be disposed of and which also meant fewer RA moves to the "New" facility.



Out gassing of redundant items

Size reduction activities after out gassing

After size reduction

126. To arrive at this point and prior to removal of the air boxes, the equipment/vessels within them were removed. Local services to boxes were also isolated. Even though the gas within the vessels had been removed as part of POCO, levels of off gassing capable of triggering alarms were often encountered when metal storage vessels were opened to air.

127. January of 2005 saw the removal of molecular sieves which were used as part of a gas clean up box to remove tritium from the gas stream. This operation was deemed so hazardous that a stair lift was built in to the stairwell prior to removal of the sieves to enable them to be taken down stairs without the chance of falling

Some steps involved in the "Molecular Sieve" move and packaging

128. Throughout 2005 and 2006 some larger gas transfer pumps called Toepler pumps were removed followed by airboxes. Toepler pumps were an "Old" type of pump which contained mercury (Hg) and were used to move gas around the process lines. Glass Toeplers contained about 1L of Hg, however the larger metal pumps (3 off) had 100L within them. Over the years Hg had sometimes leaked along the process lines. It was found out exactly where

when decommissioning commenced! Due to the density of Hg manual handling was a real issue when it was found that a 50L storage vessel has several litres of Hg in it. The Hg was eventually gathered up and stored in approved containers. This involved a combination of contract staff and AWE staff. The AWE staff removed the primary containment pumps with the contract staff following closely behind to size reduce the airboxes.

129. Size reduction activities, conducted within the boxes, also gave rise to out gassing. When the air boxes had been stripped of equipment, the box itself was cleaned as low as reasonably practical. This meant that when the boxes were size reduced there was no off gassing and little free contamination to be spread about the remainder of the laboratory. Because the vast majority of contamination had been removed and the boxes were in ventilated laboratories, size reduction could be conducted wearing face masks and standard PPE with no need for additional ventilation/containment.


Typical fume cupboard


Typical air box


Dismantled air box

130. In 2006 the ventilation and stack was removed. Scaffolding was erected all around the building to enable ventilation on the roof to be removed. Once this was done, the stack had to be taken down. This involved careful planning as roads had to be closed as part of safety measures i.e. if the stack were to fall whilst being lifted

Stack removal from the facility

131. In 2007 the building was handed over for demolition. During decommissioning numerous samples of building fabric were taken. This enabled waste sentencing to be accurately predicted such that when ownership of the building is transferred, no nasty surprises await.

Facility ready for demolition

Services Stripout

132. After careful identification of all services as part of the preparatory paperwork, the removal of services and ventilation systems was not difficult. As each airbox was due for decommissioning, services were isolated prior to work starting. When all the boxes had been removed, the services were removed and isolated to agreed points. Temporary supplies were then used for the final stages of the work. Specialist contractors were employed for removal of the stack.

Building Demolition

133. The facility has been transfer out to AWE’s Site Remediation Group for demolition. Prior to demolition, a Visual Sampling Plan (VSP) shall be determined dependent upon both known and historical information regards the facility. Samples are taken to assess for both radiological and chemical inventory. Once the result of the sampling is known building rubble is then assigned to appropriate waste streams.

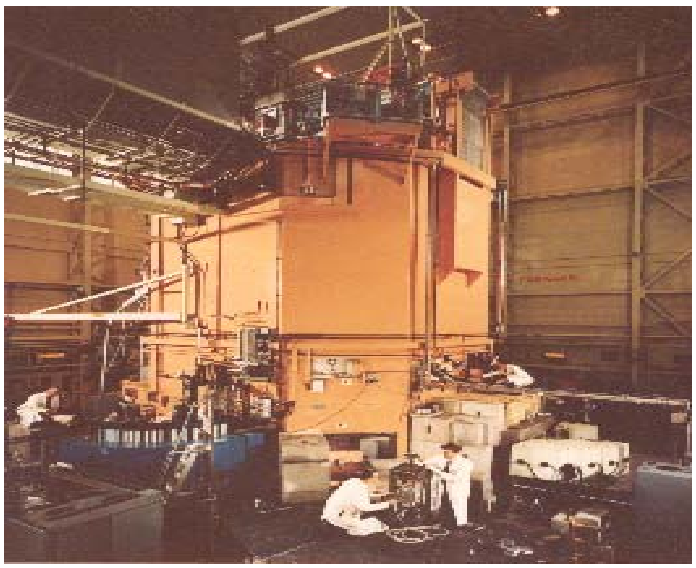
4.6 Reactor Decommissioning Project

Facility Description

134. The research reactor was a pond type reactor with a thermal power output of 5MW and having a core with the capability to accommodate five experimental rigs. It was constructed in the mid-1950's to provide a research reactor, for materials irradiation and neutron beam research. The reactor was commissioned in 1960 and operated until it was taken out of service in 1988. It was then de-fuelled and placed into “Care and Surveillance”.

