The Future of Decommissioning at AWE Aldermaston - 11211

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ABSTRACT

AWE commenced decommissioning of redundant plant and facilities at the end of the 1980's. The traditional method employed was in-situ size reduction with disposal of waste to an ILW drum. There has been little attempt to improve this process or decontaminate these items to their lowest level. This is clearly not acceptable for the volume of highly contaminated plant and equipment that will be generated in the future. AWE is, therefore developing a programme of work to accelerate clean up of legacy facilities utilising best practice within the industry. This paper attempts to tell the story so far of a long term commitment to generating waste in its lowest hazard category by careful segregation, dismantling and decontamination to the correct level for long term storage or disposal. The processes involved are still at development stage but early indication is that the approach is sound.

PREAMBLE

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

AWE plc on behalf of the Ministry of Defence (MOD) manages the AWE (A) site and all undertakings including decommissioning.

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

Nuclear operations have been carried out at the AWE sites since the 1950s. This work involved various processes and activities including purification and recovery of plutonium and uranium, casting and machining of components made from beryllium, plutonium and uranium; operation of research reactors, tritium plants and radioactive waste plants.

Most of these activities have resulted in contamination of facilities with alpha-emitting nuclides and beryllium, although some facilities handled tritium and others are radioactive because of neutron activation (e.g. research reactors).

The Environmental Operations Projects Group manages the decommissioning at AWE and is involved with a number of decommissioning projects across the AWE site. The majority of the projects undertaken are Hazard category 3, 4 & 5 facilities, systems or plants which have the potential for on site / off-site release.

Over 40 facilities with nuclear liabilities have been identified at AWE (A). These are categorised and prioritised in accordance with AWE decommissioning strategy. A detailed 25 year programme is currently being progressed with foreseeable works out to 2060.

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

INTRODUCTION

As outlined above AWE is undertaking major decommissioning activities within facilities under its care. This work to decommission redundant plant and facilities commenced at the end of the 1980's and techniques continue largely unchanged.

The traditional method employed was in-situ size reduction. The traditional process was to identify an item of plant, glove boxes, fume cupboards or even a whole facility for decommissioning. Safety documentation is produced then a ventilated modular containment system is assembled around the item. The containment is fitted with breathing air and electrical service panels to support operatives wearing pressurised suits. The operators are then deployed with traditional hand held tools such as reciprocating saws, band saws, nibblers etc. The operatives then proceed to size reduce the item into manageable sized pieces and these are placed in an ILW drum and monitored. There has been little attempt to improve this process or decontaminate these items to their lowest level.

This is clearly not acceptable with the high risk of injection wounds, dose to the operator and for the volume of highly contaminated plant and equipment that will be generated now and in the future. AWE is, therefore developing a programme of work to accelerate clean up of legacy facilities utilising best practice within the industry by employing a range of innovations to reduce the risk and ultimately, our objective, is elimination.

AWE has therefore gone out to examine best practice across the nuclear community and have sought advice from our UK and USA colleagues to develop a new waste led decommissioning approach. A number of initiatives are being considered and some of these are discussed further within this paper.

INNOVATION 1 - TECHNIQUES

AWE has developed and implemented innovative techniques such as plasma cutting and diamond wire cutting in pressurised suit environments with varying degrees of success. Other commercially available equipment such as a passive aerosol generator and airless spraying equipment have been deployed along with bespoke mechanical handling equipment to minimise operator time at risk.

INNOVATION 2 - MOVING THE WORK

The traditional in-situ methodology is not flexible and leads to a lengthy strategy of constructing multiple containment systems. Each one requires erection, commissioning, decontamination and dismantling. It was decided that we would move large contaminated boxes into existing containments to allow us to move away from the traditional method of decommissioning and minimise the overall project timescales and costs.

Six glove boxes were selected and a full set of safety justification documents were produced to allow this to happen. The boxes were originally designed to be moved but have not been moved since the 1980's. This departure from the norm was considered to be novel and contentious therefore approval was sought through our Nuclear Safety Committee. Once approved the boxes were transferred into an existing Modular Containment System (MCS) to await size reduction.

Twelve months of preparation and planning took place producing paperwork, training operatives, validating equipment and gaining high level approvals.

