Radiological Protection Challenges of Retrieval of Legacy Intermediate Level Wastes (ILW) at the Solid Waste Plant B462 RSRL Harwell

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ABSTRACT

Originally the United Kingdom Atomic Energy Authority (UKAEA) was involved in all kinds of Research and Development (R&D) into nuclear energy, including running a number of research nuclear reactors of differing types. The UKAEA site at Harwell, Oxfordshire was established in 1946, but the last reactor at Harwell ceased operation in 1990, therefore changing the focus of UKAEA towards decommissioning and radioactive waste management. Since 2009, the nuclear site licence and radioactive waste disposal authorisation for Harwell has been held by Research Sites Restoration Ltd (RSRL), who have been tasked with decommissioning the sites at both Harwell and Winfrith in Dorset on behalf of the UK Nuclear Decommissioning Authority (NDA).

The solid waste facility, B462, within the Harwell nuclear licensed site has been receiving wastes from this nuclear research for the last 50 years. One of the ongoing key projects involves the retrieval, repackaging, and storage of legacy Intermediate Level Wastes (ILW) from below ground storage tubes. The radioactive waste containers stored within the vertical storage tubes before 1988 were constructed of mild steel, and in a number of forms including "common or garden" paint cans and fruit tins. More recently, stainless steel receptacles with engineered sealing and release mechanisms have been utilised. The mild steel construction of some of the older stored wastes, sometimes limited control of waste container contents and the unexpected longevity of storage has caused some of these cans to have corroded and even disintegrated spilling their contents into the tubes. Radioactive wastes in this condition obviously increase the challenge of safe and controlled retrievals. New facilities have been provided to improve the throughput and effectiveness of retrieving and re-packaging of the historic ILW. For example, a second retrieval machine, RM2, has been designed to enable the recovery of over 6500 of these waste cans and their contents, whatever their condition. RM2 became fully functional in 2009.

This paper describes the work already undertaken to safely extract these historic wastes, focussing on the practical radiological protection challenges faced. Topics covered will include the radiation protection practices appropriate when dealing with issues such as waste deterioration, as well as the contamination control issues which arise a) at interfaces between modern engineered retrieval machines and simply engineered storage tubes, b) during access to multiple tubes and c) during the movement of machinery to enable further tubes to be emptied.

KEY WORDS – operational radiation protection radioactive waste

1 INTRODUCTION

The Atomic Energy Research Establish (AERE) and subsequently the United Kingdom Atomic Energy Authority (UKAEA) was set up to undertake Research and Development (R&D) into nuclear energy. This included the development, construction and operation of a number of research nuclear reactors at its site in Harwell, Oxfordshire. The site at Harwell was established in 1946, the first reactor was operating by 1947, most reactors and research facilities were built on the site between 1946 and 1960, and the last reactor at Harwell ceased operation in 1990. Since that time the focus has changed towards decommissioning and radioactive waste management. Since 2009, the nuclear site licence and radioactive waste disposal authorisation for Harwell has been held by Research Sites Restoration Ltd (RSRL), who have been tasked with decommissioning the sites at both Harwell and Winfrith in Dorset on behalf of the UK Nuclear Decommissioning Authority (NDA). The current plans are to decommission all the reactors on site by 2031, with the whole site closed following emptying of ILW storage facilities by 2064.

The solid waste facility, B462, within the Harwell nuclear licensed site has been receiving wastes from this nuclear research and now post operational clear out (POCO) and decommissioning for the last 50 years. One of the ongoing key projects involves the retrieval, repackaging, and storage of legacy Intermediate Level Wastes (ILW) from below ground storage tubes.

This paper describes the work already undertaken and ongoing programme of work to safely extract these historic wastes, focussing on the practical radiological protection challenges faced. Topics covered will include the radiation protection practices appropriate when dealing with issues such as waste deterioration, as well as the contamination control issues which arise a) at interfaces between modern engineered retrieval machines and simply engineered storage tubes, b) during access to multiple tubes and c) during the movement of machinery to enable further tubes to be emptied.

