Responding To Changes in the Decommissioning Plans for Demolition of a Former Active Handling Building at The United Kingdom Atomic Energy Establishment Winfrith

N. Brown, S. J. Parkinson, R. M. Cornell
RWE NUKEM Limited

A. T. Staples,
United Kingdom Atomic Energy Authority

All located at
Winfrith Technology Centre,
Dorchester, Dorset,
United Kingdom

ABSTRACT

The full decommissioning of the former Active Handling Building A59 at Winfrith in Dorset is being carried out by RWE NUKEM Limited under contract from the site owners and nuclear site licence holder, United Kingdom Atomic Energy Authority (UKAEA). Following recent government changes, the United Kingdom's Nuclear Decommissioning Authority (NDA) has now set up contracts with UKAEA for delivery of the site clean-up programme. The building contains two heavily shielded suites of caves originally used to carry out remote examination of irradiated nuclear fuel elements together with other supporting facilities. The original intention was to demolish the caves ahead of the building but after detailed consideration it was concluded that demolition of the building in advance of the caves was more operationally effective. As a result, the original decommissioning plan had to be reworked to reflect these changes.

The paper briefly explains how this situation arose and the means by which the problems experienced were overcome by a complete revision to the decommissioning programme. The updated plan has been adopted by UKAEA and work is now proceeding apace to clear the building of redundant items, to complete decontamination of all remaining areas and facilities and to carry out detailed radiological surveys to confirm that the building structure is clean and ready for demolition. Both cave lines have been completely decontaminated to low residual levels of activity and are essentially ready for controlled demolition.

This paper describes some of the significant tasks undertaken during the past year with particular reference to the decommissioning techniques that gave the greatest success and the limitations of others originally considered. Some of these processes were aimed at minimising the volume of low level waste (LLW) generated by using standard off-the-shelf equipment to remove contamination from ~5 Ton concrete blocks recovered from both cave line structures. A novel hot-cutting technique used to remove steel coatings from sections of each block was also instrumental in assisting with achieving this objective.

Finally, the paper sets out the plans that have been developed for the sequenced demolition of the building structure, the two heavily reinforced concrete cave lines and the base slab. This will include details of the means by which residually contaminated and partly inaccessible items will be recovered for disposal during the demolition process. The decommissioning programme remains on schedule and has been achieved by the employment of a non-adversarial team working approach between client and contractor. This has greatly assisted in developing cost-effective and safe solutions to a number of problems that have arisen during the programme, demonstrating the worth of adopting this co-operative approach for mutual benefit.

INTRODUCTION

The Active Handling Building A59 is a large facility constructed by UKAEA in the 1960’s in support of what was then a growing nuclear power generation programme in the United Kingdom (UK). The main purpose of this building was to provide two heavily shielded suites of caves that could be used for the post irradiation examination of a wide range of materials, including discharged fuel elements from power reactors. Decommissioning started in 2000 in accordance with UKAEA’s mission which is to carry out environmental remediation of all its nuclear sites and to put them to alternative used where possible. After a competitive tending process, the demolition contract was awarded to RWE NUKEM Limited with the objective of carrying out the full decommissioning and demolition of the building to time and budget in a safe, cost-effective and efficient manner. The contract requires RWE NUKEM to minimise the quantities of LLW and intermediate level waste (ILW) generated throughout the decommisioning whilst remaining below specified levels with both positive and negative financial incentives applicable.

The original decommissioning plans were prepared at the tendering stage and can be linked together to form a set of nine specific phases:

- Clearance of redundant equipment, benching and services
- Remote cleaning down to target dose rate levels to permit man entry
- Man entries to complete the removal of all residual items and carry out surface decontamination down to low levels
- Removal of mobile shielding window units, internal wing walls and shield doors and the encast ventilation ducting
- Final decontamination of all internal cave surfaces to de-minimus levels
- Demolition of the two cave line structures
- Clearance of all remaining out-of-cave facilities including decontamination bay and overhead cranes
- Demolition of the building structure
- Removal of the building slab and encast floor storage hole liners and other items

Progress with the decommissioning plan has been reported in three earlier papers [1, 2, 3], such that by the start of 2005 four of these nine phases were complete and work on the decontamination and final monitoring of the two heavily shielded cave lines was progressing well. Further, plans were well advanced to address the final four stages of the programme principally concerning the approach to demolition of all facilities.

