

Harwell to end well



The Atomic Energy Research Establishment was set up in 1946 on a former military airfield at Harwell in what is now Oxfordshire. Harwell was the first site to be developed in support of the UK nuclear power programme.

England's green and pleasant land, plus the Harwell 'reactor area' during operation. The UKAEA is committed to accelerating its decommissioning

The Atomic Energy Research Establishment (AERE) site was originally part of the Ministry of Supply but was transferred to the newly formed United Kingdom Atomic Energy Authority (UKAEA) in July 1954, an arrangement which continues to this day. The UKAEA is a non-departmental public body which reports to the Department of Trade and Industry (DTI). The UKAEA was set up on a trading fund basis in 1986. In the early 1990s it was clear that parts of the UKAEA were suitable for privatisation and a large number of the staff at Harwell were transferred to the private sector when AEA Technology was privatised in 1996. The ownership of the site and responsibility for existing waste and decommissioning liabilities remained with the UKAEA, who is also the holder of the nuclear site licence. (All the UKAEA sites were licensed by the Nuclear Installations Inspectorate in 1990.)

In parallel with the privatisation of AEA Technology, there was a greater involvement of private sector contractors on the site. New construction work had been carried out by contractors from the start of the site but in

1995 many of the site infrastructure services were transferred to contractors. At the same time contractors became more extensively involved in decommissioning work and most of the decommissioning work is carried out by contractors selected by competitive tender.

A major recent change came with the formation of the Nuclear Decommissioning Authority (NDA). The NDA is now responsible for the decommissioning and waste management work on the former UKAEA and BNFL sites. The UKAEA now operates as a contractor to the NDA for the management and operation of the Harwell site.

HARWELL'S GOLDEN ERA

In the first few years of UK nuclear research at Harwell, existing Royal Air Force (RAF) buildings were converted into laboratories and were used to house some of the major research facilities such as the Graphite Low Energy Experimental Pile (GLEEP).

From the late 1940s new purpose-built buildings such as the B220 radiochemical facility started to be brought into use. During the 1950s the two materials testing reactors (MTRs),

DIDO and PLUTO, were built together with a whole host of supporting active facilities. All types of radioactive materials could be handled including short-cooled highly irradiated fuels, and high toxicity alpha emitters such as plutonium. Materials such as uranium were widely handled but, in the early days, in ways which were not as well controlled as today. This has resulted in many buildings at Harwell having had some radioactive use, albeit often at low levels.

By 1960 there were 6000 staff employed at Harwell, a significant proportion being scientists and engineers. In addition to the research facilities, radioactive waste management facilities were provided. A treatment plant was built for liquid wastes and effluent was discharged to the River Thames. Storage was provided for solid radioactive wastes, although in the early days this was only seen as an interim measure as sea disposal was used for many years to dispose of solid wastes.

The rapid growth of the site to meet the expanding nuclear programme, the construction of new buildings and adaptation of old buildings resulted in large numbers of radioactive handling areas across the site. (A contributory factor was the senior management focus on

science and technology which meant that the site was not well planned). This has had implications for the site restoration work now being carried out.

Many of the major radioactive facilities operated through to the late 1980s, although the BEPO (British Experimental Pile 0) and LIDO reactors had been shut down earlier and partly decommissioned. In the late 1980s many of the large government funded R&D programmes were running down and could no longer sustain the major research facilities at Harwell. The DIDO and PLUTO reactors shut down in 1990 followed by a progressive reduction in R&D and technical service work involving radioactive materials. The B220 radiochemical facility ceased to carry out R&D and technical service work in 2004. While there continues to be a wide range of organisations working on the Harwell site, most of the work involving radioactive materials arises from decommissioning of redundant nuclear facilities and the management of stored radioactive wastes.

SITE RESTORATION

The key elements in the Harwell site restoration strategy are to convert radioactive wastes into a form suitable for disposal or long-term storage and eventual disposal, and to progressively decommission the redundant nuclear facilities. The products of the work are packaged waste, clean land and clean buildings. The work has been carefully prioritised over the years to give a progressive reduction of hazards on the site. Account has also been taken of environmental considerations, public acceptability and value for money. Since the early 1990s, plans have been prepared looking to the complete clearance of the Harwell site with most attention being given to production of ten-year plans. As part of preparations for the NDA, more detailed plans have now been produced called the lifecycle baseline, which describes in detail the complete programme of work to clear the Harwell site.