2 HARWELL's SOLID RADIOACTIVE WASTE STORAGE FACILITIES

The solid waste complex was built to process and sentence radioactive waste from the research, development and nuclear operations carried out by UKAEA and its predecessor at its research sites at Harwell and Winfrith. The complex includes stores for Remote Handled ILW (RHILW), Contact Handled ILW (CHILW), and Concrete Lined Drums (formerly known as Sea Disposal Drums, they remain on site since the voluntary moratorium for sea disposals in 1983). The complex also includes facilities for retrieval, processing and re-packing RHILW and a processing and packing area for CHILW and LLW operations including decontamination. A waste encapsulation plant has been built in the complex that will be used to make RHILW passively safe by encapsulating the waste that is in 500 litre drums with cement.

The key waste strategy targets at Harwell are to convert all historic arisings into a passively safe form or transferred off site, by 2026. This includes historic ILW arisings in tube stores, drummed legacy CHILW and beta/gamma and CHILW concrete lined drums. Legacy ILW and ILW arisings form decommissioning will continue to be stored on the site until a Geological Disposal facility (GDF) is available for disposal. To achieve this target, the ILW encapsulation plant (currently in in-active commissioning) will be operational by 2014, off-site disposal of ILW will subsequently be completed by 2060 and the Solid Waste complex fully decommissioned by 2063.

2.1 Waste storage facilities and waste processing

The ILW storage facilities have been receiving wastes for more than 50 years. The RHILW in stock and future arisings will be packaged into 500 litre drums in the cells of the solid waste complex. The sources of ILW included :

- Historic RHILW to be retrieved form the tube stores
- Nuclear materials such as research reactor fuels
- Radioactive sources e.g. from the former National Disposal Service (NDS).
- RHILW from decommissioning.

The majority of historic RHILW arisings were produced during the research and development work relating to civil nuclear energy production and the nuclear fuel cycle. Due to the nature of the work the wastes are very heterogeneous and in some cases the records are limited. There is a programme of retrieval, processing and repackaging through the head end cells (HEC) on the solid waste complex. Bespoke retrieval machines (RM1 and RM2) are used to recover the wastes from the older tube stores. The retrieval machines are required because some of the original steel containers have failed. The retrievals of legacy wastes from these older tube stores is discussed in greater detail below, however a relatively modern third tube store (1990) is used for the interim storage of waste in stainless steel cans and employs a simple gamma gate and shielded flask arrangement to receive and recover wastes. Once recovered the majority of wastes are processed and assayed in the HEC and packaged into 500 litre drums, which are then stored, ungrouted in a vault store pending immobilisation in the waste encapsulation plant.

The tubes stores, all consist of vertical below ground storage tubes, embedded in concrete. The older of the two legacy stores (B462.2) was constructed in the 1950s and contained at the start of retrievals 1310 cans in 422 tubes (2.5m deep). The second store (B462.9) was built in an inter-connected building in phases. The first in the early 1960s, with further extensions to the tube arrays in the late 1970s, which significantly increased the number of storage tubes in the building. On filling it contained 6650 cans in 777 tubes (4.5m deep). In 1991, 75 mm thick steel floor plates and storage tube covers were installed over both older storage tube arrays to provide additional shielding and hence reduce the background radiation dose rate in the building. In 1992 improvements to the building containment was made by including a building ventilation system. Wastes continued to be receive into these older storage tubes until the arrival of the new tube store in 1990.

A variety of tube sizes and tubes array spacing were constructed over a number of years – both square array spacing and more closely packed. Tube diameter varies from 250 to 400mm. Tube depths vary 2.4 to 4.6 metres in depth. The storage tubes are normally topped with steel lined concrete filled shield plugs, the depth of which varies from 230 to 400mm depth. Following original construction and during the loading of the older storage facilities with waste, staff would be walking on the tube shield plugs and the unpainted concrete surrounds, as shown in the photograph below. With the 75mm steel plates in place, dose rates at waist height are less than 5 μSv/h,. Dose rates at floor level can be higher and are variable depending on storage tube contents and array design. Floor surface dose rate may locally exceed 100 μSv/h, particularly if the 75mm shield plates have been removed to facilitate waste removal.

