SEA DISPOSAL DRUM RETRIEVAL EXPERIENCE AND SUBSEQUENT INTERMEDIATE LEVEL WASTE MANAGEMENT AND STORAGE SOLUTIONS

H. R. Abbott, E. M. Davies, R I. Storrie
Amersham plc

ABSTRACT

This paper is a continuation of the paper presented in 2002, which outlined our approach to dealing with an historical legacy of pharmaceutical manufacturing operations, which arose as a result of the temporary cessation in 1983 of the sea disposal of intermediate and low level radioactive waste. It should be noted that these drums had been prepared during the 1970s and stockpiled for disposal.

The result of that cessation was an accumulation of 1061 sealed and capped reinforced concrete lined steel drums containing nuclear waste of mixed chemical and physical form.

We have since processed the vast majority of the drums and as part of our strategy for managing historical, decommissioning and manufacturing wastes, we have built an Intermediate Level Waste (ILW) store using up to date technologies. This has the capacity to manage all of the company's waste arisings out to a forty year horizon.

The overall objective is to reduce the financial liability of the waste with a strategy of segregation, progressive decay, size reduction followed by long term storage or residues in a retrievable waste form. We are now self sufficient in radioactive waste management and handling facilities until the provision of a national facility, currently predicted to be approximately the middle of this century. The paper will summarise lessons learnt in the operation of the waste handling plant and the strategies and policies used to develop our long term storage and decay facilities. In future papers we will be addressing how this policy and strategy has enabled specific decommissioning projects.

INTRODUCTION

Amersham plc is a manufacturer and distributor of products, which utilise the characteristics of radioactive isotopes. These products have been successfully applied to medical research and therapy. As a by-product of the manufacturing operations involved, radioactive wastes are generated. These consist mainly of items of laboratory equipment, glass, tissues, rubber and residual amounts of spent stock.

Until 1983 all wastes were sealed into reinforced concrete ballasted steel drums which were then transported by road to a Central Government holding facility. This facility was used to store all nuclear waste prepared in the same manner by operators within the Nuclear Industry. Once sufficient stocks had been amassed to fill a specially modified merchant ship, the stock was loaded and sent for sea disposal.

In 1983, in response to mounting concerns from Maritime Unions and Environmental Groups, the Government proposed the placing of a "temporary ban" on all sea disposal of nuclear waste until a more environmentally-acceptable solution could be found. As a result, Amersham, in line with other companies in related nuclear industries, decided to continue to prepare and seal the ILW drums in the same manner pending the result of the Government inquiry that was expected to recommend the eventual reinstatement of the sea-disposal route. Discussions continued until 1995 when it finally became clear that there would be no resumption of sea disposal of any nuclear waste, anywhere in the world. By this time the company had built up considerable stocks of prepared drums which were now classified as ILW.

During the 1990s a Low Level radioactive waste disposal facility was established by British Nuclear Fuels (BNFL) at Drigg in the North of England. Although the waste stored in the sea disposal drums was originally ILW, it was now over 10 years old. The nature of pharmaceutical production is such that many of the isotopes utilised are of short and medium half-life (mostly less than 10 years), and therefore a large proportion of the drum contents had gone through at least one half-life cycle of decay. However, the packing operations originally employed to populate the sea disposal drums were not isotope-specific and now, many years later, the conditions of acceptance for disposal of waste at Drigg are isotope-specific.

The problem faced by the waste team was that although they had access to a new disposal route for Low Level Waste (LLW), the route demanded specific radiological and physical qualities that the waste would have to adhere to, prior to disposal. It was clear that the only way of meeting Drigg's disposal conditions was to retrieve and re-characterise the waste, both isotopically and physically.

There were two major problems facing the project team. Firstly, the waste was encased within an eighth of an inch (3mm) of steel, which in turn was encased within 6 inches (150mm) of reinforced concrete, all of which was prepared 13 years previously. Secondly, the age of the waste meant that the extent of deterioration due to the combination of different physical and chemical types presented an indeterminate challenge.

Another characteristic of sea disposal was that isotopes were often mixed at random with respect to half-life and no specific measures were taken to reduce the volume of waste by efficient packing or segregation of different physical forms.

After a detailed review of the relevant records, it was decided that the most cost-effective approach would be to open the steel reinforced concreted and capped sea drums.