135. It consists of a reactor hall and various ancillary buildings. The reactor is a pool type with a thermal power output of 5MW. The reactor fuel was highly

enriched Uranium and the fuel was cooled by water which also served as the moderator. The core reflector was constructed from Beryllium (Be) elements. To minimise neutron absorption the core structure, reactor tank and much of the cooling water system were constructed in Aluminium. In view of its purpose the reactor was constructed with a graphite thermal column and various penetrations through the biological shield which housed beam tubes. Additionally a rabbit system was installed to enable samples to be sent to and irradiated in the neutron flux before being returned to the lab facilities. It was not operated at full power until 1963 whilst modifications were made to the reactor. Thereafter the reactor was operated almost continuously over the period 1961 to 1988.



Reactor circa 1979

Radiological Inventory

136. The radioactive inventory is dominated by Co-60, with a half-life of 5.27 years. It was decided as the result of discussions that a 50 year period will allow the radioactivity to reduce by about a factor of 700, resulting in the significant benefit of reducing radiation exposures to individuals involved in the decommissioning. It is estimated that the dose rate at the storage ring (with no water) will reduce from 500 mSv/hr to 0.7 mSv/hr.

137. As a result of the Co-60 decay, there will be a reduction in the volume of generated ILW. However, some of the core components will remain as ILW after fifty years due to the Nickel 63 being the predominant isotope.

Decommissioning Progress to Date

138. The reactor was taken out of service in 1988, fuel elements were withdrawn and the reactor placed in “Care and Surveillance”. Some initial

decommissioning work was undertaken at this time and involved the removal of the dummy fuel, removal and disposal of a number of experimental facilities and the reflector and aluminium elements removed and sent to the AWE (A) Used Fuel Store tank (UFS). Water was then drained from the reactor leaving approximately 2m above the lattice plate as radiation shielding.

139. In 1996 a decommissioning option study confirmed that decommissioning strategy for the reactor of placing the reactor into a passive safe environment (e.g. dry) and defer full decommissioning for a period of up to 40 year to allow for the decay of Co 60 was the correct approach. It also outlined the decommissioning and, as appropriate, demolition of ancillary building and structure and the removal of services. This strategy was endorsed by the AWE Nuclear Safety Committee and approved for implementation.

140. Decommissioning work began in 2002 and finished in 2006. During that time the following tasks were completed

- Decommissioning and demolition of the Air Blast Radiators – these provided the main water cooling system for the reactor whilst operational. It was constructed from concrete and housed six radiator banks constructed form finned aluminium

1.ABR structure prior to decommissioning work

2. Removal of radiators

3. Cutting radiator pipes into small lengths

4. Grouting cut pipes into 200L drums

5. Demolition of ABR structure

6. Landscaped site.

- Decontamination and demolition of the Beam Plug Store – The BPS structure consisted of keyed concrete blocks surrounding an iron shot concrete core and was used to house beam tubes used in the reactor. All but three of the storage pockets held tubes, with activity levels varying from ILW to LLW along the length of the tube dependent upon operational usage and reactor residence time. Many of the tubes were found to contain discrete areas of ILW with the remaining material as LLW, applying waste minimisation principles, cuts were made at the ILW

/ LLW interface and the ILW segments sentenced separately. The tubes were positioned such that the ILW segment was contained within a shielded zone which permitted both cutting and direct transfer of the cut portion into a shielded drum. The remainder of the beam tube was sentenced for disposal at the UK LLW repository. After treatment of the beam tubes, the pockets were decontaminated to permit demolition of the structure and its disposal as ‘clean’ waste using the DQO methodology

1. Beam Plug (BP) Store

2. BP withdrawal shielding and cutting equipment

3. Assaying the LLW section of a beam plug

4. Lead casket housing ILW segment of BP

5. Monitoring surfaces of storage pockets

6. Outer steel casing ready for transport off site.

- The Mortuary Pits – these consist of two concrete lidded storage areas cut into the reactor hall floor. The pits are 1.9m x 1.4m x 2.3m deep and were used to store irradiated components from the reactor. Some items were already sealed in AWG 404 ‘Red Devil’ containers (encapsulated) stored in one pit whilst the other contained loose items including fuel element end pieces, experimental rigs etc. The AWG 404 package was originally designed for sea burial and consists of a hollow tube located in the centre of a waste drum, the void around it being filled with barytes, iron or lead shot concrete. Loose items are placed in the centre tube, which is then grouted, and the package topped off with the appropriate concrete mix