Storage tube array (including RM2 base plate shims)

Historic store loading operations utilised unventilated shielded flasks to deposit higher dose wastes into the storage tubes as contamination on newly packages wastes was not normally an issue. An accepted practice at that time was also manual lowering of cans using metal cables – doses being restricted by "hiding" behind shield walls whilst these wastes were being deposited within the tubes. Tubes could be loaded with anything from a single waste container up to around 10 wastes containers. The tubes contained no furniture therefore waste can simply rest one on another.

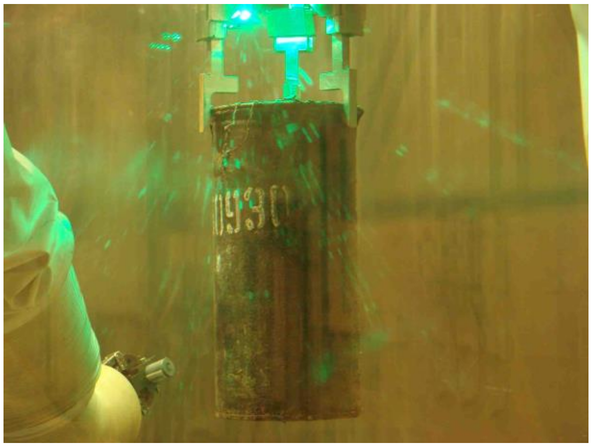
Modern retrieval machines are utilised to retrieve wastes from the older storage tubes because of the risk of corroded wastes. Two retrieval machines (RMs) are currently in operation, RM1 is capable of attaching itself to a single storage tube. RM2 is capable of accessing to up to an array of 20 storage tubes. Both machines are discussed further in sections below.

2.2 Wastes form

When the majority of the waste currently stored in the two older arrays were packed into containers, mild steel cans were used on the expectation that a long term solution to the UKs ILW waste storage would be promptly available. Neither a national deep geological storage facility nor a national surface ILW store materialised, leaving this older radioactive wastes with the potential to deteriorate. A change to the use of more long term robust storage cans (stainless steel) was made in 1988, however a large amount of waste was already in storage tube arrays, and as time passes the risk of more cans failing / corroding increases.

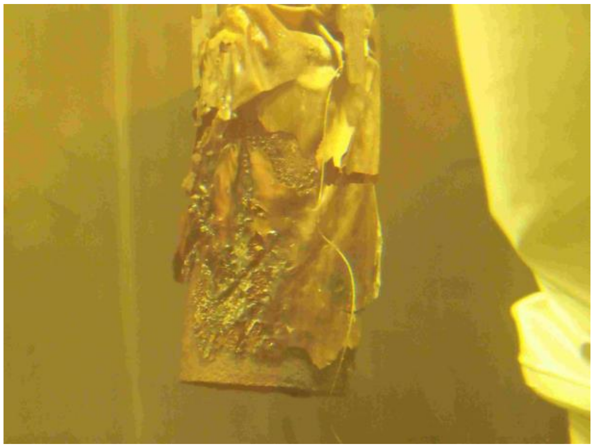
The mild steel cans used, in the majority were up to a few 10s of litres in volume, but could be as small as paint cans of a few litres. The mild steel construction combined with an atmosphere which includes damp/wet materials such a wipes used for decontamination, the presence of ionising radiations readily producing free-radicals and wide spread use of chlorinated hydrocarbons (plastics) for containment and wrappings has lead over time to both water induced corrosions, radiation induced corrosions and plastics deterioration of the wastes, waste cans and any wrappings.

The result is storage tubes which may contain waste cans in a variety of conditions, cans which are intact and in good condition, cans that are corroded but structurally sound, cans that are corroded but fail during attempted retrieval (e.g. the bottom fails out) so the contents fall back into the tube, or cans that are completely disintegrated and the can and its contents remain as a mix of wastes items, dust and corrosion residues (often referred to as ‘debris’ cans). A few examples of retrieved wastes are shown below. Current estimates indicate that 5 – 10% of the waste cans in the storage tubes will have deteriorated due to corrosion. Although the potential of debris is difficult to accurately predict, experience to date has shown that, in general, the cans at the top of the storage tubes seem to be in better condition compared with the cans deeper down.