Having established a strategy, the writers were faced with the problem of how to achieve implementation. The first part of implementation was to open the drums themselves. At that point no other organisation had attempted opening the drums.

It was clear that such an operation could only be achieved within a purpose-built plant, which would facilitate the opening of drums followed by the retrieval, identification and size reduction of the contents.

Once segregated the waste could be packed into new containers intended variously for long-term storage in the case of ILW and immediate disposal to Drigg, in the case of LLW.

SEA DISPOSAL DRUM RETRIEVAL PROJECT

Lessons Learnt and the Construction and Operation of the ILW Cassette Stores and Decay Facilities

The last phase of the sea disposal drum retrieval project commenced on the 29th May 2002, with the final 305 drums to be processed through this facility. Approximately 60 per cent contained Beta Gamma isotopes and the remaining 40 per cent containing Alpha isotopes.

A unique facility was installed on one of Amersham's sites, which is capable of handling sea drums in all configurations.

Already, 756 drums had been successfully processed and this plant now had the specific and final enhancements installed, necessary to handle high gamma dose packages and loose alpha contamination which were a characteristic of this last group of drums. As such it represented the culmination of our technical expertise in waste management of sea disposal drums. This group of drums contained three variations of the standard sea disposal package.

All package types consisted of a 0.75 cubic metre steel outer, within which were placed three configurations, each of which was surrounded by a reinforced concrete annulus and completed by a reinforced concrete cap.

The first configuration was three layers of 7 x 5 litre containers. Each layer in a circular configuration and three layers stacked on top of each other. The interstitial spaces were back filled with concrete grout.

The second configuration, was a 200litre drum which had been placed in a reinforcing cage, within the primary containment, with at least 100mm spacing between the drum and the primary containment in all directions and the annulus field with concrete grout as before.

The third configuration was lead shielded drums of various volumes of approximately 100litres, placed singly within the primary containment and the remaining space filled with concrete grout as before.

During the processing of these drums, several challenges presented themselves largely as a result of the fact that the drums were prepared during the 1970s and early 1980s.

Shape of Drums

The basic design for sea disposal began with the 0.75 cubic metre steel drum, which was manufactured as a cylinder with a circular cross section. However, at the conception of this design no consideration was given to retaining the integrity of the shape, as the objective was only to contain the waste until it was dropped over the edge of the boat! It soon became clear that dimensional consistency was not maintained when the waste was prepared and the drums were in fact, of varying geometry beginning with circular at the base, and varying geometries of oval as you rose towards the top of the drum. The solution to this was an alteration to the cutting software to allow a pulsed approached to cutting and the ability for manual intervention and control of turntable and cutter speed in certain restricted circumstances.

Reinforcement Placing

The reinforcement was placed by hand and not by skilled construction operatives. As a consequence, there were large variations in the placement of reinforcement in relation to inner and outer package surfaces. In some cases, the reinforcement was in contact with the outer containment and in other cases in contact with the inner containment.

The solution to this problem was again manual remote intervention varying cutter speed, turntable speed and cutter pulsing as before.

Variable Package Placement

In all package types, there was some variation in package positioning but generally speaking this did not affect the overall operability of the plant as the cutting and splitting operations were unaffected. However, in the case of the package where a lead container was placed within the sea disposal package, horizontal placement was consistent, but the vertical placement was entirely random. In this case the solution was simple. Based around the fact that a masonry drill will not cut lead, it was a matter of consulting the records and drilling pilot holes horizontally until two of them hit lead!

Contamination

No routine contamination was experienced as a result of either handling the drum, cutting the drum or retrieving the drum contents. All dust suppression, mist clearance and air scavenging systems worked well. There were no breaches of containment by dust particles.

Other materials

In the 1970s, it was common practice to place loose items amongst the primary waste packaging prior to concreting. Typically these were lead pots or small glassware. Although these items were largely inactive, they presented the major portion of manual intervention with tongs, manipulators and concrete breaking equipment. This affected a relatively small proportion of the drums (10%) but accounted for a disproportionate delay in each case.

The Prequel (Long Term Packaging and Storage)

The prequel to the sea disposal plant was a waste strategy to deal with the arisings. In the UK there is a disposal route for LLW which is the BNFL facility at Drigg Cumbria and this is where the LLW from the sea disposal drums was despatched. However a significant proportion of the arisings were ILW, for which there is no disposal route in the UK and for which no facility will be constructed until at least 2050.

