Decommissioning of a Research & Development Tritium Facility - 9274

Kevan P. Ticehurst, Environmental Programmes Group, AWE PLC, Aldermaston, Reading Berkshire, RG7 4PR, UK

ABSTRACT

This paper provides an outline of the issues and challenges in the successful decommissioning of a R&D tritium facility undertaken for the very first time at the Atomic Weapons Establishment (AWE) Aldermaston UK. It goes onto describe the Safety Management, technical and commercial arrangements for the detailed off gassing and dismantling of the Tritium process lines/storage systems (in particular the molecular sieves), together with the removal of all contaminated ventilation plant and services. Details of waste streams and environmental discharges are given together with an Assurance analysis and a description of lessons learnt.

INTRODUCTION

The Tritium Facility (hereafter referred to as the DX Facility) comprising of 10 buildings and structures were constructed around 1940, with the main Building formerly used as a runway control tower for RAF Aldermaston. Detailed information regarding the wartime use of the buildings was difficult to obtain although it has been established that they were the home of the American 101st Airborne Division in support of the D-Day landings. During the 1950's the buildings were converted to Tritium use in support of the UK weapon production.

The Decommissioning Project programme lasted from 2001 to October 2006 in which it successfully reached its Engineering and Radiological end points in readiness for final demolition planned for March 2009.

DECOMMISSIONING POLICY AND STRATEGY

The AWE Decommissioning policy [1] is to proceed with decommissioning of radioactive facilities for which no future use is foreseen as soon as practicable, subject to safety and cost effectiveness, thereby minimising radiological risk and saving unnecessary expenditure on care and surveillance.

AWE's strategy is to divide the decommissioning of redundant facilities into five phases. These phases are used as a general framework for planning and implementation of decommissioning and are broadly consistent with the three stages of decommissioning defined by the International Atomic Energy Agency. The Five Phases of Decommissioning at AWE are:

- Phase 1: Post Operational Clean Out.
- Phase 2: Post Operational Care and Surveillance.
- Phase 3: Dismantling of plant and decontamination of structure.
- Phase 4: Building Care and Maintenance.
- Phase 5: Building Demolition.

DECOMMISSIONING PLANNING AND IMPLEMENTATION

A Decommissioning Safety Case (DSC) [2] was also be prepared and based upon the Best Practical Means study (BPM)[3], Decommissioning Plan [4] and the Decommissioning Strategy. The Decommissioning Safety Case [2] provided the assurance that all safety considerations have been taken into account and that decommissioning will be conducted in accordance with statutory requirements, applicable standards and codes of practice.

CONTRACTUAL ARRANGEMENTS

POCO and phase 3a was carried out by the existing facility team supported by Contract Operatives in order to remove inventory materials and reduce the Hazard Category of the DX Facility from 5 to 3 [5]. Once this was completed, a contract was let to RWE NUKEM ltd (now Nuvia) through competitive tender [6] for the Phase 3b element. In essence the contract required the removal of all secondary containments (air-boxes, glove-boxes and fume-cupboards), removal of all building services including ventilation, electrical supplies, heating, gasses, and water distribution systems, delay tank system and the 33m high building stack. This included all fixtures and fittings not part of the building fabric in order to meet an agreed engineering and RA end point. During Phase 3b, the Contractor remained under AWE's own management team for the duration of the Works.

SAFETY MANAGEMENT ARRANGEMENTS

Safety Documentation.

Management control of safety is maintained by having clearly laid down responsibilities for safety at all levels from the Decommissioning Safety Case (DSC) [2] down through to the safe systems of work at the work place. The DSC [2] was prepared in order to justify safety during the decommissioning operations, which identified the safe operating envelope (SOE), the safety related maintenance and testing schedule and emergency response plan. However, the DSC [2] for the DX facility differed from those of the other decommissioning facilities at AWE in that it presented a bounding risk assessment encompassing all Phase 3 activities up to the point of demolition. This had the advantage of a less onerous approval route due to the reduced number of documents and hence presented programme savings.

Environmental Protection

To comply with environmental legislation, three Best Practical Means (BPM) [3] studies were prepared to demonstrate that all reasonably practicable steps were been taken to reduce discharges to the environment of all radioactive waste. The third BPM [3] study concluded the prudent removal of potentially high inventory molecular sieve beds from the Argon Suite as soon as practically possible. Prior to detaching the sieves, the associated pipe work was characterised for activity burden to enable the sieves to be removed without impact on gaseous discharge.