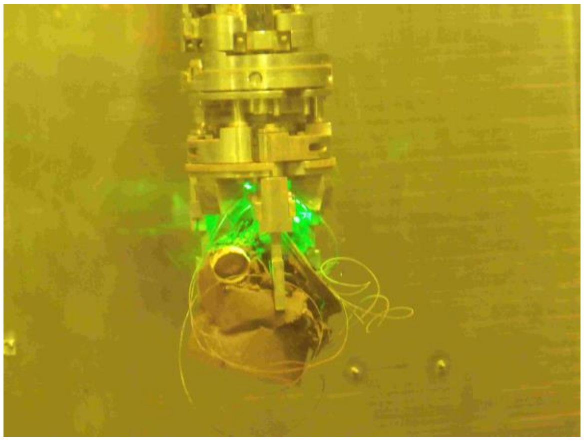


Intact waste can

Corroded but intact



Corroded and wrapping degradation



Debris retrievals

Although leaving these waste in their current location does not increase present worker risks significantly, the future potential risks are being elevated as the process of corrosion and waste degradation continue. It is therefore ALARP to retrieve and process these wastes sooner rather than later, to this end the programme of work required is to promptly retrieve the wastes.

2.3 Waste radiological inventory

The waste stores contain a large range of radionuclides, obviously typical of the period of research into nuclear fission from which the largest volumes of wastes originated. Across the storage tubes alpha bearing materials in the order of 10s of TBq (Pu-238/239/240, Am-241, Ra-226, U-235) are stored, as well as 1000s of TBq of beta/gamma materials (Sr-90, Eu-154/152, Cs-137, Co-60, H-3). There is also large variation in the radiological hazards associated with individual waste cans in storage. Each can is unlikely to contain a fingerprint typical of the whole waste store, instead the radionuclide fingerprint of each waste can will directly relate to the original producers of the wastes and the process being undertaken at the time. The waste from a post irradiation examination facility during a period when metals were being irradiated for say embrittlement studies will be significantly different from the ILW wastes which were produced as a result of research reactor operation that provided the high neutron flux for that particular experiment. This range of waste can hazards is further complicated by the presence of significantly numbers sealed sources, who in the majority will have a large inventory however these cans will have a low potential for failure as sealed source are normally double encapsulated with stainless steel.

Records indicate that just 0.3% of the wastes contain 27% of the total inventory of one of the legacy waste tube stores (20 cans out of 6647 cans), however 88% of the stored cans make up only 10% of the total inventory. In terms of external exposure risk, less than 10 cans have dose rates in excess of 100 Sv/h (at 300mm), most cans having dose rates of < 1 Sv/h at 300mm and in some cases (inventory and radioactive decay) dose rates can be less than 1 mSv/h. An examination of the internal exposure risk potential from individual cans stored shows only 10s of can having an Pu-equivalent exceeding 1 TBq, more than 50% of cans however have internal potential of < 10 GBq.

3 RADIOLOGICAL CHALLENGES OF RETRIEVAL OF LEGACY ILW WASTES

The majority of the risks associated with the retrieval of the wastes described are managed by engineered waste retrieval machines that consist of ventilated containments within substantial quantities of radiation shielding. Problem areas of have historically been associated with the interface of these machines with simply constructed storage tubes. At the time of the construction of the older storage tube arrays and loading of wastes, waste can failure and thus radioactive contamination was not anticipated and therefore the design did not provide an engineered contamination interface. The sections below discuss the main radiological protection features of the retrieval machines that are currently undertaking the task of retrieving these legacy wastes. Experiences will also be provided of the sometimes simple methods used to control radioactive contamination at the interfaces both with the storage tubes and the separation interfaces between parts of the retrieval machines needed to allow movement from storage tube to storage tube (or array to array). These simple methods have a role to play in both maintaining operational efficiency and keeping radiological risks as ALARP.