DECOMMISSIONING

Decommissioning has been carried out since the early days of the site. Harwell has always been a research site and so experimental rigs have frequently been set up and then dismantled to provide space for new experiments. The BEPO reactor was decommissioned to stage 2 following closure in the late 1960s and the area around the reactor used for new work. Some of the early facilities set up in former RAF buildings were superseded by purpose-built facilities. An

example was the first decontamination facility which was partly decommissioned and then converted to an inactive materials development facility. This past use had important implications when it came to the final demolition of the building as unexpectedly high levels of contamination were found in some parts. If space was not required for new work some facilities were mothballed and left for later decommissioning. In these cases an important first step in decommissioning was to pull together as much relevant data as possible from archives and consultation with retired staff. Before 1986 there was no specific funding stream for decommissioning which did not encourage early removal of redundant plants if space was not needed for other purposes.

Across the Harwell site, decommissioning work became a major task from the early 1990s. The facilities to be decommissioned included MTRs, post-irradiation examination (PIE) facilities, plutonium handling gloveboxes, development plants and accelerators. Following the closure of the MTRs, the first priority was to remove the fuel and coolant followed by much of the peripheral equipment. The experimental rigs containing fissile material were removed from the reactor and size-reduced in the B459 former PIE facility. The rigs that did not contain fissile material have continued to be stored in the reactor structures. In order to ensure that the remains of the reactors could be safely stored to allow later decommissioning, an environmental control system was installed for the care and maintenance period.

The GLEEP low power reactor has been completely decommissioned (see *NEI* July 2004, p42).

In the B220 radiochemical facility some 150 gloveboxes were redundant by about 1990. Many of these were decommissioned semi-remotely using a robot. This technique reduced the time spent by workers in pressurised suits and allowed more extensive size reduction of the gloveboxes to allow the minimum volume for long-term storage. Two large plutonium-contaminated pressurised suit areas have been completely removed and one of the areas is now used for waste storage. With the cessation of use of part of B220 by AEA Technology, most areas of the building have been subject to post-operational clear out. All the lead-shielded facilities have been removed from the B393.6 materials examination building.

A number of buildings were used for chemical engineering development rigs. These contained a range of equipment

The intermediate-level waste vault store at Harwell



from that which was no more than trace active to equipment used for the development of vitrification processes for high-level waste at full levels of activity. In many cases these rigs had been mothballed when the experimental work had finished. This diversity meant that a careful approach had to be taken in decommissioning, using modular containment systems to control any radioactive hazards.

In some cases there were significant hazards that were not radioactive. In a building which had been used for development of the process used in the Site Ion Exchange Effluent Plant (SIXEP) at Sellafield, the main hazard was a form of asbestos insulation which coated the inside of the building. This necessitated provision of an enclosure around the building.

Since 1990 a total of over 90,000m² of building footprint has been removed from the site.



During the removal of graphite bricks from GLEEP's core, the tracks on which materials could be irradiated were exposed. GLEEP has now been completely decommissioned



Plant for the cementation of radioactive liquids and sludges

RADWASTE MANAGEMENT

The provision of an appropriate infrastructure for managing radioactive wastes is essential for any nuclear site, whether in an operational or decommissioning state. The standards and practices have evolved over the years, as have infrastructure needs. Low-level solid radioactive waste has been sent to Drigg in Cumbria for disposal for many years and this route continues to be used, albeit with significantly improved characterisation and waste packaging.

The sea disposal route was used for disposal of intermediate-level waste (ILW) until 1982 when the operation was suspended. The availability of this disposal route meant that for some wastes (such as plutonium-contaminated material) only limited storage was available as wastes were largely sent for disposal as they arose. Some highly active ILW was stored, often to allow

radioactive decay prior to disposal. Following the cessation of sea disposal, provision of increased storage capacity for ILW was a priority. At the time, the new stores were seen as being required to support the continued operation of the reactors and associated facilities. In practice, the new facilities have been crucial in supporting the decommissioning programme. The new stores were provided for contact-handled ILW such as plutonium-contaminated wastes and remote-handled ILW.

It also became clear in the 1980s that much of the remote-handled ILW held in the older stores was not suitable for long-term storage. The waste was stored in mild steel containers within tube stores. This prompted the need for further storage capacity and a vault store was built.

Recovery of the wastes started in 2002 using a fully contained and shielded retrieval machine. The recovered wastes are assayed by gamma spectrometry and active and passive neutron assay methods and packed into 500-litre cement-lined stainless steel drums for interim storage. The next stage will be the provision of a plant for cementing the wastes into the 500-litre drums.

In addition to the remote-handled wastes described above, there are also a range of other wastes including a range of sealed sources held in shielded containers which had been used for various industrial purposes (such as radiography). Many of these arose from the operation, by Harwell, of the former National Disposal Service. The sealed sources are generally very small in volume and so they are being removed from the shielded housings inside a shielded cell leaving only a small volume of ILW for long-term storage.