Although the DX Facility employed 3 separate ventilation systems, only 1 (HPE to lab 2) contained HEPA filtration. Due to the nature of tritium, this type of filtration would only arrest particulate and would not reduce environmental discharges. A feasibility study [7] was conducted on the possible installation of a modern Gas Clean Up System (GCUS) , but was discounted on the lines of time and cost. During the Facility's operational and decommissioning periods, DX was responsible for 96 % of the airborne tritium discharge from AWE [8]. Therefore all operational and decommissioning activities would have to be extremely well managed so as not to break Regulatory discharge authorisations and Company KPI's.

Management of Decommissioning operations

The Facility Manager has overall responsibility for the facility and the decommissioning programme. A Decommissioning Project Manager was appointed with responsibility for the management of all activities required to implement the decommissioning programme. These activities include the design, installation and commissioning of pre-works for decommissioning operations and the management and supervision of decommissioning operations. Assurance and Facility Engineering Managers, provided specialist support to the decommissioning programme activities. A facility engineering section provided work control, configuration control, general engineering and maintenance support. Safety Case requirements, health physics and other professional safety and quality services support is provided by an Assurance section. Due to the specialist nature of tritium, the facility team retained the use of its two senior project scientists who carried out much of the POCO and Phase 3a work as well as acting in management support roles.

FACILITY DESCRIPTION AND HISTORY

The Tritium Facility was constructed around 1940; The main building (DX) was a runway control tower and secondary (DXY) was a mortuary for RAF Aldermaston. Detailed information regarding the wartime use of the buildings is difficult to obtain although it has been established that they were in use until the end of the war. In the mid 1950's DX and DXY were allocated to tritium handling and remained part of the Tritium Chemistry and Technology (TCT) Section until the commencement of Decommissioning

A number of tritium related projects had been undertaken during the years. Other projects included basic research into metal hydrides, provision of gas process lines for separation, displacing and recovery of hydrogen isotopes together with analysis techniques of mass spectrometry, liquid scintillation counting and calorimetry. However these had been minimised since the mid 1990s due to the construction and commissioning of a replacement facility (AX).

Building Identification

There were over 10 buildings associated with the Decommissioning Works, the most notable were:-

Building **DX** covered an area of approximately 420 m² and was divided into four laboratories housing 6 fume cupboards, 2 glove boxes and 7 air boxes, together with a plant room incorporating the ventilation systems. The non-controlled area contained the Workload Control Centre (WCC), an office, an electrical switch room, storage and sanitary facilities.

Building **DXY** The building consisted of a rendered and painted brick shell with a pitched, corrugated asbestos roof covering a light steel structure. DXY was equipped with 2 air boxes and a glove box linked to an extract system and 9.2 m stack

Building **DXX5** was a free standing 30 m stack of steel construction which provided one of the designated outlets for environmental discharge of tritium from the DX facility;

Building **DXX7** the building was a large 0.94m high bunded area (unprotected from outside weather conditions) housing four effluent delay tanks.

DECOMMISSIONING PROJECT

Phase 1: POCO

This phase is normally carried out immediately following the end of process operations and is considered to be an operational rather than a decommissioning activity. Where part of a facility has ceased operations, POCO is carried out on the plant that has become redundant. It provides a safe environment for the period of care and surveillance prior to the start of dismantling work.

The purpose of POCO was to remove all free tritium gas, tritium gas storage, (PU) beds and containers, rationalise tools and equipment and consign as waste any redundant loose items

Inventory transfer to AX was effectively completed in May 2001, with POCO, comprising of over 500 items continuing until the end of 2002.

Phase 3: Dismantling

This is the main decommissioning or dismantling phase and therefore represents the most hazardous work. The work undertaken will include the removal of all contaminated materials, plant and equipment to agreed radiological and engineering end points defined within the Decommissioning Plan. Cutting equipment currently used in decommissioning operations include reciprocating saws, nibblers, band saws, crimp shear tools and circular saws.