The first part of the physical work was the building of a scaffold and enclosure around the top of the box to disconnect and remove services. This was followed by separation of a large transfer tunnel on top of the box. Figure 1 shows this process being undertaken within a purpose made glove bag, thus eliminating any spread of contamination during this task.

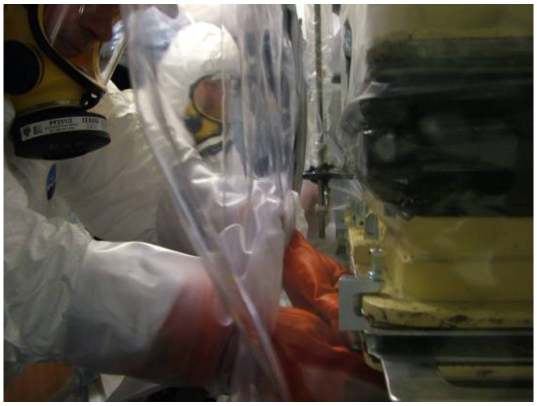

Figure 1 Transfer Tunnel Separation

Once all the preparations were complete the containment and scaffold were removed and the lifting and transport equipment bolted to the glove box. The lifting equipment was originally manufactured in the 1960's and required approval from the design authority for hazardous lifting before use. Each glove box weighs up to 10,000kg and an electric tug was used to provide the motive force to move the box, Figure 2.

Figure 2 Glovebox in Transit

The position of the glove boxes within the MCS was pre-determined and subject to movement control restrictions. The glove boxes were accurately located within the MCS and lowered back onto the floor. Figure 3 shows the first three glove boxes located inside the MCS.

Figure 3 Glove boxes positioned in MCS

Following the success of the glove box moves a second trial was carried out in an adjacent facility. This time the suite of glove boxes were not designed to be moved. An engineered framework was designed and installed around the boxes to allow the boxes to be moved without the risk of breaching containment between the boxes.

Both trials were successful and proved that it was possible with the right engineering solution to move glove boxes within the nuclear facilities to pre-determined decommissioning areas.

INNOVATION 3 -WASTE LED DECOMMISSIONING (WLD) PROCESS

The next innovation to be considered was the trials of decontamination agents at source within the containment system. Once the boxes were ready for size-reduction a waste led decommissioning trial process was established to test the process of decontamination and monitoring of materials as well as to test the effectiveness of each type of decontaminant material. The overall process flow is shown in Figure 4.

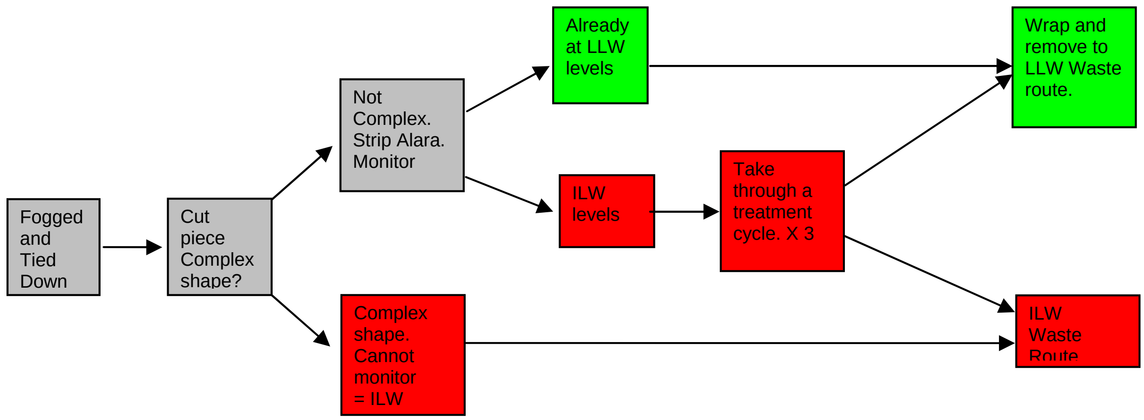

Figure 4 Decontamination Process

The process for the measurement and classification of waste items was designed to be applicable at any monitoring point in the process flow. It was also determined that items that could not be monitored would be segregated and disposed of as ILW as there was no benefit in monitoring them.

The boxes were firstly “fogged”. This consisted of a passive aerosol generator (fogging machine) sending a fine mist into the box which trapped and tied down any airborne contamination to the glove box surfaces.