Liquid radioactive wastes have always been subject to stringent decontamination to allow discharge to the River Thames and the flocc precipitation process has been developed and improved to target specific radionuclides. In the last five years emphasis has been placed on reducing arisings at source. Substantial reductions have been achieved, partly due to changes in work patterns, but also through minimisation of effluent generation and minimising ingress of rainwater and inactive waste streams. It is expected to eliminate the need for the effluent treatment plant within about five years.

There are some stocks of effluent treatment sludges and liquids which cannot be treated for discharge. While these are held in double contained tanks it is a priority to cement these wastes.

A plant has been built to cement

these wastes and the work is expected to be completed by around 2008.

REMEDIATION

In the late 1980s it was found that there was contamination of the groundwater under the Harwell site with chlorinated hydrocarbons which, along with a range of other chemicals, had been disposed of into unlined pits in the chalk. This prompted work to review records and survey the site to identify any areas which had been used for disposal of chemicals and radioactive materials.

The survey work generated a programme of remediation work. The largest project was the remediation of the Southern Storage Area, an area at the south of the site which had been used for packaging of radioactive waste and disposal of chemicals, beryllium wastes and low levels of radioactivity.

The area had also been used as the RAF bomb store prior to 1946. In an extensive project, over 250,000m³ of soil was sorted and checked and 18,000m³ of wastes (including 230m³ of LLW) were sent for off-site disposal. There were also quantities of munitions, much of which was destroyed by controlled explosions on site. Stakeholder communication was a major part of this project. This included a variety of regulatory and official bodies and particularly the local primary school which was adjacent to the Southern Storage Area.

A project has been recently completed to excavate the chemical disposal pits in the Western Storage Area. These pits were used for the licensed disposal of a range of wastes including chlorinated hydrocarbons. A total of 24 'room size' pits have been removed for off-site disposal.

Some early decommissioning work which was not carried out to current standards has also resulted in the need for remediation. In the Liquid Effluent Treatment Plant some redundant effluent tanks had been demolished into the bund that surrounded them and covered with tarmac. Unfortunately there was some residual radioactive contamination associated with the tanks. The former tanks collected water which became contaminated and had to be treated. It also resulted in much of the rubble within the tanks becoming contaminated. This meant that a significant part of the rubble had to be treated as low-level radioactive waste when the area was remediated. A more effective initial decommissioning would have resulted in much less radioactive waste. In current projects decommissioning is planned to leave the area suitable for delicensing.



Excavation of the beryllium disposal pits

SITE INFRASTRUCTURE

Throughout the decommissioning programme the site infrastructure has had to be maintained in a cost-effective way to ensure that licensing and other regulatory requirements are met. At an early stage, the holdings of fissile material were reduced to allow savings to be made in security costs. Attention also had to be paid to the physical infrastructure of the site and buildings. Most of the utility systems dated from the 1940s and were life expired by the 1990s. The gas, electricity and water distribution systems were completely renewed in the 1990s. As well as providing infrastructure for new developments, the work was essential to support the waste management and decommissioning programme. Major cost savings resulted from the installation of local gas-fired heating systems in place of the central boiler house and associated steam distribution system. Improvements have also been needed to essential systems in radioactive handling buildings, particularly the provision of modern radiological protection instrumentation, improved ventilation systems and electrical rewiring.

USE OF CONTRACTORS

Much of the early decommissioning work was carried out by what was then 'in-house' staff. In the early 1990s there was a move to more extensive use of contractors both for decommissioning work and provision of services. Since the privatisation of AEA Technology, around 67% of the annual expenditure

has been with contractors. For decommissioning and remediation work the use of contractors has proved to be very successful and there are a significant number of competent contractors available for this type of work. In setting up contracts, care is taken to ensure appropriate allocation of risks between UKAEA and the contractor. This approach has worked well for both UKAEA and the contractors. Frequently a staged approach has been taken to decommissioning work so that the risks being taken by the contractor has been manageable. A knowledgeable UKAEA management team has been key to this approach to ensure that UKAEA can meet its safety and licensing responsibilities as well as providing overall project management.

For decommissioning of low-active facilities, a term contractor approach has been used successfully for some years. There has been sufficient work for two term contractors to be selected and a degree of competition between the two contractors has been maintained. The approach has provided UKAEA with a flexible and cost-effective way of working.

There are fewer experienced contractors available for decommissioning of facilities with an alpha active hazard. In some cases specific training has been provided to the decommissioning operations to ensure that they have the right level of expertise of working in situations where there is a significant internal dose potential. Very close supervision from UKAEA staff has been found to be

essential in these situations.