Waste produced during dismantling operations is packed into 200 litre steel drums with polyethylene liners or HHISO's, waste items are initially cleared as, or decontaminated to, free release [14]. As work progresses further waste is then categorised as low or intermediate level waste depending on the fissile material content detected.

On achieving limited structural access (4 Bq/cm²), which may be a defined end point, restrictions are placed on any future work involving the building fabric to ensure that hazardous material is not disturbed without suitable controls being in place

Characterisation Survey

Monitoring for tritium is difficult and it has been found that the best methods of sampling for tritium are by smear sampling in which the smears are then counted on a proportional counter or by liquid scintillation. An alternative analysis method is to take samples of the material of interest. These samples are then soaked for several hours in a suitable liquor to leach out the tritium and then analysed using liquid scintillation counting.

During Phase 1 POCO, a collation of preliminary characterisation reports [9] for sample testing was carried out on DX Facility buildings civil structure, together with the metals and other materials that make up various items of plant and equipment. This type of testing was necessary to determine the base line levels of Tritium Contamination.

In all some 93 building fabric samples were taken for the initial survey and sent for combustion analysis. The results showed that 58 were above the 0.4 Bq/g free release limit with the highest concrete sample result being 90.1 Bq/g

The RWE NUKEM detailed characterisation survey [10] was undertaken prior to commencing decommissioning operations, approximately 170 characterisation samples were identified and extracted from the building infrastructure. These results detailed that only 4 samples were below the 0.4 Bq/g free release limit, 17 were deemed to be ILW (mainly form the bases of air boxes), whilst the remainder were classified as LLW. Oil samples were analysed using liquid scintillation counting available both locally and at the AWE

Oil samples were taken from six of the rotary pumps within the DX Facility, yielding six individual results. The rotary pumps from which the oil was sampled were chosen as representative of the entire pump inventory. The analysis results showed five range between $1.87\times10^{+06}$ to $6.94\times10^{+07}$ Bqg^{-1}, with a five further results clearly in excess of the LLW / ILW threshold of 12000 Bqg^{-1}.

Asbestos

During Phase 1 POCO the Facility team commissioned an asbestos Type 3 survey [11]. In all some 118 samples were taken which identified some 40 separate areas containing Amosite and Crysotile.

Laboratory 6

Laboratory 6 was originally used for routine analysis of gas samples either containing, or composed entirely of, hydrogen isotopes, using a VG 30-01 mass spectrometer. This instrument was deemed redundant prior to decommissioning and all services to the equipment were isolated.

The laboratory was supplied with an extract and ventilation system separate to the rest of the building, exhausted through stack. Regulatory monitoring was also undertaken via an Overhoff Bubbler unit.

Once the strip out of the mass spectrometer and associated services was completed, followed by routine HP surveys, environmental monitoring continued for a period of 7 days. During this time, with no equipment or material remaining, the reduced airborne discharge remained at a steady rate @ 0.05 Gbq/month.

Laboratory 4 Box 12

Air-box 12 was built in the 1960's, contained 4 No 40 litre and 2 No 50 litre aluminium Kegs used as helium-3 containers which had to undergo an out gassing regime The size reduction of kegs proved problematic in that although they had similar histories, final out-gassing varied enormously eg: one key gave a discharge of 300 Mb whilst another gave 4 Tbq! [12] Each keg was treated in turn by 'cracking' the valve and measuring the off gas rate. Once this had subsided a small pilot hole was drilled to encourage tritium exchange with the air. Finally when a point of no discernible out gassing was reached, the keg was cut into two sections, assayed and placed in the waste stream.

Laboratory 4 Air-box 14 (Metal Line)

Air-box 14 built in the 1960's and is of the same construction materials as Box 12, These lines dated back to the earliest period of tritium handling within the facility, but were not used for a number of years prior to Phase 1 POCO.

The line consisted of storage volumes, uranium solid storage beds, activated charcoal traps together with mercury diffusion and Töepleur pumps (100 kg Hg). The size reduction was performed in-situ with awkward ergonomic issues making the containment of the Hg difficult at times. All Hg was kept within the confines of the air-box and transferred to RAMTAP approved containers.

In order to decommission the lines it was necessary to systematically open all of the valves and gradually let the line 'up to air' whilst monitoring the airborne discharges. Once the lines had reached a state of equilibrium, sections could be removed by using conventional pipe cutters. Due to the fact that the lines had seen significant tritium content, they were therefore consigned as Intermediate Level Waste.