Decommissioning operations are now complete in the two heavily shielded suites of concrete caves designated North Cave Line, (NCL) and South Cave Line, (SCL). These two facilities, which are almost identical in design but of differing sizes, have now reached the stage where they are essentially clean and demolition can be undertaken. The next steps are to concentrate on monitoring and disposal of the redundant equipment and other loose items within the building so that final monitoring of all surfaces can be undertaken. This latter process is currently well advanced and should be completed against an agreed protocol [4] by the end of 2005. There are also other processes to complete including the shutting down of the active ventilation systems, the decontamination facilities and removal of all above ground active ventilation ducting. Some progress has been made on all these fronts and experiences to date will be described.

The programme plan was to demolish the two cave lines in situ to minimise the risk of spread of airborne contamination. However, during a review of the building's structural drawings it emerged that cave line walls provided significant structural support to the building roof. Extra structural steelwork was also required to support the elevated roof above the South Cave Line. It quickly became apparent that the original decommissioning approach could not be sustained without significant time and cost penalty, so the programme was amended to allow for demolition of the main building first. This decision delivers some advantages since the challenges of controlling dust, noise and exhaust fumes from the demolition equipment inside a fully operative building largely disappear. Additionally, the internal brick walls constructed above the cave lines up to the roof height can be left in situ rather than having to be removed, and two of the five building cranes can also be left installed rather than having to be removed in sections to allow the cave demolition to be undertaken.

Plans have now been completed to support the demolition of the main building structure to be followed by the two cave lines and finally the building base slab. In each case there are challenging problems to address, not the least the separation of any residual radioactive materials from the vast quantities of clean materials such as bulk concrete and steel structures. This paper sets out the plans that have been made to address each of these issues and focuses on the progress made in deriving appropriate solutions.

CHANGE IN DEMOLITION ORDER OF FACILITIES

The original demolition plan provided for the removal of the two cave lines followed by the building structure and then the base slab. Towards the end of 2004 it became apparent that that the cave walls provided considerable structural support to the building steel frame such that the original plan would have to be amended. An assessment revealed that the costs and timescale required to provide alternative structural support to the building frame to allow the cave walls to be removed with the building in place could not be justified. As a result of a full review of the options, a decision was taken to demolish the building structure first, an outcome that provided both benefits and disbenefits.

During earlier within-building trials using demolition plant it was apparent that the noise, fumes and dusts generated during the demolition of the cave lines would require well engineered solutions to keep these hazards under control. By reversing the demolition order, the problems associated with these three hazards essentially disappeared and apart from needing to minimise dust emissions at all times, fume emissions and noise control could be treated routinely.

Above each cave line there are single skin brick walls rising to the full roof height of the building together with a number of associated plant items such as a 26 Ton crane and a large cold water tank. Between the two cave lines in the maintenance area there is another 10 Ton crane supported on rails mounted upon the sides of the cave walls. In the original scheme, all these items would have been dismantled and removed but in the revised scheme they can all be left in place and removed by the contractor. Other plant items can also be left in position including three further large cranes, all the building fresh air inlet plant, fans and all the distribution ducting running around the building. Apart from monitoring to confirm that they are free from radioactive contamination, all these items can be left in position and removed as part of the demolition plan for the building structure. This has significantly reduced the work required during the approach to demolition of the two cave lines.

A few disadvantages have also been introduced as a result of the change principally the early loss of basic services such as water, power, office and sanitary facilities plus cover for the remaining items, exposing them to the elements. There will also be the need to provide covered facilities to receive, process and pack the remaining LLW materials recovered during subsequent demolition into International Organization for Standardization (ISO) containers. It will also be necessary to close and seal all external openings in the cave structures and the exposed building floor to prevent the ingress of rainwater once the building has been removed. This will be quite a time consuming task but the 650 steel tubes cast into the walls and roof will only need to be waterproofed on their outer surfaces. The larger openings into the cave structure such as the original window recesses and entry doors will need to be closed and sealed and the whole structure made capable of withstanding the effects of the surrounding building demolition. Finally, the prior demolition of the building removes one layer of containment when it comes to consideration of the demolition of the two cave lines. However, the external structure of both cave lines is uncontaminated and by installing a large air-mover unit at one end of each facility and demolishing the caves from the other, some 'containment' can still be maintained during this process. On balance it is judged that these changes in demolition order have been largely beneficial and the work is now proceeding to achieve this objective. A detailed demolition specification has been prepared and external contractors invited to tender for carrying out this work.