1. Red Devils in North pit

2. Assorted equipment in South pit

3. Recovering Red Devils for assay and waste sentencing

4.Assay equipment for installation in South pit

5. Red Devils in interim store

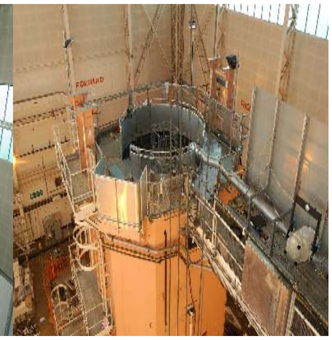
6. Assayed Red Devils in HHISO container

- Reactor - The reactor consists of a tank with a height of 8.85m and a diameter of 3.51m narrowing to 1.67m around the core. The tank is manufactured from aluminium with a 25mm wall thickness. At the core level a lead thermal shield surrounds the tank. A bio-shield comprising layers of iron shot, barytes and gravel concrete completes the shielding. Fuel elements were arrayed on a lattice plate mounted to the top of the core box which concentrated water flow to the core during operation. Although the majority of the material used in this area was aluminium, a number of steel components were unavoidable. At the time of manufacture the British Standard for aluminium specified a cobalt content <6% however analysis of the aluminium in equivalent reactors built at the same time at Harwell suggest that the cobalt content is closer to 2%. At the start of the work the tank held 12,000 litres of water In order to achieve the decommissioning objectives a number of key steps had to be undertaken.
    a) Cutting of control rods and storage pocking rink
    b) Removal of superstructure / overhead gantry
    c) Installation of working platform
    d) Installation of plug support and load with lead
    e) Installation of shielding in reactor basement
    f) Removal of water
    g) Installation of upper cap

h) Installation of drying plant

1 Reactor with water level lowered and lattice plate visible

2 Removal of superstructure



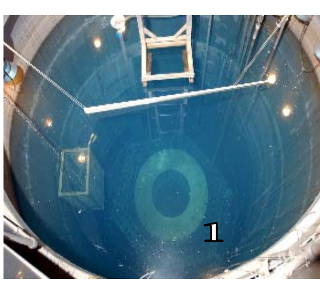
3 Cap placed on top of reactor vessel

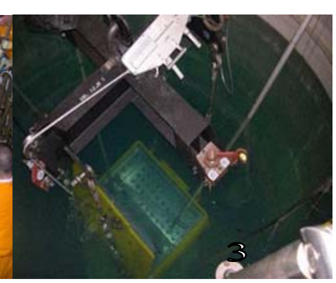
4 Reactor after removal of control rods etc

5 Insertion of plug and lead shielding

6 Plug cover plate and finishing of edges

- Demolition of the “Used Fuel Store” - The Used Fuel Store (UFS) consisted of a 9.2mm wall thickness aluminium tank 6m in height (4m of which was sunk below ground) and holding 56,000 litres of water. Like the reactor in order to achieve the decommissioning objectives a number of key steps had to be undertaken,
  - i) confirmation of activity in stored elements,
  - j) removal of peripheral equipment,
  - k) installation of shielding
  - l) loading of lead castle with element and control blades
  - m) transfer castle to $3m^3$ box and drying
  - n) water removal
  - o) tank removal





1. UFS pond with stored elements **2. Installing the lead castle** **3. Loading elements into castle**

4. UFS after removal of water **5. 3m^3 box showing pre-installed lead shielding** **6. Lead castle installed in 3m^3 box ready for drying.**

- Service strip-out - Services were isolated wherever possible to agreed end points. With the exception of the cooling water circuit, all remaining systems were shutdown in 1989. Support services were isolated, portable electrical equipment removed and fixed items electrically disconnected and their associated fuses withdrawn. Whilst the overhead gantry superstructure was largely retained, a number of supported mechanisms/systems were removed. The cooling water system continued in operation until 1999, when the pumps were shut down and the reactor outlet pipe isolated from the cooling water plant. The water level currently sits at 2.5m above ground level. The stack was removed in December 2005

Building Demolition

141. The reactor vessel itself will not be touched (current philosophy) until at least 2042, by which time it will have been left 50 years. The reactor hall is currently in Care and Surveillance which is obviously incurring a financial cost. Whether it would be cost effective to demolish the main reactor hall and construct a smaller structure with less cost will be debated in forthcoming review.