The internal surfaces of the glove box were further tied down using a peel-able coating, then box size reduction commenced. As each section was cut from the box it was assessed against the process map. If it was suitable for decontamination it was taken to a preparation area for decontamination. Items not selected were disposed of to the ILW route.

There would only be three attempts to decontaminate each section as this was seen as a reasonable point to stop decontamination operations as they were liable to become “disproportionate” at this point. These constraints cumulated in there being a change in the interaction between Health Physics (HP) teams and the decommissioning operatives with one of the primary drivers for how the box was dismantled being the monitoring requirements for HP as detailed in the process outlined above.

The purpose of the WLD trial carried out in the facility was:-

- To dispose of a Glove box investigating the effectiveness of several decontamination products.
- To encourage the decontamination of Intermediate Level Wastes to Low Level Wastes.
- To determine whether cutting operations could be reduced in favour of dismantling or other methods.
- To assess whether dose uptake could be reduced using this process.
- To determine whether the risk of injury could be reduced.

These objectives are all dependent on the capability of HP monitoring to support these activities.

INNOVATION 4 – ACTIVITY ASSESSMENT AND DECONTAMINATION

To maximise the volume of waste disposed of as LLW a number of innovations have been tested. An outline of the surface contamination objectives process, decontamination techniques currently being employed, including, the use of household cleaning materials are described below.

Surface Contamination Objectives Process (SCO)

One of our biggest problems is being able to reduce Intermediate Level Waste (ILW) to Low Level Waste (LLW) levels or further to exempt levels whilst it is in an MCS environment. Therefore the trial utilised a process of activity assessment that met the requirements for Surface Contaminated Objects (SCO). Items must be monitored to provide evidence that they are suitable for both transport and disposal. The traditional method of assigning waste is to place the material in a waste package (drum etc.) and perform Passive Neutron Assessment (PNCC) on the total package. Unfortunately given the limit of detection for neutron systems this will result in the waste being almost exclusively intermediate level (ILW) and thus requiring long term storage on site.

For waste to be categorised as low level (LLW) a consignment must on average by less than 4000 Bq/g total alpha and 12,000 Bq/g beta gamma. However as a constraint for post closure risk assessment in the UK there is a limit of 100 Bq/g plutonium alpha activity in LLW. The only restriction on plutonium beta activity is the 12,000 Bq/g LLW limit.

The limit of 100 Bq/g plutonium alpha equates to approximately 0.001 g of plutonium/ drum (based upon average drum mass). This is below the limit of detection for PNCC based measurement systems and below the limit of detection for gamma based systems where high density material is present. Therefore if waste generated from the decommissioning of contaminated glove boxes is to be sentenced as LLW it must be measured prior to entrance into the waste package.

For transport of Surface Contaminated Objects they must be classified as SCO-I or SCO-II material. This classification defines the type of container that should be used for transport. These rules apply for off site moves under the carriage of dangerous goods and transportable pressure vessels regulations 2010, and on site through corporate policy at AWE.

- SCO-I material is limited to loose contamination on the object of 0.4 Bq/cm^2 and fixed contamination of 4000 Bq/cm^2 on accessible surfaces for plutonium contaminated items. This means that following decontamination within the MCS environment for material to be SCO-I it must be monitored to below 0.4 Bq/cm^2 or the material can not be classified as SCO-I.
- SCO-II material is limited to loose contamination on the object of 40 Bq/cm^2 and fixed contamination of 80,000 Bq/cm^2 on accessible surfaces for plutonium contaminated items. This means that the vast majority of material from the MCS will be classified as SCO-II.

The impact of this is that SCO-I packages can be transported without an over pack on-site but SCO-II packages require an IP-2 container such as a Full Height or Half Height ISO container to be transported.

Process For Monitoring

Surface contamination (Bq/cm^2) must be assessed for transport requirements and specific activity (Bq/g) for disposal classification. To allow the decontamination and disposal process to be simple for the operators conversion factors were derived to convert counts/second to Bq/g before the works commenced. The conversion factors were based on the density and thickness of the material to be disposed off.

Therefore for operational simplicity a series of limiting values (both sides contaminated) were calculated for common materials used in the construction of glove boxes. These values were presented in easy to use charts such that if the declared value was not exceeded then the item would definitely be LLW.