Laboratory 4 Box 16

Operations were conducted in the sealed, gloved air-box using a hydraulic press fitted with interlocked guards. Ceramic particulate waste was generated which would give rise to a significant hazard in the event of a breach of containment the components constituted solid intermediate level radio-active waste.

Prior to the decommissioning Characterisation surveys, tie down coatings were applied in order to suppress any tritiated dusts. During Phase 3b Decommissioning, a containment system was constructed around the box and a local extract point installed connecting to the building ventilation system via a temporary HEPA filter.

Decommissioning of Laboratory 1 Box Lines

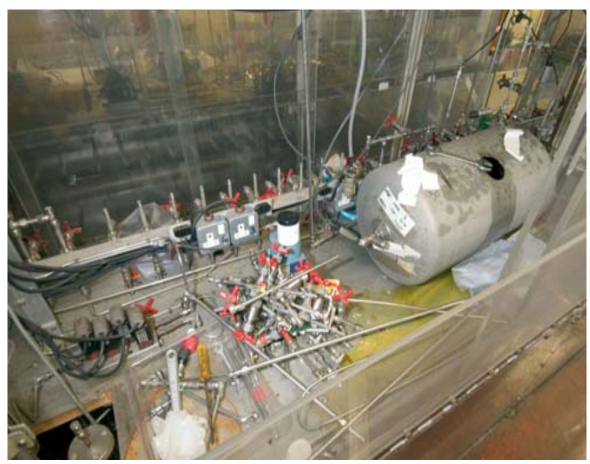
Early characterisation took place by identifying areas of the line which had seen heavy tritium use. A number of samples were taken and sent for destructive assay. Following discussions with the Regulators, the Best Practical Means (BPM) [3] for the disposal of the primary containment lines concluded that the preferred option was to gradually break the line down section by section to its component parts. Each time a joint was separated it was allowed to off gas until discharges reduced to such a level so as to allow the box to be opened and physical dismantling to re-commence. This had the advantage of reducing operator dose whist also being able to control airborne discharge rates within Company KPI and statutory limits. Over a period of some 18 months the air boxes were dismantled just leaving the Töepleur pumps and the storage vessels intact. Although at this stage a Decommissioning Safety Case was still being developed, the Regulator gave permission to finally dispose the primary containment items as ILW.

Laboratory 1 Air-Box 5 (Isotopic Separation Line)

Air-box contained the Isotopic Separation Line built (ISL) in 1986, which was used for the purification of tritium by the removal of Protium and Deuterium contaminants. This was achieved by the chromatographic separation of the hydrogen isotopes on palladium columns. The displaced gases were collected into a number of volumes or on to solid storage beds for later transferral to the purpose built AX facility.

This ISL system comprised stainless steel pipe work (various sizes), various valves types and compression fittings (HOKE, SWAGELOK,). The system contained oil based rotary and diffusion pumps, plus a large toepleur pump containing 100 kg mercury. Below the box were a number of hydrogen storage vessels comprising of 2 No 50 litre, 2 No 12 litre and 1 No 7 litre capacity. These had to be evacuated of free gas.

Lab 1 Air-box 5



Lab 1 Air-box 5 Line Partially Dismantled

Laboratory 1 Air-Box 6 (General Purpose Line)

Air-box 6 contained the General Purpose Line, which was used for the removal of contaminants from bulk quantities of hydrogen isotopes by reaction in a uranium furnace. These contaminants typically being inert gases (helium, argon, and nitrogen), water vapour and hydrocarbons (methane and ethane derivatives).

The line consisted of the furnace; online storage capacity of 56 litres solid storage in the form depleted uranium and 107 litres of free gas storage in three volumes (2 No 50 litres and 1 No 7 litre). Gas circulation through the system was by means of diffusion and Töepleur pumps containing 100 kg mercury The line was provided with a variety of instrumentation for temperature, pressure and gas quality measurements.

Lab 1 Air-boxes Removed Lab 1 Decommissioning Complete

Laboratory 2

Laboratory 2 contained the argon glove-box suite consisting of standard AWE design glove-boxes, a fume cupboard and argon treatment plant. The suite was installed in the mid 1950's for handling inorganic tritides (lithium) in an inert atmosphere: it had also been used as support boxes for other operations using tritium in the event of emergency and for repairs. Due to these uses the argon glove-boxes had been used as primary containment.