DECOMMISSIONING PROGRESS

At the start of the year 2005 the two cave lines had been extensively decontaminated but still contained the steel floor and through-wall steel lined tubes and other items with fixed contamination. The active ventilation ducts had just been removed [3], and a major push was required to effect the final decontamination and monitoring of all cave surfaces in the presence of some of these residual active materials. As a result, a means of removal of the contaminated steel floor and other items was required and a decision made about the fate of the ~650 internally contaminated steel tubes penetrating the cave walls and roof structures. The overall targets for the year were thus as follows:

- Removal of cave steel flooring and other contaminated items
- Cleaning, closure or removal of the steel lined penetrations
- Shut down and removal of sections of the input ventilation system
- Shut down and removal of the above-ground hazard extract ventilation system
- Decontamination of the below ground hazard ventilation system
- Clearance of all redundant plant and equipment for reuse or disposal
- Decontamination and monitoring of all building surfaces.
- Preparation of the two cave lines for demolition

Removal of Cave Floor Plates by Petrogen System

Once the encast ventilation ducting had been removed, attention turned to removal of the residual activity at the cave floor. The majority of the cave floor was covered by quite heavily contaminated steel plates and earlier experience with complete removal of the contamination from these surfaces had not been good. It was thus decided to remove these items and this was achieved using a relatively novel cutting process (Petrogen) using an oxygen-petrol gas mixture rather than the more usual oxy-acetylene system. The process works in a similar way to the oxy-acetylene cutting but is much more efficient and can cut cleanly even when backed by cast concrete.

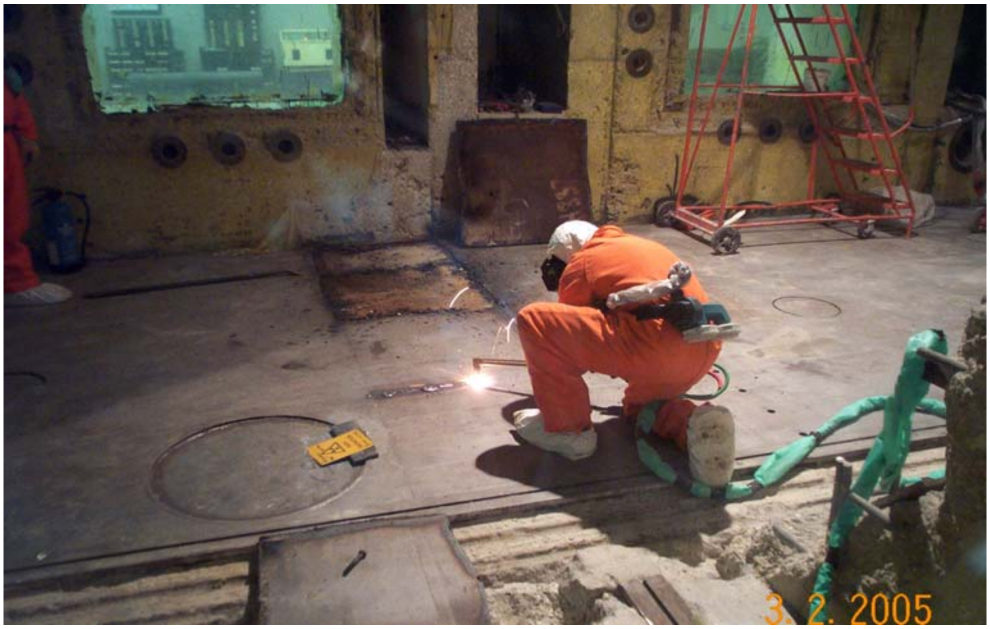

Fig. 1. Cutting away the steel cave floor using the 'Petrogen' System:

The system produces almost no liquid metal and leaves a powdery residue for recovery by a cyclone vacuum system after cutting. Operatives wear fire-retardant clothing, goggles and gloves and the cutting head carries a range of special nozzles to suit different types and thicknesses of steel. The petrol is held inside a pressurized container located in a bund quite clear of the cutting area and has to be pumped up to a set working pressure using a hand operated system to keep the process fully operative. Over a period of about two weeks, the whole of the floor plates from the larger NCL were cut away (Figure 1 above) leaving only narrow strips of more deeply embedded plates where the internal doors had been located.

After vacuum cleaning the floor, the gross activity levels in the cave were seen to have been significantly reduced and local monitoring then enabled most of the revealed ‘hotspots’ to be abraded and removed. Some of the ‘hotspots’ were found on deeply embedded steel rails spanning the length of the cave line and in most cases were cut away using the same process to good effect. The recovered debris was wrapped and placed into ISO containers for disposal as LLW.