This approach however would lead to a large amount of material that is LLW being sentenced as ILW as no averaging of activity was being undertaken. It can also be seen that the values are relatively fine in increment and as such the accuracy of an RM5 readout is not acceptable therefore an alternative rate meter was used.

If an item failed to meet the simple LLW criteria a further set of measurements could be undertaken to assess the material. This required that the monitored item was divided into at least 2 but no more than 30 equally sized areas and that these were then measured. The mean and the 95% confidence value for this mean were then calculated. If the confidence was greater than 95% it would be disposed of as LLW and diverted from the ILW stream.

In addition the potential for hot spots on the item was assessed along with an indication as to whether removal of the hot-spot by decontamination or cutting would affect the status of the items waste category. This process may be repeated as many times as the item is decontaminated.

Following decontamination and monitoring of the item to LLW levels it would then be painted to fix contamination, wrapped and cleared from the MCS. It is however unlikely that in a MCS environment the item would be less than 0.4 Bq/cm^2 post painting and therefore arrangements for the transport of SCO-II material were considered prudent.

Decontamination Using Household Materials

As part of the utilisation of the SCO assessment process AWE attempted to decontaminate materials using some readily available household products to trial methods of reducing ILW to LLW.

These products were short listed from a range of possibilities that were thought to be usable, paying due regard to safety constraints within an MCS. Two cleaning products were selected from the following list. The remaining products are yet to be tested at the time of writing this paper.

> Rapid Alcohol, Lemon Juice, Firedam, Cerium Nitrate, Mr Muscle, Cilit Bang, Vanquish, Decon Gel and Decon 90.

All the products used a decanted amount and swabs were made wet with the product. The swabs were then applied to the surfaces and once used were laid to one side to dry.

It was found that Cillit Bang was successful at reducing contamination where grime and dust was holding contamination. The product is designed to cut through grease which may have contributed to its effectiveness. The product was seen to cut contamination levels in the hundreds to levels in the tens - 400cps down to 50 cps in a single application (i.e. 8 x cleaner.) In some cases multiple applications were needed. Cillit Bang was seen to be a very easy product to use and no residues were left on decontaminated surface with this particular product.

At the conclusion of the Vanquish trials it was seen that this product was a powerful decontamination agent. Again, the product allowed a certain amount of degreasing to assist cutting through the contamination which is possibly why it was able to take contamination levels in the range of 16000cps to a value of 500cps in a single application. (i.e. 32 x cleaner)

However, second applications were required to attain LLW qualification in some cases and it was reported back that the product left a residue. This could be removed using a degreasing agent such as rapid alcohol although this was not performed due to disposal criteria limitations (mixing of products).

The total amount of waste material produced during these trials is 3255 kg. If the soft waste figure is removed, the material cut from the box is 2493 kg by size reduction and dismantling of which approximately 378 kg is waste that had been decontaminated and its waste category reduced to LLW. This equates to 11.6% of the total box thus far decommissioned and the equivalent of 3-4 drums. In cost terms this demonstrates a saving on ILW disposal of £30-40K.

As a trial it has proven successful but further improvements in the process will be needed especially the monitoring of awkward shapes as discussed earlier.

INNOVATION 5 - SOFT SIDED CONTAINMENTS

AWE is also investigating the use of soft sided containments to allow greater flexibility when undertaking decommissioning and dismantling activities. The current preferred method is a Modular Containment System (MCS), Figure 5. The MCS is manufactured from re-usable GRP panels that require extensive decontamination and monitoring operations to enable them to be re-used or dismantled. Soft sided containments, Figure 6, should offer more efficient construction and removal times.

Figure 5 Current method MCS

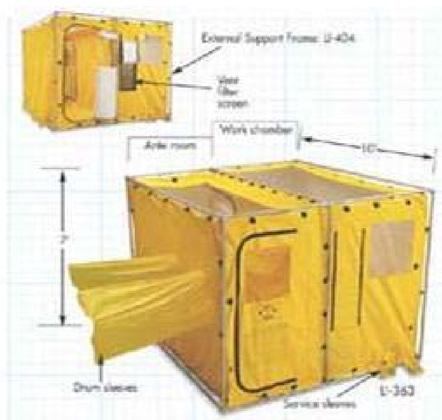

Figure 6 Proposed Soft Sided Containments

IMPROVEMENTS TO THE WASTE LED DECOMMISSIONING (WLD) PROCESS

Following the trials in the facility, it is clear that in order to undertake WLD properly, changes would need to be made to the decommissioning philosophy undertaken at AWE.

