RECOVERY & SIZE REDUCTION OF ILW FLOOR STORAGE LINERS

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ABSTRACT

A major task entrusted to NUKEM Nuclear Ltd (NUKEM) at UKAEA’s Winfrith Technology Centre concerned the recovery, size reduction and disposal as LLW of nine contaminated steel floor storage hole liners. These had been used to hold a variety of irradiated fuel elements and other items associated with post-irradiation-examination programmes on the site. Following a survey and monitoring of the general activity levels of these liners, it was established that two contained a quantity of water and corrosion sludge and seven were dry. NUKEM devised a safe means of recovery of these items from the floor storage holes in a cost-effective manner. A full assessment was made of the hazards involved in emptying the contaminated water and sludge from the wet liners and their subsequent staged recovery. In the case of the other seven liners that only contained dry sludge residues at lower radiation levels, a simpler recovery procedure was developed prior to decontamination, size reduction and disposal. This report describes the techniques developed for recovery of all the liners, including the means of removal of the contaminated water and sludges and the basis of the safety arguments used to support recovery operations. The whole process was completed ahead of schedule over a period of 6.5 months with lower than expected man absorbed doses. Examples of good practice were captured at the end of the operations for incorporation in future projects of this nature.

INTRODUCTION

Building A59 is provided with a series of floor storage holes of varying depths into which, over the past 30 years, various irradiated items have been placed for retention and later retrieval. Within this bank of storage holes there is a set of 36 deeper holes into which a number of irradiated water reactor fuel elements and welded cans of waste from post-irradiation examination programmes were previously stored. In order to accommodate these items, some holes were provided with a steel liner tube with a closed lower end in order to be able to retain the items in water for cooling purposes. All the fissile material from these liners had already been recovered and moved off-site.

One of the major tasks required by UKAEA in the decommissioning of facilities in Building A59, which was awarded to NUKEM, comprised the recovery and disposal of nine contaminated floor storage hole liners. Seven of the liners were dry and two contained up to 45 litres of contaminated water from the earlier programmes. Details of the liners involved in the operations are set out in the next section and their starting condition reflected the nature and state of the items stored in them over the years. Several of the liners, having held water for a long period, were in a corroded state and two contained hydrated sludge whereas, apart from containing dried sludge the remainder appeared to be much less corroded.

Surveys of the liners showed all to be contaminated to varying extents and a means of recovering these items had to be devised to allow their subsequent chemical decontamination prior to cutting up and disposal as LLW. One of the liners, M4, contained very contaminated water and sludge and for this and the second wet liner a detailed safety submission was required before recovery and subsequent disposal could be undertaken. The dry liners were perceived to present less of a hazard and recovery followed a series of detailed steps set out in a method statement. During all operations it was important to minimise operator radiation dose and to carefully control any risk of spread of contamination.

This report describes the processes carried out to recover and dispose of the nine liners and to comment on the overall performance against the original targets. The report concludes with a brief review of the whole process and draws together some of the important lessons learnt from the exercise.

DETAILS OF THE LINERS AND RECOVERY OPERATIONS

Storage Hole Liners Recovered

The nine storage holes formed part of a set of thirty-six located in Building A59 storage area and are identified individually in Table 1. The steel liners were 6.52m in length overall and 244mm in diameter over the lower 6.3m section with an overlapping larger diameter of 349mm over the upper 609mm portion of its length. This arrangement provided a stable sealed liner to fit into the floor storage hole, which was itself lined with a steel sleeve. This provided a small diametral clearance of about 13mm over the upper section with a more generous 50mm clearance over the lower section, although in this region the liner was fitted with shallow fins at $3x120^o$ to assist with centralising.

Recovery Programme and Achievements.

The programme of work drawn up by NUKEM showed the process of liner recoveries stretching from March 1997 to February 1998. The work fell into a number of phases but essentially the recovery of the seven dry liners was planned to span the period to the end of June 1997 with a further period of planning, set-up and commissioning of equipment leading to the recovery of the two wet liners. Within this period, time and resources were to be provided for production and approval of the necessary Safety Case for the recoveries, to include all the appropriate documentation such as Operating Instructions, Method Statements and Risk and Dose Assessments.

At the commencement of this programme, an Operating Instruction had been prepared setting out the basic details of the recovery process for the liners from the storage holes and into the Decontamination Bay for cleaning, size reduction and disposal as LLW. This Operating Instruction centred first on the liners from O2, M3, M2 and O1, which had been selected broadly on the basis of their dose rates and condition. It was later extended to include the other three dry liners M1, N2 and N6 following the successful treatment of the first batch. The dose assessments included timescales estimated for various aspects of the recovery operations and the anticipated dose uptakes by staff.