3.1 Interface with single ILW storage tube (RM1)

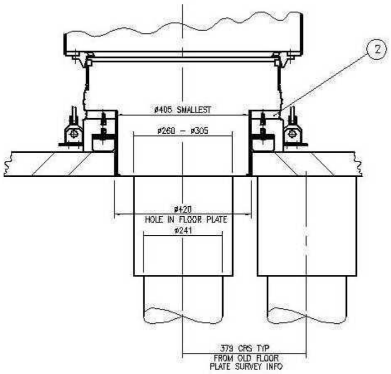
RM1 comprises a shielded upper module housing the main containment module (MCM), connected by two interlocked double-lidded ports to a lower shielded module (LSM). One of the MCM ports allows the transfer of the retrieved waste can from a single storage tube into the MCM while the other allows the transfer of the waste / can down into a transfer drum (TD). The TD is the standard container utilised for all legacy waste movements from retrieval machine to the cells for assay, sorting and re-packing into 500 litre drums. The MCM houses an in-cell hoist used for lifting operations into and out of the TD and storage tube. The LSM houses a storage tube shield plug box which forms part of the MCM containment during retrieval operations, and is used to store the storage tube shield plug during waste retrieval.

The LSM also has a gamma gate port to enable shielded transfer of the TD between RM1 and the flask. The TD is placed in a transfer-drum-trolley in the LSM and is moved between the MCM port and the flasking position along rails. Interlocked skirt shielding is also placed around the RM1 before the start of retrieval operations to ensure the machines shielding at the gap between the floor of the store and the retrieval machine, especially during the transients when waste is being withdrawn for the storage tube into the MCM.

The RM1 has a dedicated ventilation system. This ensures that the RM1 operates at a depression with respect to the building and any airborne contamination arising during waste retrieval remains within the confines of the RM1. The RM1 ventilation system extracts from the main containment module through a series of HEPA filters contained both local to the machine and in an adjacent plant room prior to monitored discharge through its own discharge stack.

During waste recovery, containment is provided by a combination of a bagging tube, lower module plug box, upper module containment cell and the ventilation system. The flexible bagging tube assembly maintains the containment seal between the underside of the RM1 LSM plug box and the storage tube. The bagging tube assembly height is adjustable in order to accommodate variations in the floor on which the machine sits. An internal steel guide tube is used to restrict the amount of debris (dispersible wastes from failed or corroded cans) falling into the RM1 plug box or bagging tube. The tube however incorporates some perforations to allow the RM1 ventilation system to operate without obstruction.

RM1



RM1 bagging assembly diagram

3.1.1 Contamination challenges

The retrieval of legacy waste using RM1 started in 2002 and is expected to be completed in 2012. The waste retrievals of intact cans throughout this period have largely been without issue. Intact cans can normally be "grabbed" relatively easily, and its movement up to and across the MCM from storage tube to transfer drum is a quick and simple one. The main radiological hazard is the penetrating radiation from these cans and the shielding of the machine has continued to provide adequate protection to this hazard. In these cases the retrieval of a couple of cans within a storage tube and transfer through the complex and be achieved in less than a couple of hours. Once the tube is cleared the machine is in a position to be dismantled to facilitate movement of the machine the next storage tube to be retrieved from.

The dismantling of the machine can normally be started once a) the storage tube shield plug is replaced, b) checks have been made that the dose rate within the machine is suitably low (< 1mSv/h next to the MCM containment box), so that the shielding can be compromised by lifting the shielded upper module away from the lower. At this point in the machines split the two double lidded ports are exposed. Simple wet smearing as a low risk protected operations (disposable coveralls, gloves and negative pressure RPE or airhoods) is adequate to deal with the low levels of contamination normally found on these seals. Over the last few years, this has been less than 1000 cps beta (100 Bq/cm^2) with little, if any, loose alpha.