Many other services (health physics, some maintenance, production of safety cases, project management support) are supplied by contractors. Following the Health and Safety Executive/ Scottish Environmental Protection Agency audit of Dounreay in 1998, there has been some significant strengthening of UKAEA. This has been partly due to the need to be able to demonstrate that UKAEA, as licensee, was in control and an intelligent customer.

Where there is little or no risk transfer to a contractor and when the work will continue for some time it has often proved more cost effective to use directly employed staff.

SAFETY AND ENVIRONMENTAL PERFORMANCE

Throughout the programme of work, a high priority has been given to safety and environment. The same standards have been applied to both UKAEA staff and contractors working on the site. Where contractors are used, safety and environmental standards are made clear in the invitation to tender and contracts will not be placed with contractors that fall below a fully satisfactory standard.

There has been a progressive improvement in performance – as witnessed by a steady fall in safety events and lost time accidents. This has been achieved through improvements to systems, but more importantly through increased awareness of everyone work-



The 'reactor area' of Harwell. PLUTO and DIDO are clearly visible, LIDO has been removed, as have many auxiliary plant buildings

ing on site. An open culture has been encouraged with a steady increase in reporting of minor 'unusual occurrences'. Regular assessments are carried out against the International Safety Rating System (ISRS) and Level 7 has been achieved. There has also been a significant increase in environmental awareness and the site is certificated to ISO 14001. The decommissioning work has the potential to increase aerial and liquid discharges of radioactivity but throughout the programme discharges have reduced.

FUTURE PROGRAMMES

A wide-ranging review has been taken of the programme for completion of the restoration of the Harwell site and an improved plan has been submitted to the NDA. Previously the plan showed all the ILW being in a passive state by 2020 and complete clearance of the site by around 2050. Conversion of the ILW to a passive state will now be complete by 2015 and complete clearance of the site can be achieved by 2025 – provided that there is a route to send ILW from the Harwell site. The key change has been the acceleration of the programme for recovery and packaging of remote handled ILW from the old stores. A second improved retrieval machine is being procured and a contract is being placed for the construction of a cementation plant for the wastes.

In order to minimise new plant construction, treatment of some of the unusual wastes will be carried out in some of the relatively modern shielded cells in the B220 facility.

In parallel with the work on treatment of radioactive wastes there will be a progressive decommissioning of other buildings on the site. Priority will be given to buildings used for handling highly active materials. In B220, priority is being given to decommissioning the remaining gloveboxes used for handling alpha active materials. This will be followed by removal of the active ventilation system and clear up of the active areas. The B459 active handling facility will be decommissioned once it has completed the work on repacking radioactive wastes.

The work to reduce the arisings of liquid effluent will allow closure of the Liquid Effluent Treatment Plant by around 2008. The site drainage system will be decommissioned either by cleaning and leaving *in situ* or complete removal. Any remaining radioactive effluent arisings will be treated at source.

There are a range of buildings across the Harwell site that have been used for low active work, some of which continue to be used by tenant organisations. These buildings are a lower priority for decommissioning but they will be progressively checked, and radioactive contamination removed as required.


As noted above the Harwell plan is based on the assumption of an off-site route being available for ILW in 2015. The policy for ILW is a matter for government but UKAEA believes that there are significant advantages if sites such as Harwell can be completely cleared. The storage of ILW in a passive state requires the maintenance of significant security and safety infra-

structure costing over £5 million (\$9.1 million) per year. Availability of an off-site route for ILW also means that early decommissioning of the MTRs becomes the best option. The decommissioning of the MTRs is thus planned to take place in the 2015-2025 period together with the decommissioning of the BEPO reactor. The decommissioning of the MTRs could be delayed as the containment buildings will provide safe storage for some tens of years. There is a stronger case for decommissioning of BEPO as this is housed in one of the old aircraft hangars.

As buildings are decommissioned, the site will be gradually delicensed. This will release significant areas of land for new development either for government-funded science and technology projects or commercial uses.

A significant area of the nuclear licensed site has been surveyed and remediated where necessary to allow a case to be made to the regulator. The work has involved surveys of land and buildings including checking of core samples.

There are already a number of exciting new developments adjacent to the Harwell nuclear site.

The Medical Research Council has recently opened the Mary Lyon Centre which is part of the human genome project. The new diamond synchrotron is due to open in 2006 as a major new UK science facility and the existing Rutherford Appleton Laboratory ISIS facility is being extended. Harwell continues to be a major centre for science technology. 



Despite the decline of UKAEA activities, Harwell is thriving. Dominating this picture of the Harwell-Chilton campus is the new diamond synchrotron