Conclusion

142. The reactor has been placed into a safe state to permit a further period of decay of the principal isotope ^{60}Co. This has been achieved by replacing the existing

shielding water with a lead loaded plug. The benefits of this approach are that risks to the environment through water leakage have been removed and that decommissioning options for future generations have not been ruled out.

143. Other tasks completed under this programme have significantly reduced the Care and Surveillance / Maintenance requirements for the remaining facility structures. The shut down and decommissioning of all ventilation systems associated with the reactor facility has reduced reported discharges and released airborne discharge monitoring equipment for re-utilisation in other site facilities.

4.7 Future decommissioning projects

144. A number of facilities are planned to enter or are about to enter decommissioning ate AWE below is a indication of the type of facilities:

- OWMG – The Old Waste Management Group effluent plant and system is made up of a large number of liquid effluent collection tanks with associated pump houses varying in Hazard Category (2 to 4).They are scattered around the AWE (A) site together with a liquid waste treatment plant located within the fenced off area known as the NSPA. In addition, within the NSPA, there are storage tanks for both liquid and process sludge wastes and several additional pump houses. The plant collected radioactive liquid arisings on a continuous basis from a number of buildings on site, with treatment of this liquid undertaken on a batch basis. The liquid originates primarily from floor washings and the stack drains of the donor buildings which, besides radioactivity may contain toxic materials (such as heavy metals).
- A Radiochemical research and Development Facility. Situated within the NSPA. The facility is currently a Hazard Category 3 with control transferred to Decommissioning Division in 2006.
- A Radiochemical facility situated within the south-west corner of the NSPA. It was the first facility at AWE to process fissile material, subsequently being used for basic research related to accidents with nuclear materials. The facility is currently a Hazard Category 3 with control transferred to Decommissioning Division in July 1995. POCO operations commenced in October 1996 and were completed in January 1998

5. NEW TECHONLOGIES

5.1 General

145. The New Technologies Group (NT) was created in 2001, the primary aim being the introduction of new technologies into decommissioning projects within AWE to remove decommissioning operatives from the hazard area, thereby reducing risk and dose uptake

146. The research and development activities conducted by NT are project driven and focus on providing solutions to problem/high hazard areas. Staff from NT visit the facility concerned and discuss the situation with facility staff. Because of the experience NT have of investigating different equipment and techniques, a potential solution to the problem can sometimes be offered straight away. More often though, a review of external ideas is conducted, or modification to the existing idea is required which is tailored to a particular facility. A strategy is then developed to suit the project

147. Where possible, simple "Off the shelf" equipment is used. This cuts the cost and provides shorter lead times for the availability of the equipment for use. To comply with UK legislation a "CE" marking is essential, or else even where a commercially available item is obtainable, modification to tooling is often required. This may take the form of a guard or further insulation to a particular part, but once corrected will comply with the relevant legislation e.g. PUWER (Provision and use of Work Equipment Regulations), LOLER (Lifting Operations and Lifting Equipment Regulations) etc

148. Once an idea of equipment to be used and a strategy has been developed, the next stage is to assess if it is cost effective. For this a "Business Case" is produced which looks at the net benefit of the new "Item". This new equipment may well reduce dose to staff and save time on the project, but if the cost is prohibitive, the idea will be abandoned! A sound business case is essential to the work proceeding and this can often take much time and effort, as work to assess how much dose is reduced by and also how much time is saved on the programme are calculated.

149. The subsequent sections provide examples of some of the equipment NT have investigated and progressed to aid decommissioning.

5.2 Mobile Diamond Rope Cutting Machine (MDRCM)

150. Diamond wire technology has been used with great effect for a number of years throughout the quarrying and construction industry for the cutting of various types of stone, such as granite and marble, and for the modification of reinforced concrete structure.

151. Following successful on-site trials it was proposed to design and construct an operational machine for use in size reduction of gloveboxes and other large items of plant and equipment in one of the former production Facilities. The equipment is currently undergoing trials within the former production facility.

152. The MDRCM uses diamond impregnated beads threaded onto a continuous steel wire rope. The rope is run around pulleys mounted on a frame, which is fixed to the base plate of the glovebox in which the target to be size reduced is mounted. Drive for the wire is provided by variable speed electric motor unit. Initial construction of the machine is carried out manually. The operation of the machine is by means of a control panel which can be operated remotely.