Once the LSM is removed and the double lidded port that connects it to the bagging assembly has been cleaned (in the same way as the two ports between the upper and lower shielded module) this leaves the bagging tube that requires disconnection from the storage tube. The internals of the bagging assembly need to be accessed for decontamination. These internal surfaces have been part of the machines containment barrier during waste retrievals, and therefore the potential for loose contamination is higher. A small ventilated containment facility is therefore placed over the bagging assembly whilst it is still attached to the emptied storage tube to facilitate decontamination and detachment. Where debris has not been encountered during retrievals the activity associated with the bagging assembly has not normally been found to be considerable higher than that found on the double lidded port seals. In reality, any activity found in these areas is largely as a result of previous debris retrievals that have contaminated the port seals and this material is either sweating out or being moved out of port seals by compression.

When debris is encountered, which is to be expected for one in every 10 for 20 cans retrieved, the form of the material determines both the speed of recovery and clearance of the tube being visited and the contamination to be found at the point of dismantling of the machine. The presence of failed cans and therefore debris will take considerably more visits to the storage tube with a waste grab better suited for handling debris type materials. This in turn increases the number of traverses of the waste in/on the grab from the storage tube to the TD, and therefore there is an increase in the potential for contamination in the MCM, on the ports within the MCM, in the plug box and the bagging assembly.

When the debris materials are not too fine in nature, or fine but does not have a high concentration of activity, some additional care during machine dismantling (additional housekeeping, more frequent changes of gloves etc) has been sufficient to ensure that the contamination on the ports found during the machine dismantling is manageable (perhaps a few 1000 cps beta of smears of ports). However, over time ALARP challenges have led to the addition of further, sometimes simple, contamination control methods.

The use of port protectors, a disposable plastic collar that fits over and inside the double lidded ports, has been shown to significantly reduce contamination is these areas during debris retrievals. The double lidded port arrangements are detailed in their construction, and the ‘nooks and crannies’ present are difficult to clean / decontaminate effectively using remote methods. The port protector simply helps to keep the radioactive debris away from the port seals and the bagging assembly. A photograph below shows how the use of simple non-residue tape is used to protect the concrete and steel of the tube head beneath the bagging assembly. Contamination and debris that falls during waste retrievals has the potential to fall onto the floor of the tube store within the bagging assembly, therefore use of this tape simply and effectively protects the concrete from contamination during retrievals and makes the decontamination of the area following bagging assembly removal and decontamination significantly easier.

RM1 - tape use at tube head

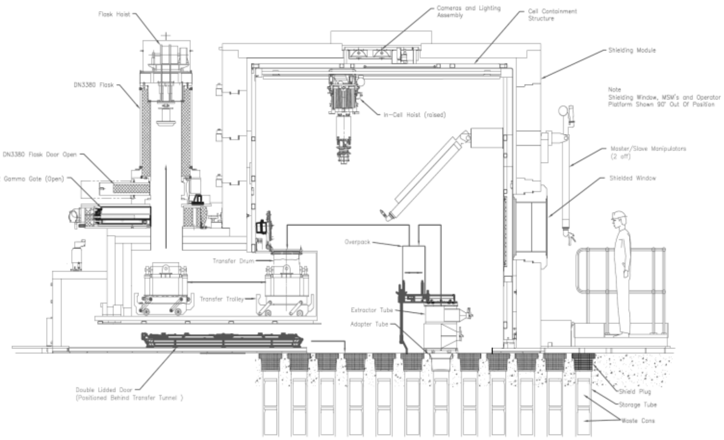
RM1 bagging assembly internals

On rare occasions, some waste forms have led to additional radiological challenges. At the time of a split of the machine after a tube containing particularly dusty debris was attempted, the small amount of debris normally associated with the ports was quickly identified as presenting considerably higher risks than usual debris operations. Initial health physics checks indicated more than 100,000 cps beta, a few mSv/h gamma dose rates local to the ports and beta/gamma dose rates in excess of 50mSv/h beta/gamma. The existing radiological hold points successfully stopped any further dismantling work. Subsequently, the machine was re-assembled to enable remote cleaning, i.e. vacuuming and swabbing inside the containment box using in-cell equipment. The picture below shows the internals of the bagging assembly at that time, showing a detached hoover nozzle (used in the remote internal cleaning) and the use of sacrificial beta/gamma dose rate instrument to check on gross levels of beta/gamma contamination inside the containment box and add confidence that sufficient cleaning had been achieved to allow the machine to be re-split. This internal check using sacrificial probes is now a routine radiological check always made following the retrieval of debris from a storage tube.