Closure of Steel-lined Penetrations

As noted earlier, the two cave lines were known to contain about 650 steel tubes encast into the structure that originally carried a variety of services into the facilities to operate equipment. These stepped tubes range from about 75-300mm in diameter, are ~1.5m long and are slightly contaminated inside after cleaning.

Fig. 2. Typical steel lined penetrations recovered from cave line blocks being monitored in controlled area of external compound

Experience has shown that these tubes cannot be completely decontaminated to allow disposal as exempt materials and will thus become LLW. In an earlier paper [3], a means of recovery of these tubes intact during conventional demolition has been demonstrated (Figure 2 above) and it was thus decided that these can all be left in situ until demolition of each cave line is undertaken. However, each tube has to be internally coated with a tie-down paint to fix loose contamination and the open ends closed to contain any residual radioactivity and to prevent rainwater ingress on the outer face. This process has been completed except for some the internal surface closures with tubes below 75mm diameter sealed with expanded foam. This development has delivered a considerable cost saving ahead of demolition since the complete removal of 650 tubes by diamond drilling or other similar process would have delayed the completion of the programme by many months.

Decontamination and Decommissioning of the Ventilation Systems

The A59 ventilation systems are complex but there is essentially a fresh air input system with ducts running around the building and a filtered extract plant located close to the building stack where the building air is removed and discharged via a High Efficiency Particulate Air (HEPA) filter bank. There is also a hazard ventilation extract system which provides for removal of air from each cave line, the floor storage holes and the decontamination bay facilities using a set of fans and secondary HEPA filters ahead of its discharge to the building stack. The extracts from each cave pass through a set of primary HEPA filters located below ground in 2m deep pits before passing via encast ducting through to the secondary filter bank. Most of this ducting lies below ground with limited access but there are final sections greater than 0.8m in diameter above ground where they run to the secondary filters. All above ground hazard ducting has to be cleaned and removed for disposal but the encast ducting can only be decontaminated down to LLW levels and left in position for removal with the building slab at the end of the project.

The change in demolition order has delivered considerable savings in time as far as decommissioning of the fresh air ventilation system is concerned. The completion of the cave line decontamination earlier in the year has now enabled the fresh air and hazard ventilation systems to both be shut down permanently and only locally installed ventilation is now applied where required inside the building.

The input plant and ductwork delivering the air around the building will all be left in situ for removal during building demolition. The internal surfaces will be monitored for radioactivity but early tests show that these surfaces as expected are clean. However, the building extract plant draws air at one position from the whole building and tests show that there are traces of radioactivity in the filter bank and the associated ducting. The removal of all this building ventilation extract plant, fans and HEPA filters is currently in progress and work is proceeding normally.

The shut down of the hazard extract system was carried out with the specific objective that future decontamination operations could be carried out in a manner that gave the contractor full control over the direction of air flows. Tented enclosures were constructed around the above ground sections of ducting, and air-movers only installed when there was a major risk of release of contamination during the cleaning process or other operations. Where possible newly exposed internal duct surfaces were painted with a water-based tie down coat 'Spraylat' to minimise the spread of contamination and this proved to be very effective. The large above ground sections of ducting were successfully cut away, size reduced and wrapped for disposal as LLW. Some of these sections were fabricated from thicker steel and electric angle grinders had to be used to size reduce them for disposal. In this instance HEPA filtered air movers were required to control the potential release of contamination from these duct sections and these proved very effective.

The below ground brick and concrete floor pits gave considerable trouble and the deepest sections, 2m below ground, were heavily contaminated beneath a steel support plate used to locate the original filter. This 1960's design was deficient in that contaminated cave air was pulled out though a 45 x 15mm steel ducting into a free space roughly 1m square before passing through the spark arrest and HEPA filter, allowing any contamination to build up below the support plate. Initial activity levels here were very high in the 100's of millisieverts/hr range and over the years serious contamination had spread throughout these pits. In most cases the levels were reduced by vacuum cleaning, painting with 'Spraylat' and then chiseling away the contaminated pieces of brick and concrete for disposal as LLW (see Figure 3).