5.3 Hard LLW Shredder

153. A requirement was identified for a heavy-duty shredder to carry out size reduction of hard LLW as a pilot scheme prior to the introduction of similar machines in other Decommissioning Facilities.

154. The business case supporting purchase of a LLW shredder estimated lifetime savings on the project of £890k, against a capital cost of £75k, this was based on increased packing factors in the production of LLW drums alone

155. The machine is a 4 shaft system with a grading screen fitted beneath the cutting shafts. Therefore the waste size is predictable increasing the waste packing factor.

5.4 Passive Aerosol Generation (Fogging)

156. Passive Aerosol Generation or 'Fogging' as it is more commonly known has been purchased as a means of fixing of airborne contamination in ventilation ductwork and laboratories prior to decommissioning.

157. On arrival from the manufacturer, in the United States, the equipment needed to be modified in order to make the equipment compliant with PUWER & CE certification. A period of Factory proving trials will be required to ascertain how much fluid is required for a certain volume/space, what droplet size is best and what frequency to set the ultrasonic vibrators to, to achieve optimum density, volume and coverage

5.4 Remotely (Operated) Advanced Segmentation Process (RASP)

158. The Remotely (Operated) Advanced Segmentation Process (RASP) is a pneumatically driven reciprocating wire saw. It is claimed by the manufacturer to be a versatile and flexible system that can be used to segment components regardless of geometry, material or size. It was developed in 1998 by RWE NUKEM and is still in the prototype stage with only two systems in operation, one in the United States and the other in the United Kingdom. It is specifically designed for use within the nuclear industry for various decommissioning and size reduction tasks such as plutonium contaminated glove box lines and tanks.

159. The technology was identified as possibly being applicable for the size reduction of machine tools, glove boxes and accessories within the AWE decommissioning programmes, and a contract was placed with RWE NUKEM for the use of the UK machine for trials and testing. The trials, involving the cutting of ferrous metals such as machine tools proved a tough thorough test for the RASP during a two-week trial period with the Decommissioning New Technology section at AWE.

5.5 Other equipment

160. Below are other examples of equipment investigated. For further details or more information on the ones above

- Remote Waste Handling (For Use With MDRCM)
- Next Generation Cutting Machine (Diamond Wire Phase II)
- Chemical Decontamination
- PHADEC
- Airless Spraying
- Remote Cutting (Robotics)
- Remote Arm For Crated Gloveboxes
- Remotely Operated Decommissioning Of Gloveboxes (Rodog)
- Glovebox Base Turnover Fixture
- Decontamination Showers
- Electrokinetic Decontamination
- Technology Readiness Mapping
- Cool Vests
- Decontamination Of Surfaces, Using A Dry Surface-Stripping Technique
- Diamond Wire Band Saw
- Large Reciprocating Bow Saw
- Mobile Containment Systems (MCS's)
- Mobile Vent Plants (MVP's)

6. REVIEW AND LEARN ISSUES

6.1 General

161. As mentioned previously the facilities which make up Decommissioning Group projects are former R&D / operational facilities with varying degrees of RA inventory predominantly held in contaminated plant and equipment systems.

162. The majority of the decommissioning effort is centred on Alpha contaminated facilities which were either former production or research facilities. However all have had research and development programmes activities undertaken within them at some point in time. All are / were populated with redundant heavy duty glove boxes and supporting plant and equipment systems with varying degrees of RA inventory within them, all are designated Hazard Category 5.

163. Theses projects still have much of the original scope to complete against their original approved programmes and remain problematic in terms of maintaining programme delivery and stakeholder expectations.

164. The process facility a former tritium facility was designated as a Hazard Category 5 and reactor project (a former experimental reactor, designated a Hazard Category 3 facility) are the other two significant projects that have been undertaken in recent years. Both of these projects were smaller with a better defined scope and less problematic than alpha contaminated projects mentioned earlier. Both these projects were fixed price contracts and

successful in terms of maintaining programme delivery, within budget and delivering stakeholder expectations.

6.2 Alpha production / research facilities

165. The alpha production facilities are all based around a common decommissioning strategy and share many common problems. The following is a précis of the common issue:-

- All of the former production / research facilities are being decommissioned in a safe, controlled manner using decommissioning operatives in pressurised breathing air suits, using hand held, predominantly cold cutting equipment. Alternative cutting techniques such as Diamond Wire and Plasma Arc cutting have been introduced and there is some evidence of success with the potential for further improvement. The first generation Diamond Wire equipment has been shown to be useful but limited on its operability; however a second generation machine is being explored with a view to improving operability along with reliability. Plasma Arc has also been found to be extremely promising but needs more preparation prior to use than first envisaged. Consequently decommissioning activities at present remain labour and dose intensive, expensive and continues to generate quantities of secondary waste.