They used to be purged before any work with lithium. Originally any (inevitable) tritium present within argon was trapped on molecular sieves in the oxide form, but this part of the system was taken out of service many years prior to decommissioning. Tritium was then released (via the ventilation system) during purging. The sieves remained in place (though isolated by valves) in the system

Laboratory 2 Decommissioning Box 7 and 8

Both glove boxes were provided with a 50 mm air curtain between double Perspex panels and were maintained under a static atmosphere of argon (purged quarterly) (contaminants being air and water) fed from the argon plant, until May 2003.

During 2004, it was discovered that argon purging of the box had little effect on discharges and therefore it was decided to bring the boxes up to an air atmosphere. This was achieved by installing a small bleed valve in to the and introducing air in small quantities. As a result of the tritium exchanging with the moisture in the air, the discharges would then begin to rise for a period of time before falling back to their original level, at which point the valve was opened for longer periods. Once this exercise had been completed the tunnel door which led to the open fume cupboard was opened at 1 mm increments to encourage increased airflow. Eventually the tunnel door was left fully opened and the top hat bungs removed with the airflow still being maintained by the High Pressure Extract System (HPE).

Decommissioning of Molecular Sieves

Decommissioning of the Argon suite and molecular sieves proved to be the most technically challenging aspect of the project and attracted a great deal of interest from the Company and with the Regulators.

In the DX Facility, molecular sieves have been used for extracting water from gas streams. The main inventory from these sieves would be on the Argon Plant clean-up system. Although these were redundant, they did have a significant tritium inventory on each sieve. It was impossible to measure the inventory without breaking containment due to safety considerations.

Assessed Inventory of Molecular Sieves

The argon plant clean-up system was a “Once through” system. The sieve material was reported to be 50% efficient, which means that for every Bq that was discharged up the stack, there was an equal amount taken up by the sieve. In order to ascertain the hold-up on each sieve, discharges for the entire facility throughout the 1960’s, 70’s and 80’s were taken and 50% of this is assumed to be worst case for the sieves. In reality, the sieves would contain much less activity than the 50% uptake for sieve material, as there were many processes being performed which resulted in a discharge NOT as part of the Ar suite, so an additional 50% reduction was assumed for inventory loading.

As there were three fully packed (with sieve) containers within Box 18 of the Ar plant, the final inventory figure was for all three To obtain a figure of Bq/g for each container meant dividing the total inventory by the number of sieves (3) and also the estimated weight of sieve material in each container (2620g). The density of 4A molecular sieve was $0.715gcc^{-3}$, and $3665\ cc^{3}$ was allowed for in each container as assessed by X-ray photographs. These values gave a figure of $379.5TBq/(3 \times 2620g) = 0.048TBqg^{-1}$.[13]

X-rays had been taken of most of the containers to assess if they are “Full” of sieve material. This gave NO indication of the inventory contained within the vessel but is used “Crudely” to predict “Worst Case” hold-up within the container. This method was only used where no reliable data is available (the majority) for any particular container.

Due to the age of the lines, there was very little in terms of historic information or configuration control. Therefore each component of the line was individually marked and a detailed method statement was prepared for its systematic removal in a similar manner to the dismantling of the lines within the airboxes. Again as each piece was removed, off gas rates were measured before moving onto the next item. This eventually left the 3 sieves held in position by tie straps prior to final removal. For the transport of the sieve to the AX facility, specialist containers (AWG 644) were employed.

Lab 2 Argon Suite Treatment Plant

Lab 2 Molecular Sieve Removal

Decommissioning of Remaining Areas

DXY1 was divided into a controlled and uncontrolled area by a stud-work and fibre-board partition with a similarly constructed monitoring room on the controlled side of the barrier

Upon completion of decommissioning, the air boxes and internal ventilation ductwork extract fan and 9.2 m stack had been removed in their entirety together with the associated services. External apertures had been sealed with timber blanks.