Briefly, the recovery process relied upon an ability to raise the dry liners from the floor using the 30Te building crane. The liner was pulled vertically upwards into a close fitting PVC sleeve to contain contamination. This process is shown in Figure 1. Once clear of the ground the sleeve end was sealed and the unit lowered down onto a handling trolley. The extreme lower end was known to be the most active and local dose rates up to about 30mSv/h were present in one extreme case. This part of the wrapped liner was covered with sheets of lead to reduce local dose rates to staff.

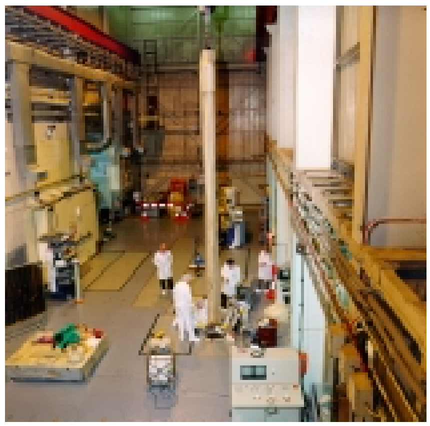

Figure 1: Recovery of Floor Storage Liners Using Overhead Crane

After recovery of the liner, the lower end was cut off in the Decontamination Bay using a band saw and then promptly moved into a fully shielded cave to minimise dose uptake. Here, the dried sludge was scraped out to effect a major reduction in dose rate on the liner end such that it could be removed from the cave and chemically cleaned to allow hands-on size reduction and disposal as LLW. The dried sludge was collected in a tray and recovered for disposal as ILW. The volumes of material involved were minimal. The first six dry liners were recovered and disposed of over the period March 25th to May 8th 1996 without mishap and well ahead of schedule. A small amount of mildly contaminated water was latterly detected in liner M1 and this was recovered with a peristaltic pump and disposed of prior to recovery in the same manner as before.

At this stage attention turned to the recovery and disposal of the two wet liners by a modified method, taking into account the need to control and manage the identified hazards. Specifically, there had to be a procedure to deal firstly with the water disposal and then the liner recovery. These new operations were supported by sampling and analysing the water from the remaining two liners O6 and M4 and by carrying out detailed activity surveys of the liners using a calibrated dose meter. The analyses revealed that the activity levels on the O6 water and liner were relatively low whilst those on the liner M4 were extremely high. For information, the water in M4 contained around 200GBq of beta activity (mainly Ba-137/Cs-137) and 2.6MBq of alpha contamination (mostly Pu-239/240). Additionally, the lower end of this liner was full of active sludge to a depth of about just over 1m with local dose rates of up to 220mSv/h. An activity profile of this liner also revealed local hotspots of up to around 50mSv/h at other positions. Subsequently, the O6 liner was pumped out, recovered and disposed of by the beginning of September and operations on the M4 liner were concluded by the beginning of October 1997. These dates were well ahead of the actual programme, which had originally extended to February 1998.

Technique Development for Liner Recovery and Disposal

Before the two remaining wet liners could be removed from their storage holes it was necessary to devise a satisfactory means of dealing with the water recovery and disposal and then a method of safely handling the very active liner. The methods adopted are set out below and on the basis of these plans, an agreement to proceed was achieved by early September 1997, based upon a series on specially prepared and assessed safety arguments.

The chosen technique was to transfer the water directly from the liners into a tray located inside one of the adjacent shielded caves using nylon hose connected to a peristaltic pump. During storage in the cave, the water was allowed to evaporate to effect an almost complete disposal. This process worked very well for both wet liners and led to a minimal quantity of debris for disposal at the end of the process. Dose rates on the PVC piping used for the transfer were very low and staff were kept away during this operation to good effect. This left the liners containing a variable quantity of damp and active sludge at their bottom end still needing to be removed.

In order to cope with the expected high activity levels at the lower end of the liner, it was decided to raise the item with the building crane and then cut off each in situ at a position about 1m above the bottom end. This would enable the lower activity section of each liner to be recovered and processed as for the dry liners, just leaving the more active lower section for special attention. However, before this could be done, a means had to be devised to retain the lower section after cutting to allow its safe recovery. Additionally, for practical purposes it was necessary to make this cut at a reasonable height above the floor.

The solution adopted was firstly to assemble a set of four 600mm high concrete blocks around the storage hole to provide a minimum of 500mm of local shielding for the liner. A steel plate was located firmly to these blocks, centred on the storage hole, in order to mount and retain a specially manufactured clamp ring made in two half-round sections and an industrial pipe cutter selected to carry out the liner separation.