166. All of the projects are based on initially undertaking high hazard reduction. However in one facility the choice of decommissioning strategy was heavily influenced by the NII's direction to the Company to commence decommissioning and reduce the high hazard / high inventory gloveboxes. The premise of doing the high hazard reduction first does not always stand up well to scrutiny as it can lead to impractical decommissioning situations in terms of space constraints and supporting infrastructure works having to be adopted which has certainly contributed to increased costs and programme timescales.

167. This strategy to decommission high hazard (alpha) components first also fed into the contractual arrangements. Two of the alpha projects started life as fixed price packages of work, both of them were formally ended on the change over from Hunting Brae to AWE ML as AWE managers. Both projects were having difficulties is achieving the reduction of the high hazard and commercial claims had to be addressed. Consequently, a decision was made in 2000 whereby AWE decided to work with contractors on a time and materials basis and directly manage the contractor personnel in the performance of the work. This approach was considered to be the most expedient at the time and the most commercially viable to complete the high hazard (alpha) size reduction phases of work.

168. Managing Decommissioning facilities also place significant demands in terms of resource and cost. The legislative and Company requirements to maintain the Authority to Operate is significant and a great deal of time and effort is expended on managing Hazard Category 5 facilities as well as managing the

regulatory and customer expectations. This prioritization between facility and project needs does contribute towards slippage experienced on the major decommissioning programmes. AWE places safety as its number one objective whilst undertaking decommissioning in that culture within the facilities and projects is for the safe operation of the facility being the number one priority and the delivery of the decommissioning project is of secondary consideration.

169. AWE's current matrix management arrangements are another feature which has also contributed to the difficulties experienced in meeting the decommissioning programmes. The Facility / Project Manager has no direct line management responsibility for engineering and assurance staff, they are "loaned" to the facility from their donor matrix organisations. Personnel within these donor matrixes often have competing priorities, especially the assurance staff who are often involved in company assurance initiatives. These initiatives, although having laudable aims, are not allowed for in the planning stages (due to the fact that they are new and were not known about at the planning stage) and do not always directly contribute to achieving the facilities business; however they always take time and reduce staff availability which impacts upon the delivery of decommissioning programmes.

170. Programme performance (over many years) has not been as good as expected. All of the alpha facilities have underestimated the planning norm for the size reduction of gloveboxes. It should also be noted that a far greater amount of time is expended on the MCS life cycle of design, build commission etc. Durations of 100 days for setting up are not uncommon and decontamination and dismantling in one of the alpha facilities has averaged 178 days. To date all of the major alpha decommissioning projects, have slipped against their original programme dates.

171. All the (alpha) projects have long duration programmes and consideration has been given to the effects this has on staff motivation against projects durations (>10 year). There has also been in the past an "inward looking" culture within the facilities with too many people responding with reasons why tasks could not be done differently, rather than embracing new ideas with a determination to make them happen.

172. Two of the (alpha) facilities did not undergo a complete POCO programme for valid technical reasons associated with the degree of difficulty involved, however the consequences of that decision has adversely impacted upon programmes delivery. One of the (alpha) production buildings is experiencing difficulties with the additional administration resulting from the significant over recovery of RA material against an estimated inventory. Estimates of material were produced prior to decommissioning commencing and criticality controls were agreed based upon the estimates. In one glove box alone, more RA material has been recovered than in the "whole" of one of the former (alpha) production facilities.

173. Another of the former (alpha) facilities has suffered different, but extremely disruptive problems with the uncovering of pyrophoric material which has

manifested in two off small smouldering “fires”. Recovery action and additional mitigation measures have resulted in significant delays.

6.3 Process Facility

174. The following is a précis of the common issues found whilst decommissioning the former tritium process facility

175. The facility was decommissioned in a safe, controlled manner using decommissioning operatives with hand held, predominantly cold cutting equipment. The significant difference with this project was that it was on a much smaller scale with fewer staff and a greater degree of AWE/contractor interface and supervision. (2 AWE staff and 2 contractor staff)

176. As with the former alpha production / research projects, managing decommissioning facilities place significant demands in terms of resource and cost. The legislative and Company requirements to maintain the Authority to Operate is significant and did lead to conflict with the decommissioning contractor.