3.2 RM2 - Multiple Tube Access

Retrieval machine 2 (RM2) became fully functional in 2009 and successfully completed its active commissioning in 2011. It has been designed to enable the recovery of over 6500 waste cans and their contents, whatever their condition. It is similarly in basic function as the first retrieval machine (RM1), but with improvements to throughput and effectiveness of retrieving the legacy ILW from the tube stores. The main features to achieve this are the ability to access an array of storage tubes and more engineered features for debris handling, lessons learnt from earlier RM1 operations. RM2 is required to be assembled over 64 different arrays of storage tubes over its operational life. Nine of the 64 arrays will be completed by the end of March 2012.

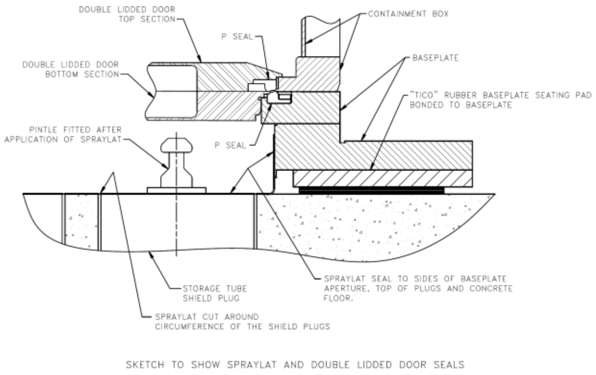
RM2 photograph



RM2 profile diagram

RM2 provides shielding and containment as the waste cans are lifted from the storage tubes. The waste is placed into a TD and transferred, using a shielded flask, to the cells for assay and packing into 500 litre drums, as with RM1. The machine has a dedicated ventilation system located in an adjacent plant room, connected to RM2 via fixed and flexible ducting. The RM2 containment box, which is considerably larger than the RM1 box, is fitted and sealed onto a baseplate. The containment box and base plate have corresponding apertures which give access to an array of storage tubes at a given location. A double lidded door seals the apertures (bottom of containment box and top of base plate aperture) so containment is maintained when the containment box is detached to allow movement of the box away from the base plate. A pair of Master-Slave Manipulators (MSMs) are available at a shielded viewing window to enable decontamination of the box interior and in-box maintenance. The majority of the required tooling for normal operations is held within the containment box, including a range of waste grabs.

The base plate requires to be level over an array of storage tube, to facilitate retrieval, so is placed on shims following a floor survey. The base plate aperture is then sealed to the tube store floor using a thick rubber compound (‘spraylat’) strengthened by the introduction of layers of muslin. This same compound is continued across the whole of the base plate aperture (across the storage tube array) to provide a contamination barrier for the floor of the tube store. To enable access to each individual storage tube a shield plug lifting pintle is then attached and the spraylat is cut around each storage tube shield plug to facilitate lifting.



RM2 Floor seal

RM2 Vortex debris removal system

RM2 has an in-cell hoist which enables the removal of the shield plugs and subsequently removal of waste cans and debris from the storage tubes. Within RM2 however waste on a grab is not traversed across the internals of the containment box, once raised a waste container is moved under the waste and the waste then lowered. This simple change reduces the amount of debris that both falls from the grab reducing cross contamination of in-box equipment and that falls onto the spraylat on the tube store floor inside the base plate aperture which makes the floor of the machine’s containment box.

As with RM1 when cans retrieved are intact, then few problems arise. Due to the large number of tubes accessible at each array however, the likelihood of no failed or debris cans from a single RM2 array is unlikely (and to date has not happened). An additional air vortex / air knife arrangement is used around the tube head to remove any dusts from both the grabs and the wastes when they first leave the storage tube and enter the containment box, again reducing the risk of cross contamination and contamination spread.