Plant Room

A dedicated stack sampling system was present within the Plant Room to monitor discharges from the DXX5 stack during both operations and decommissioning. The Decommissioning of the plant room involved the removal and size reduction of all fans (including HPE), motors, steel mounting beams, bunds, steam lines, heaters (including anti-frost coil), fly-screens, linoleum, electrical supplies (including lighting) and water supplies. All services passing through the lab have been terminated and removed, including the fire detection system. The plenum and ventilation ductwork has been removed in its entirety, and the resulting apertures in the walls, ceiling and floor covered by timber panels.

DXX5 Stack & External Ventilation Ductwork

DXX5 was the 30m stack which discharged the output of the Main Building and HPE Extract systems. The stack was of steel construction and free standing, connecting to a concrete plinth

The preparatory work involved the erection of a large scaffold structure to enable a number of stack metal core samples being removed for destructive assay. These results showed that the material was to be consigned as LLW.

Stack section retaining bolts were either loosened off or replaced. It should be noted that the lift required a high degree of planning and co-ordination which required the temporary evacuation of nearby buildings, liaison with emergency services, road closures and protection of services.

The stack was removed in its entirety during decommissioning, being lifted and lowered in two sections, before separation and size reduction and being placed in a HHISO. The studs in the plinth were cut flush to the base concrete and the earthing strip removed.

DXX6 and DXX7 Delay Tanks, and Active Drains System

DXX7 was a large bunded area housing four effluent delay tanks. The tanks were used to store water pumped from the DXX6 sump tank. The bund walls and floor slab were internally coated with a bituminous material, and the floor of the area was covered with ceramic tiles.

Upon completion of decommissioning, the external drains had been removed in their entirety along with the associated support brackets and stands.. The tanks were lifted whole, wrapped and consigned as LLW to AWE's Waste Management Group (EP OP's) section for size reduction using plasma arc. Once the tanks were removed the tiled floor of the bunded area was lifted.

WASTE AND DISCHARGES

All Facility gaseous, liquid and solid Low Level Waste arising were subject to limits ratified under Radioactive Substances Act (RSA 93) by Environmental Agency (EA) Authorisation No BR8441. All Radioactive (RA) waste streams were accountable to the protocol established in current AWE Compliance and Arrangements documents.[8]

Airborne Discharges

Airborne stack discharges were well within RSA 93 authorised limits (Local Area Limit 120 TBq) throughout the six-year decommissioning programme. Discharges increased proportionally with decommissioning activity.

Calculation of airborne discharges for 2004 determined a KPI of 15 TBq proved inadequate to accommodate the programme of work and application was made to increase the KPI to 18 TBq. Provision of an accurate prediction of discharges for the conversion of inert atmosphere boxes up to air was difficult - due to the fact they had been under Argon atmosphere for some 30 years and the introduction of moisture would promote tritium off-gassing. Rate of air ingress governed utilising fine control bleed valves, in-situ oxygen monitoring and analysing discharge data after admitting each aliquot of air. Endorsement of the revised KPI facilitated continuation of the POCO decommissioning programme delivering an accrued discharge of 17.9 TBq for year 2004.

2005 discharge KPI was established as 130 TBq. These increased levels were deemed sufficient to negate constraints to the contractor driven Phase 3B decommissioning programme. However, discharges were very low for the remainder of decommissioning as the majority of surface out gassing already released from the now sentenced primary containment systems. Phase 3b activity gave rise to total annual discharges of 13.4 TBq 2005, and 300GBq for 2006.

Formal endorsement from Company Airborne Discharge Monitoring Group in June 2006 (Lab 6) and July 2006 (Main and HPE) enabled conversion of these points to an assessed discharge regime.

The well executed arrangement of work control enabled practical control of gaseous discharges from Phase 1 to Phase 3b gave a total discharge of 64 TBq.

Liquid Waste Arising

Liquid waste from non-designated areas of the Facility was discharged to the foul drainage system. During decommissioning activities, actual volumetric RA arising decreased compared to operational periods and activity levels continued to be very low despite the increased level of hands-on working (Fig 2). Discharges remained well within the $1m^3$/day allocation stated in the Waste Service Agreement (WSA).

An engineering estimate indicated 300kg of mercury in Toepleur pumps. This activity commenced only following endorsement of the revised RSA 93 Authorisation that includes provision for disposal of RA contaminated mercury to Winfrith

A programme to manufacture a bespoke containment system for long-term storage of highly contaminated oil was driven by the project team. The AWE Tritium Waste Strategy Best Practicable Environmental Option (BPEO) [15] determined incineration to be the best disposal option for legacy organic liquid wastes.