177. Although a smaller scale short duration project there is just as much time and effort expended on managing a smaller Hazard Category 5 (later reduced through good progress to cat 2) facility and the regulatory and customer expectations. As mentioned above, the culture within the team was that the safe operation of the facility is the number one priority and the delivery of the decommissioning project is a secondary consideration. However it should be noted that this project suffered less of the problems associated with DI matrix managed staff

178. However the project team had a greater degree of confidence in the validity of the tritium inventory and associated recovery activities. Consequently the risks were better known and the Company had a greater degree of confidence in placing this project on a fixed price contract. However the project did experience commercial difficulties with the contractor early on which were overcome and the project was successfully completed on time and within budget. The facility is currently in a care and surveillance phase and has been handed over to the AWE Site Remediation Manager on phase 4 C&S awaiting final demolition work

6.4 Research Reactors

179. The following is a précis of the common issues found whilst decommissioning the former research reactor and associated laboratories and plant rooms.

180. This facility was also decommissioned in a safe, controlled manner using decommissioning operatives with hand held, predominantly cold cutting equipment. The significant difference with this project was that it was a beta/gamma radiological problem with the overall decommissioning strategy being determined by the decay and delay process.

181. As with the former alpha production / research projects, managing decommissioning facilities place significant demands in terms of resource and cost. The legislative and Company requirements to maintain the Authority to Operate is significant and did lead to conflict with the decommissioning contractor, as did the roll out of a number of Company initiatives.

182. Although having a large building footprint the project was classified as a Hazard Category 3. However it was considered novel and the first project at AWE on a research reactor of any substance, consequently the facility management requirements, regulatory and customer expectations still required a great deal of effort. As noted above in the former production and process projects, in general, the culture within the team was that the safe operation of the facility is the number one priority and the delivery of the decommissioning project is a secondary consideration. It should be noted that this project also suffered less of the problems associated with DI matrix managed staff.

183. Again the project team had a greater degree of confidence in the validity of the RA inventory and associated risks. The risks were better known and the programme durations relatively short, the Company had a greater degree of confidence in also placing this project on a fixed price contract. The project was successfully completed on time and within budget. The facility is currently in a care and surveillance phase and has been handed over to the AWE Site Remediation Manager on phase 4 C&S awaiting final demolition work

7. IMPROVEMENT - FUTURE

7.1 General

184. Decommissioning facilities and projects will always attract redundant facilities with varying degrees of radiological / hazardous material inventory predominantly held in contaminated plant and equipment systems. The very nature of the work they were commissioned to do will ensure that hazards prevail within the contaminated plant and in general the facilities will arrive in a condition not suited to support decommissioning operations with deteriorating mechanical and electrical services.

185. Likewise, when DG takes over a facility there is usually some form of a programme commitment to the regulator with stakeholder expectations (NII and MoD) relating to decommissioning, these expectations are not always the same. This is a typical scenario based upon the traditions and conventions of the past. However whilst the facilities may still be handed over to DG in a condition not suited to decommissioning, the programme commitment and management of stakeholder expectations will be handled in a different manner from now on.

186. The following is a précis of the lessons learned from DG facilities and projects. It also draws on the findings of an independent project review carried out on two of the longer term alpha decommissioning projects.

7.2 Establishment of Approved Programmes and Regulatory Monitoring Arrangements

187. New decommissioning facilities will no longer be handed over to DG with a stakeholder expectation that AWE will commence decommissioning activities as soon as possible. Front end planning, including scope capture, characterisation and substantiated strategies will dominate the first phase of any new facility / project activity in conjunction with new regulatory monitoring arrangements, based upon CSI 1535, namely to proceed with decommissioning of nuclear facilities for which there is no future use as soon as is practicable, subject to safety and resource availability.

188. It is proposed that 5 Key Events are used for every new project which covers the entire Decommissioning lifecycle of the project. The Key Events will generally be sequential and therefore the achievement of the Key Events will demonstrate the position of that particular project in the Decommissioning Project Lifecycle.