As a consequence it was decided that the company would be self sufficient in ILW management facilities until at least 2050. The sea disposal drum waste formed the initial part of this waste stream but in addition facilities for manufacturing and decommissioning waste would have to be provided for the foreseeable future.

Clearly a government supplied repository would not be available within the time span of the project due to the politicisation of any waste storage decision. The features of the waste repository would be as follows:

1. a clean, dry environment with no risk of contamination
2. simple, reliable technology, robust for at least a 50-year horizon
3. minimal maintenance requirements and operating costs
4. accurate and repeatable placement and retrieval facilities for waste management
5. easy identification of waste by remote methods
6. sufficient volumetric capacity for a 50-year horizon

The facility was therefore sized to accommodate all of the company's decommissioning and manufacturing waste arisings until 2050.

Located at our UK Grove Centre production site the facility had to be constructed within the existing congested nuclear licensed site. It was decided to use the 500l NIREX container as the primary waste container and the containment envelope for the waste. However for specific decommissioning projects shielded waste cassettes were designed which could contain Cs137 waste with unshielded surface dose rates of up to 10Sv/hr. These cassettes would contain the waste in such a manner that the surface dose rate of the stored cassettes would be reduced to 2mSv/hr.

Surprisingly (for me) the worst case scenario for dose was a single drum in the centre of the facility. After that subsequent drums could be arranged to provide shielding to other drums and the dose levels reduced. The drums were also designed to accept internal peripheral and top shielding.

Waste estimates until 2050 dictated the number of drums to be stored. The available footprint dictated the plan area of the building and the storage requirement the overall volume. The consequence of this was that the height of the building was pre determined by the need to stack the drums three high, with appropriate allowance made for horizontal separation to allow them to be picked up and resorted and vertical allowance for stacking rings. Once height allowances had been made for the craneage required for handling the drums and their transport over packs, the building was significantly higher than the local planning restrictions would allow!

Consequently the waste storage area was sunk below ground such that three layers of drums could be stored without the waste being higher than the surrounding area. A consequence of this design was that the bulk of the shielding for the facility was provided by the surrounding earth. With minimal shielding being provide by the building structure above ground. Only the control room and waste receipt area was sited above ground and the height of the building above ground was the minimum required to receive and distribute the waste via a travelling crane which had access to the whole plan area of the facility.

The crane was designed to be a simple twin parallel rope design which ensured repeatability of location to within plus or minus 0.6mm. This was combined with a laser targeting system attached to the crane and located against pre-determined fixed points on the building structure.

Although the crane was required to carry out six different functions on two types of container the whole functionality was based on a sequential mechanical device. All six functions are able to be carried out using the same grab with only two lifting devices, both of which can be attached or removed by remote control without the use of automation or computers. All functions are carried out using cameras and laser location.

All waste is transported to the building in two different sorts of transport overpacks; a 750l shielded 9.5 tonne container for the NIREX drums and a smaller 1.5 tonne 25l shielded cask for the high dose rate caesium waste.

The transport container is taken to the building using a purpose designed trailer and separate tractive unit which once docked with the building, has the transport container removed from the trailer via the labyrinth to the storage basement. Once in the basement the waste is removed from the shielded container and placed in its storage / decay position. When this activity is complete the transport container is re assembled and returned to the surface waste receipt area for re use.

Maintenance requirements are minimised by not attaching any items to the building. The crane carries all functions including cameras, lighting and monitoring equipment.

Shielding between the waste storage and waste receipt area is provided by a simple labyrinth terminating with a remotely controlled access gate which allows interface with the lower storage level. All remote activities are controlled from within the shielded control room.

The whole structure had to be watertight and was constructed to water retaining standards and as an additional measure, hydrostatic pressure around the facility was relieved by surrounding the structure with porous aggregate and providing a French drain and linked soakaways. The structure was tested for water tightness by filling it with 105,000 gallons of water leaving it for 14 days and measuring to see if it leaked (it did not).

Lessons Learned

This facility worked first time and has continued to be reliable. If this exercise were to be repeated, we would seek to increase traverse and long travel velocities of the craneage.

CONCLUSION

The facility was commissioned in 1999 and has been used to house the waste from the sea disposal drums and from our long term decommissioning programme. Using decay and retrieval for all isotopes with half lifes of up to 11 years, the facility will reach a quiescent state by 2025 and will never reach volumetric capacity!