Once all the accessible tubes have been cleared and shield plugs replaced, the internal of the box and the spraylat floor of the box need to be cleaned to a level that will allow subsequent man access in to the baseplate aperture for decontamination of the baseplate tube array interface. Once the RM2 outer shielding is removed, the containment box removed , a large modular containment facility in build over the base plate when the base plate door is opened to allow the spraylat floor to be removed and the floor decontaminated.

At the end of an array there is normally levels of loose contamination around the floor of the containment box that mean that man entry using simple protections techniques (disposable coveralls, gloves and e.g. negative pressure RPE or airhoods) would not be possible or ALARP. However through the use of in-box decontamination techniques (vacuuming, tacky rags and lastly damp wipes – all undertaken using the machines MSMs) the levels can be reduced sufficiently to allow the machine to be shut down in preparation for dismantling. In-box monitoring equipment (both dose rate probes and a smear counter) are used to firmly establish in-box conditions prior to the in-box cleaning being considered as complete. ALARP studies indicate that RM2 must be decontaminated to maximum surface contamination levels of the order of 50 Bq/cm^2 alpha and 5000 Bq/cm^2 beta/gamma. However, a further ALARP study is undertaken at the end of each array, which considers all the radiological conditions in the RM2 containment box and ventilation filters within the RM2 shielding.

Experience on the workings of this relatively new machine are being gained at every array. Improvements have been made to the sealing of the spraylat layer to the tube store floor, following detachment of this containment barrier occurred during decontamination on an early array. Plastic disks are now also added to the top of each shield plug prior to the shield plug lifting pintle being added. The size of the plastic disk is just larger than the diameter of the shield plugs in the array. During an early array it was found that decontamination of the floor of the array was pushing contamination into the annular gap between he shield plug and tube. The location of this contamination would not be picked up by smears and its localised nature meant that in-box dose rates measurements (again using MSMs) did not show even the high beta/gamma dose rates present. When the spraylat floor of the baseplate aperture was accessed for decontamination and spraylat removal, localised areas of 10s of mSv/h beta/gamma were found. Improved cleaning around the storage tube heads with the shield plug removed, additional more detailed monitoring around the tube heads and the use of these plastic discs have nearly removed this as an issue.

4 SUMMARY

This paper has presented a brief history of the nuclear licensed site at Harwell, described the role that the solid waste complex played and the programme of work that continues to retrieve, quantify, package and ultimately make passively safe the radioactive waste that is contained in the legacy waste stores within the complex. A description of the wastes that have or need to be removed from the tube stores within the solid waste complex have shown a diverse range of radiological hazards associated with the large number of cans. The range of radiological hazards is complicated by the potential for the waste cans and their contents to have corroded over time and possibly completely disintegrated.

An overview was provided of how the radiological risks associated with these wastes are managed through the use of bespoke retrieval machines. Experiences have also been shared on the radiological protection challenges faced by largely contamination control issues that stem from both the interfaces of these engineered waste retrieval machines with simply engineered vertical storage tubes and the separation of these retrieval machines to allow movement.

In summary, the shielding and the ventilation systems deal with the larger hazards associated, i.e. when waste cans or debris are being retrieved the shielding ensures that dose rates outside the machines are low, and the containment boxes and ventilation system ensure contamination control during retrievals. However it is often questions on ALARP, raised during the dismantling of these machines, i.e. is everything being done that can simply be done to restrict exposures, which lead to the introduction of simple contamination control techniques. The examples shown in the paper included simple plastic covers, gaffer tape, plastic discs and additional reassurance health physics monitoring, that not only keep doses ALARP but increase the decontamination efficiency and thus retrieval efficiency for the operations of machines of this nature.

The retrieval programme for legacy wastes from the tube stores at the Harwell solid waste complex will continue for around another 10 years, but the future will need to meet some additional radiological challenges. These are currently likely to include:

a) Retrieval of radium / thorium wastes that are known to have high emanation rates (low barrier efficiency) thus suggesting potentially failed cans,
b) Increase in the rate of retrieval of legacy wastes by starting a 24h shift working pattern and a change to the overall concept of RM2 to enable it be moved intact, and
c) Establishing the methods to decontaminate and decommission emptied storage tubes.