Fig. 3. Removal of contamination from below ground filter pit

The process was somewhat protracted and in two of the most heavily contaminated pits, the whole of the original brick linings had to be broken away for disposal. Nevertheless, all eight primary filter pits were reduced to activity levels below 1mSv/h, low enough to allow them to be resealed with 'Spraylat' and the decommissioning process to move on. The activity levels in the adjacent 2m x 1m 'cleanup' pits through which the cave extract air passed were also contaminated but at much lower levels than the primary pits described. The decontamination was relatively simple in these cases and it proved much less challenging to reach the <1mSv/h target activity level here in a fairly short time. The decontamination processes used were almost identical to the primary pit operations except that it did not prove necessary to remove any of the structure.

At the present time the whole filtered extract system, including the building and hazard extract systems are now isolated from the building stack, which has been sealed off at its base to prevent any further emissions to the environment. The plenum and associated feeder ducting is in the process of removal, decontamination and disposal mainly as exempt materials. All below ground hazard extract ducting has been sealed where accessible and closed ready for recovery and disposal as LLW when the building slab is removed.

Decontamination of Floors and Released Items

Many areas of the building have now had the thermoplastic flooring removed to reveal in some cases spots of radioactive contamination. In most cases the levels detected have been low and remediation has been achieved using an electrically operated scabbler to remove this activity in conjunction with a local tent and cyclone vacuum cleaner. In the cave maintenance area a survey of the freshly exposed floor revealed rather more areas of fixed contamination from spillages during operations in the distant past. In this case most were successfully chiselled away using hand tools and the application of a vacuum system to recover the debris, again working inside a tented but unventilated enclosure to ensure effective contamination control. In a few cases more deeply embedded contamination remained and these areas have been sealed with paint and clearly marked for recovery and disposal as LLW when the base slab is removed. To fully remove these local areas would have required much greater excavation of the floor, removal of deeply embedded steel rails and it was judged that this could be better undertaken during demolition of the base slab.

At an earlier stage of building decommissioning, the building was provided with a facility to carry out decontamination of some large concrete blocks released from the cave walls. This enclosure was about 10m square in floor area and provided with access for a heavy duty wheeled trolley from the storage area through a pair of full height clear plastic doors. A fuller description of this facility and its complex ventilation arrangements is set out in Reference 2. Upon completion of the decontamination of the concrete blocks, the same facility has been used to remove contamination from a series of floor storage hole shield plugs, which were essentially circular section concrete blocks cast inside a steel outer shell. The contaminated steel was cut away using the ‘Petrogen’ cutting system described earlier, backed up where necessary with electrically powered angle grinders. This enabled a considerable quantity of potentially LLW items to be converted into mainly recyclable materials and a much lesser quantity of LLW steel. A further series of items such as flask transport trolleys, wall shield blocks from the original inner-cave door recesses and other concrete shielding blocks have been processed here to minimise LLW arisings from the building strip-out operations. At the end of the process, this large decontamination facility has been cleared, decontaminated and dismantled to allow the building clearance to proceed. However, it should be noted that this facility was invaluable in helping meet one major contract objective in the building decommissioning, namely to minimise the amount of LLW released to below 750m^3. To date the amount created during the decommissioning is about 65% of target as the removal of the building structure, cave lines and base slab approaches. Careful monitoring of all potentially exempt materials has greatly assisted in achieving this objective but it should be noted that this process is time-consuming and careful judgment is required to focus upon items where the prospects for a successful outcome are high. Additionally, a clear monitoring and measurement protocol [4] had to be established early in the project to ensure consistency in the monitoring, backed up initially by separate material sampling and analysis to add confidence to the disposal decisions.

As may be envisaged, clearance of items accumulated in the building from many years of active operations has been demanding. However, many items were shown by monitoring to be clean and these have either been disposed of or removed to other sites for further use. This process will be driven to a conclusion over the next months, leaving only those larger, unwanted items that are clean and capable of destruction during building demolition.

PLANS FOR BUILDING, CAVE LINE AND BASE SLAB DEMOLITION

The clearance and monitoring of the building structure is now well advanced and includes a whole raft of items such as the inlet ventilation plant and ducting, the five building cranes, the walls, roof internal surfaces, floors, walls, etc. according to the established monitoring protocol.[4] This process will proceed towards the position when it will become necessary to relocate all staff from the building and commence the demolition process.