The liner was raised from the hole using the same process as for the dry liners and secured to allow the lower end to be cut off at the selected height. The clamp ring was then tightened on to the liner circumference before commencing separation operations with the pipe cutter. The clamp ring retention to the concrete blocks enabled the cutting head to slowly part off the liner such that after about 15 minutes of continuous rotation a total separation of the liner had been effected. The longer upper section was then enclosed as before inside the PVC sleeve and moved to the Decontamination Bay for treatment and disposal using the same processes that were employed with the dry liners. Following demounting of the pipe cutter unit, the lower end of the liner was then removed from the hole with the building crane using a wire sling and two M16 eyebolts screwed into the clamp ring. The liner was promptly placed into an adjacent concrete-shielded drum with an internal bore of about 280mm and depth 1.25m to minimise radiation dose to staff. This drum was then moved by electric truck into one of the fully shielded caves for further treatment. Here, the liner was lifted out of the shielded container and laid horizontally onto the cave bench to allow recovery of the accumulated wet sludge using a half-round scoop attached to a long steel rod. The sludge was collected into a steel tray where it was allowed to dry slowly over a period of about two weeks. It could then be recovered as a dry powder and added to the earlier batch of debris originating from the dry liners. The empty lower end was further cleaned by swabbing and then cut up in cave using a powered hacksaw for disposal as LLW. By these means the two liners were recovered and all the materials disposed of via established waste routes with minimal volumes of ILW.

OPERATOR DOSE UPTAKE

Over the six month period involved with recovery of the nine storage hole liners, the total absorbed body dose for the staff was 4.8mSv with 2.59mSv from recovery of the seven dry liners and 2.21mSv from the two wet liners, (Table 1). As might be expected, the greatest dose was experienced with the M4 liner and in this case the levels were a little greater than had been predicted. There were clear reasons for this, which were subsequently related to the presence of a 50mSv/h 'hotspot' on the upper section of the liner which remained unshielded during many of the recovery operations. A little local shielding applied to the liner during handling might have effected a useful reduction in dose had it been appreciated earlier.

Overall, with around 15 staff involved in the operations, including Health Physics surveyors, the average total dose to staff was about 300μSv. This rate of dose uptake over about six months is not inconsistent with the mean exposure in a full year for staff in Building A59.

TABLE 1

LINER IDENTITY	TOTAL ABSORBED DOSE (μSv)	DATE REMOVED	COMMENTS
O2	299	25-03-97	Dry liner
M3	682	08-04-97	Dry Liner
M2	250	17-04-97	Dry Liner
O1	245	23-04-97	Dry Liner
N2	691	01-05-97	Dry Liner
N6	170	08-05-97	Dry Liner
M1	248	06-06-97	Dry Liner(trace water)
O6	45	04-09-97	Demonstration Wet Liner
M4	2161	30-09-97	Very Active Wet Liner

9 Liners	**TOTAL DOSE ABSORBED**		**4791μSv**
7 Dry Liners	TOTAL DOSE ABSORBED	2585μSv	
	Max 691μSv		
	Min 170μSv		
	Mean 369μSv		
2 Wet Liners	TOTAL DOSE ABSORBED	2206μSv	
	Max 2161μSv		
	Min 45μSv		
	Mean 1103μSv		

FINAL REVIEW OF OPERATIONS

At the end of the process involving the liner recovery and disposal a review meeting was held with most of the key staff in an attempt to capture issues which might be of value in subsequent tasks being undertaken in Building A59. In particular the objective was to learn lessons that might lead in future to lower operator doses or better practice and also to identify those aspects of the work that went particularly well.

The review noted the tendency for observers to attend when there were major events taking place, such as the recovery of the M4 liner. This was felt to be detrimental to the close control of operations and would in future be actively discouraged. It was also important to keep to well established routines and not divert from them for whatever reason. It was also important that all team members, including the decontamination bay staff, were aware of the activity levels on withdrawn items and the position of 'hotspots', thereby avoided excessive radiation exposure at all times.

There were several examples of good practice identified. The excellent control of contamination throughout the programme by use of well tried and tested methods such as double sheeting items with PVC and regular cleaning and changing of gloves were particularly effective. Additionally, the availability and use of suitable personal protection equipment such as air-hoods provided a very effective protection for the staff, particularly during the initial recovery of the liners. Overall, it was felt that the whole operation had gone very well and as a result the work had been completed in 6.5 months rather than the 11 months expected. This was a very pleasing outcome.

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