The health physics instrumentation available will need to be expanded. The current AP2 instrument allows alpha contamination monitoring of flat unpainted items. In order to sentence complex items or items that are painted we will need to introduce instrumentation to allow this. This may include contamination probes with smaller detectors to get access to tighter areas or x-ray monitors to allow sentencing of painted surfaces.

The current trial had the size reduction, monitoring, decontamination and wrapping of items being undertaken in a single MCS. This has two disadvantages:

- It reduces contamination control. Any contamination spread through size reduction operations will either need to be removed from the MCS prior to waste item monitoring. If X-ray monitoring is introduced in the future, the background from any contamination/other boxes in the MCS will be raised, raising the detection limit of the instrument.

- All work is carried out in serial. Improvements in time-efficiency can be made by separating the size reduction, decontamination and sentencing of items.

Consideration should be given to extensive “prior characterisation” of the glove box/item to be decommissioned. This would involve NDA, gamma-camera identification of hot spots, contamination monitoring of internals (using gloveports/glovebags) and removal of as much bulk material and contamination as is practicable such that contamination control is improved during the size reduction process. Prior characterisation will also allow a bespoke cutting plan to be developed such that the amount of ILW is minimised.

The size of items removed as ILW is currently limited by the packages available. HHISO/THISO/QHISO would allow the removal of large items, negating the need (and risk) of excessive size reduction (overall, PBAS size reduction operations need to be minimised as these are highest-risk).

A key area of implementation of these and other techniques is the need for a change of culture within the organisation. The move away from “we have always done it this way” has been a challenge. This is being overcome by good early communication, applying lessons learned as we go and good leadership. The AWE senior management is committed to achieving overall improvements and continues to lead and back up the process.

INNOVATION 6 - CONTAINERS

The final end product to the processes above is the packaging and transport of waste. ILW packaging operations currently undertaken by AWE are constrained by the 200 litre drum being the only acceptable ILW container for use on site. 200 litre drums, along with full-height and half-height ISO containers are the only acceptable containers for LLW, and the same containers are also used for VLLW. The choice of these containers was determined historically and the reasons behind this choice were not fully documented. No other waste containers are approved for use, although a 3m^3 box was previously used in the decommissioning of a Reactor, as an exception.

The sole use of the 200 litre container for ILW packaging operations results in:

- A considerable amount of size reduction of wastes;
- A subsequent increase in associated worker risk;
- Poor packaging efficiency for some wastes;
- Increased handling and transport operations;
- Increased storage costs;
- Increased decommissioning timescales.

AWE is aware that there is a range of ILW containers with NDA RWMD specifications in common usage at other nuclear sites, as well as several novel container types (e.g. WAGR box, TRU-Shield container, mini-stores), that are currently being investigated by various waste producers and are currently going through the LoC process.

Additional options for LLW/VLLW containers may also increase operational flexibility. In particular, third-height ISO containers might complement the range of LLW containers available at AWE, providing a cost-effective disposal option for some wastes.

Therefore we are carrying out a review of the current waste containers used in AWE decommissioning operations to make clear the constraints and benefits of the current container option(s) for ILW and LLW, and their alternatives. For ILW, the review will focus on containers with NDA RWMD design specifications, or that were undergoing the Letter of Comfort process at other UK nuclear sites. The review will take into account the suitability of the current waste packaging strategies for the wastes in question, the constraints in place for waste container use (access, current handling arrangements, lifting and transport arrangements, cost, monitoring, decontamination, interim storage) and make an assessment of the applicability of alternative waste containers for LLW/VLLW, the review would focus on containers for such waste already in use on other nuclear sites, including the third-height ISO container. Additionally, a cost benefit analysis will be undertaken in order to identify where there would be clear advantages in the use of any of the alternative waste containers and also the benefits of continuing the current strategy.

CONCLUSION

AWE is developing a strategy to reduce its legacy issues and to achieve this in its lowest hazardous waste form. The issues discussed within this paper are only the start of a long tem exercise to stream line hands on decommissioning, reduce waste to its lowest form and achieve greater efficiency while maintaining the safety of its employees. Various other decontamination techniques will be explored and if they become viable, they will be deployed at the appropriate time.

ACKNOWLEDGEMENTS

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