A full description of the demolition lies outside the scope of this paper but the clear intention is to provide the radiological conditions with the building structure to allow a relatively unfettered demolition to be undertaken using standard equipment. Before this can be done, the two cave lines will have to be prepared to withstand the demolition of the building structure by closing all openings where there were originally cave windows, access doors etc to ensure that they remain sealed and watertight before, during and after the building has been removed. Briefly it is planned to close these larger openings using concrete blocks secured by mortar as probably the easiest and most cost-effective way of achieving this objective. Support pillars will be used where required to provide greater strength where there are larger openings in accordance with usual building practice. The wooden doors installed in the maintenance chambers at the west of both cave lines will also be removed and replaced by blockwork. The 650 steel lined penetration tubes will all be closed at both ends by steel plates either bolted or welded into place, the external face covers being sealed with a waterproof mastic to prevent rainwater ingress. At the end of this process the two cave lines will then be in an acceptable state to withstand the demolition of the building, which will commence immediately. Although the building is large, this process should proceed quickly, to include recovery of the building stack, which may be slightly contaminated internally. No practical means of monitoring the inside of this 25m high stack can be devised ahead of demolition but its unbolting from the support structure and placement in a dedicated laydown area immediately after recovery should ensure that its ultimate monitoring and disposal can proceed normally.

Following the complete clearance of the building debris, the next stage will involve the slow and careful demolition of the two cave lines, also using standard equipment. All the debris will be closely monitored in small batches ahead of recovery for disposal to include reassurance monitoring of the debris in the site-based ‘Exploranium’ unit. This will allow the majority of the concrete to be crushed to subsequently become infill material for use on site when required. Any contaminated items such as the 650 steel through tubes will be recovered intact and processed for LLW disposal in a special facility to be erected for this purpose on the base slab. Marked materials and local areas of fixed contamination will receive special attention to ensure that these materials do not enter the potentially exempt disposal waste stream.

The final and most challenging stage of the planned demolition will concern the removal of the building slab after recovery of the large number of contaminated items from within its structure. The contractor will recover the identified items/materials in accordance with a prepared schedule until reaching the final items which comprise 110 floor storage hole liners and 14 other vertical tube penetrations into this slab, some of which are up to 6.5m deep. The final stage of the process will involve removal of the building slab complete together with the structural foundations that supported the steel stanchions used in its structure. Site monitoring and remediation will follow but this aspect lies outside the scope of the RWE NUKEM contract. A full description of these latter stages of the building demolition will form the basis of a future paper.

CONCLUSIONS

The decommissioning of Building A59 has advanced in a manner consistent with the required schedule, with demolition of the whole building due to commence shortly with completion by November 2006. The decontamination of the cave line internal surfaces to minimal levels was challenging but the development of an effective means of removal of the steel cave flooring and other sources of activity, mainly on steel items, led to a major reduction in background dose rates such that efficient monitoring could be undertaken. The earlier demolition tests carried out on concrete blocks from either cave line had also shown that the contaminated steel penetration tubes could be left in-situ to be recovered intact during the cave lione demolition.

The original demolition plan for the building has been revised with advantage to allow the building to be removed first followed by the cave lines and then the base slab. This has led to the development of a modified demolition plan for the project, allowing the deployment of conventional demolition equipment and techniques throughout this process, subject only to careful monitoring of the recovered debris to ensure it is directed to the correct waste stream.

Over the past year major progress has been made with decommissioning of the inlet and hazard ventilation plants and general clearance of the building of reusable and redundant items and services. The operation of a clear monitoring protocol established at an earlier stage has greatly assisted the achievment of this challenging objective.

Once again, a combination of good forward planning, the harnessing of operator enthusiasm and skill, the use of simple and adaptable tooling together with the vital support and confidence of the client are leading steadily towards a successful conclusion to the full decommisioning and demolition of Building A59 by the end of 2006.

REFERENCES

1. Miller, K.D., Parkinson S.J., Cornell R.M & Staples A T., 2003, Decommissioning of Shielded facilities at Winfrith used for PIE of Nuclear Fuels & Other Active Items. Proceedings of Int. Conf. on Waste Management, WM'03, Tucson, Arizona, USA

2. Miller, K.D., Tizzard, G., Parkinson S.J., Cornell R.M & Staples A T., 2004, Development of Decommissioning Techniques on a Major Nuclear Facility at UKAEA Winfrith. Proceedings of Int. Conf. on Waste Management, WM'04, Tucson, Arizona, USA.
3. Miller, K.D., Parkinson S.J., Cornell R.M & Smith, D.I., 2005, An Approach Towards the Final Decommissioning & Demolition of a Major Nuclear Facility at UKAEA Winfrith. Proceedings of Int. Conf. on Waste Management, WM'05, Tucson, Arizona, USA.
4. Drew, K.I., 2005, A59 Pre-demolition Radiological Monitoring. RWE NUKEM Report PSP/045700/031