Hazardous Waste

Redundant chemicals and other substances considered to be hazardous to health were disposed of via the Trade & Toxic Waste Group utilising the Company Form 43 system. A total of 150 forms were forwarded for period 2001 to 2006.

Solid Waste

The Facility operated a waste minimisation at source policy that restricted the quantity of material taken into controlled areas. Minimisation of solid LLW was achieved by enforcing an efficient packaging regime utilising vacuum packing of soft waste and, where practicable, size reduction of hard waste. Many items were identified which, following removal of actual or potentially exposed parts, were consigned as Free Release Waste (FRW). It was impractical to attempt to utilise destructive assay methodology to prove a large number of items as contaminated below free release levels due to likely generation of a disproportionate amount of secondary waste. The Facility successfully utilised reusable coveralls that are laundered in line with site policy.

Generation of solid waste prior to Phase 3b (accounted over the 2001 to 2006 period) totalled 17 tonnes LLW and 2.8 tonnes ILW. Solid wastes associated with normal operation of the Facility were generated during this POCO period. Such waste consisted of personal protective equipment commensurate with barrier crossing, decontamination and cleaning materials. Additionally, sentencing of hard wastes from ongoing decommissioning activities to dismantle and remove primary containment systems, redundant equipment and furniture contributed waste arisings.

Solid waste arisings escalated considerably during Phase 3b with programme dictating an 8 month period (Apr-Nov 2006). A total of approx. 60 tonnes LLW was sentenced utilising various containment options, and 1.6 tonnes ILW.

ASSURANCE PERFORMANCE

Assurance management systems were put in place to monitor the decommissioning activities and then evaluate their outcomes.

Abnormal Events (AE's)

During the decommissioning period 1 April 2004 to 31 October 2006 a total of 130 Abnormal Events were raised this compared favourably to the previous corresponding 31 month period.

Over 65% (85) of those raised were for contamination that automatically attracts severity level 1 accordance with the Company guidance. If the AE guidance had allowed, many of the AE at severity level 1 would have realistically been level 0 because Tritium is very mobile with a high specific activity and consequently constant monitoring and contamination control in this old facility was required.

There were 4 AE's involving personal injury one was a minor electrical shock from a HP counter and occurred 1,105 days since any previous injury in the facility. This was raised as a company issue and all 10 HP Counters across site were modified. One AE was a stiff neck from taking smears from a ceiling, which exacerbated a previous medical condition. The remaining two were minor scratches both severity level 0.

HEALTH PHYSICS

Personal Exposure

Both the AWE and RWE NUKEM were either classified radiation or monitored workers and registered with the AWE Approved Dosimetry Service (ADS). These staff were provided with either weekly or monthly bioassay samples to monitor for any internal uptake of tritium. During the course of the decommissioning project, dose budgets were provided for the individual tasks and were not exceeded

For the decommissioning period from 2001 to October 2006 the AWE Facility team consisted of 9 staff. The highest total individual dose recorded was 0.58 mSv with the average being 0.28 mSv. The yearly average dose was about 0.1 mSv which equates to about 1/10th of doses accrued on other AWE decommissioning projects.

The dose accrued by the RWE NUKEM team from January to September 2006 was very low. The total dose accrued (external and internal) by the 13 member team was 329.8 µSv committed effective dose (CED). The average dose to each member of the team was 25.4µSv CED [16]

REVIEW LEARN AND IMPROVE

- Management and allocation of Health Physics resources. In order than the Facility were able to plan and execute operations to meet its programme, there was a business need for HP to be transferred to the same Directorate as the Facility.

- Ensure that the Contractor is prepared to fully resource the project especially in the initial stages.

- Ensure that the production and approval of high level project documentation is made a high value payment milestone very early in the programme.

- Ensuring the programme is accurate and used as a document for then monitoring on a regular basis. This required critical scrutiny and required strong project management disciplines.

- Ensuring that RWE NUKEM managed the Site to the appropriate standard was a challenge throughout the Project. If AWE had assigned a site engineer full time to supervise the works (and is common practice on external sites) this would not have led to any unnecessary delays.