189. AWE's decommissioning strategy will remain broken down into 5 phases. This strategy is well understood and will continue to be used as the foundation on which key events are built. This results in a generic hierarchical structure which will be applied to all projects. The 5 Phases remain as:

- Phase 1 – POCO
- Phase 2 – Care and Surveillance
- Phase 3 – Dismantling
- Phase 4 – Care & Maintenance
- Phase 5 – Demolition

190. Decommissioning groups work generally commences with Phase 3 (Dismantling) this is the assumed starting point for the Decommissioning Key Events. Typical key events will be: -

- Confirmation of Decommissioning project Start Date
- Full scope capture, characterisation and substantiated strategy and End Date forecast
- Commencement of Decommissioning with identified milestones
- Completion of Phase 3 Decommissioning
- Confirmation of Phase4/5 Strategy

191. All of the above should help prevent future projects commencing decommissioning activities without the true scope, cost and schedule for the respective phases of the project being fully defined and agreed with all stakeholders.

7.3 Management Requirements and Project Culture

192. The suitability of the current facility management/project team organisational interface arrangements has been judged problematic and inefficient. AWE organisational changes are currently being devised to better meet the demands of the Company Management System whilst achieving the delivery of major decommissioning projects.

193. People and change are synonymous with difficulty; however a number of facilitated work shops are currently underway to foster better understanding of the roles, responsibilities and perhaps more importantly, the behaviours and attitudes required to deliver long term decommissioning projects within a heavily regulated environment.

194. Discussions are also underway concerning the matrix management arrangements and the re-allocation of staff and line management responsibility to the decommissioning facilities / projects. It is envisaged that the “Matrix Managers” role will significantly change to that of a coaching, mentoring and professional development.

7.4 Future Decommissioning Programme Development

195. It is acknowledged that the smaller duration projects have in general performed well, the two mentioned in this paper being on time and budget. It is also acknowledged that the really long duration projects suffer from loss of focus by some staff and also attract a greater number of staff changes usually for career development etc. To mitigate against this, future programmes where size and scale of the project allow, will be based around well defined, fully scoped, discrete packages of work. Consultation with stakeholder is currently ongoing to consider the implementation of a detailed 3 year decommissioning programme. This programme is to be based on an overall cost estimate for remediation and decommissioning, with increasing confidence and details over reducing time intervals culminating in a detailed spend and activity profile for a rolling three 3 year decommissioning programme, i.e. 3 year rolling detailed programme, with a 7 year indicative look ahead.

7.5 POCO

196. In future a greater emphasis will be placed on the performance and achievement of a comprehensive POCO programme. The results from the POCO programme will be fed into the phase 3 front end planning, including characterisation and substantiated strategies of any new facility / project.

7.6 Contract

197. In the earlier day of decommissioning it was envisaged that the contractual arrangements for the majority of decommissioning projects would be on a fixed price basics, against NII approved programmes.

198. However AWE's experience from this approach was found to be problematic with all of the major projects suffering to varying degrees, programme slippage. The high hazard category 5 facilities in particular proved to be difficult in terms of underpinning programmes with realistic planning norms and the application of sensible risk mitigation measures.

199. In 2000 AWE decided (high hazard category 5 facilities) to work with contracting organisations on a time and materials basis and directly manage the contractor personnel in the performance of the work. This approach was considered to be the most expedient at the time and the most commercially viable to complete the high hazard (alpha) size reduction phases of work.

200. This change of strategy has worked reasonably well to date and AWE is now in better position with regard to developing underpinned programmes with realistic planning norms. Likewise the application of risk management techniques is better understood and the working relationships with contracting organisations are commercially less problematic.

201. Currently AWE is now in better prepared to consider placing fixed price package of work with contacting organisation on the premise that the main hazards are now better known and the scope better definable. AWE has also engaged a "term contractor" for the performance smaller, discrete packages of work, or comprise of packages from existing, mature projects.

202. Contractually, AWE is once again moving into more competitive commercial arrangements with discrete packages of work within existing Category 5 facilities have being identified as candidates for fixed price or some form of risk/profit share arrangement. It should be noted that AWE believe there will always be a potential requirement for time and material arrangements, but expect it to be a diminishing demand.

7.7 The Future

203. At AWE configuration control is good; however this was not always the case. Prior to licensing records were not always maintained and discrepancies between what was built and the item being decommission are often discovered. This also goes for what operations and research was undertaken within the various facilities. Therefore consequently AWE has learned to "Expect the Unexpected".

204. Future decommissioning strategy will still continue to try to remove the "Man" from the workface, but with affordability and practicality taken into account.

205. Lessons learnt from past work have helped develop where we go in the future with regard to in-house or contact out activities. The project must be well defined and the scope of the work fully understood with substantiated programmes and resource profiles. If sufficient effort is expended on gathering this information prior to the physical decommissioning work starting, time and money can be saved.