- There should be a way to interface with the decommissioning contractor at an early stage to make the writing of work procedures more efficient and logical first time and to avoid duplicated information where systems overlap.

- Using a previous stack lift experience formed the basis for the DX stack removal. This included using the same King Lifting supervisor.

- Consideration should have been given for using hot cutting techniques in the size reduction of the Stack and Extract ducting, this would have necessitated a change to the safety case, however, considerable time could have been saved.

Problem Areas

- Initially, the team had the wrong mix of skills and personalities which was not conducive to efficient working

- Time period to obtain suitable additional resource to support the project. Initially, Service providers could not meet the project requirements resulting in the Facility identifying, interviewing and recruiting their own resource.

- The Facility was forced to stop Phase 3a airborne discharges (and hence progress) in order to meet the Company KPI.

- Two years to procure a RAMTAP approved oil container. Long lead times install IT connections.

- Interface and approval issues for the installation of temporary accommodation. However, the Facility team located accommodation adjacent to the Decommissioning building thus enabling them to mobilise and establish a site presence.

- Increased rate of AE’s toward the end of Phase 3b, particularly the cutting of services was disappointing. A more clear identification method was required.

- Production documentation to the requisite quality was an issue at the beginning of the contract even though templates were provided.

Notable Successes

- Transfer of Facility to Decommissioning Division complete with specialist experienced staff in Tritium and building M&E systems proved invaluable

- Approval of Decommissioning Safety Case by the Regulator was both timely and without any major concerns being raised.

- The implementation, development and promotion of Target Zero in the facility without company guidance or programme. Today Target Zero values are fully endorsed at AWE

- Zero Lost Time Accidents (1105 consecutive days with a single injury). Zero Level 2 AE’s during Phase 3b

- Phase 3b was completed on time to budget whilst being £750,000 cheaper than the nearest complaint bidder and £60k under Contract value

- Recovery of a 55 day delay on a one year Phase 3b programme (see RLI above)..
- Removal of Molecular Sieves and stacks were successful high profile operations
- Consignment of solid and liquid wastes – estimation, control and management was very successful with no major issues being raised at audits.
- 100% Performance Measure score awarded by the Ministry of Defence (the only Project to achieve this within the Company)
- Phase 3a and 3b Decommissioning resulted in a 96% reduction in AWE (A)'s tritium discharge to the environment. Estimation and control of tritium airborne discharges was extremely well managed (within 2% of Company KPI)
- Company Assurance award for Target Zero, two AWE team silver awards and one team Gold award for the Project and Facility team!

CONCLUSION

- Very successful Project. Stake holders content, Assurance Performance rewarded.
- Knowledge is key – retain technical experts
- Approvals – Maintain Regulator interface
- Teamwork – Establish team with right attitudes and competencies
- There were no outstanding issues associated with the Engineering or Radiological end points. The remaining buildings have been left in the required condition for future demolition planned for March 2009.

REFERENCES

1. Environmental Programmes Management Plan EDMS1/801063A8/B/EP0800
2. Decommissioning Safety Case EDMS1/80081478/A/D7/S2900
3. Best Practicable Means Study AWE/WSC8/B/00/27/06/99
4. DX decommissioning plan Doc Ref EDMS1/8006F2EO/B/DX/D1000
5. Facility Hazard Category Reduction EDMS1/80077A4D/B/D7/S0100
6. Phase 3b Tender Specification EDMS1/80053AEB/B/D7/D1000
7. Gas Clean Up System Feasibility Study EDMS1/800EF447/B/D7/D1000

8. DX Discharge Monitoring Plan AWE/WSC8/S/32/62/01

9. Preliminary Characterisation Survey Results for DX Facility EDMS1/800A89CE/B/D7/S0100

10. RWE Characterisation RP/80144/09

11. Type 3 Asbestos Survey VNJ-4662-0018-1

12. Airbox Discharge results EDMS1/AFAD/DRMS/DEC06

13. Assessed Inventory of Molecular Sieves EDMS1/80095B49/B/D7/Q1100

14. Waste Service Agreement AWE/WSC8/S/32/19/01

15. Best Practicable Environmental Option EDMS1/80114EF4/B/D7/EP0100

16. Radiological Doses HP/80144/MR/012

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