United Kingdom Atomic Energy Authority

WINDSCALE

E.E.C. Working Group
on Hot Laboratories and Remote Handling

1987 Plenary Meeting
Ispra, Italy

Management of Wastes
Generated in PIE Facilities
Part 1 - WNL

by M.D. Jepson
HLW is in the form of mechanical test samples from structural components. These represent a very small fraction of non-fissile waste arisings at Sellafield. Test programmes are planned so as to minimise waste so far as this is compatible with the generation of the necessary test information and the specimens are then disposed of to the highly active store or silo.

Fissile waste, particularly UO₂, has to be dealt with in a different manner. During metallographic examination three or four times the volume of fuel actually examined has to be resin (using the commercial resin Araldite) impregnated. This renders it unacceptable for reprocessing and a means of "de-Aralditing" had to be found. Dissolution of the resin with proprietary solvents is feasible but slow, expensive and, since the solvents are volatile and flammable, there are explosion risks. A technique of vacuum heating was developed which dissociated the resin with minimal effect on the fuel and a unit, small enough to install in a 1 m³ cell, constructed. The current unit, using demountable quartz iodine lamps as heaters, illustrated in Figure 2, has treated 20 kg of fuel to date. The "de-Araldited" fuel, together with any unimpregnated lengths of fuel pin and other collectable fuel debris is collected in suitable cans, batched by enrichment category, and returned to BNFL for storage pending reprocessing.

ILW

The categorisation, quantification and treatment of medium active waste is summarised in Figure 3. There are three significant categories:

1. Hard waste, ie non-compactible, primarily in-cell machinery. In general the contamination is superficial and not too difficult to remove to the extent that the item can be redesignated as low active and disposed of at a hundredth of the cost. However, decontamination can generate significant volumes of secondary waste, swabs, filters, solutions etc which counterbalance this saving and may involve significant (ie unacceptable) man-dose.

A method has therefore been developed which guarantees a significant overall reduction in volume of ILW and can be installed in a 1 m³ cell or at least operated with minimal exposure to the operator.

Jet and blast methods were discounted primarily as they transfer much of the contamination to other, larger, surfaces which would subsequently require treatment but also in view of the large volumes of liquid/abrasive waste generated. Ultrasonic cleaning was attractive and in bench trials was very effective but in-cell, the piezo electric vibrators proved short-lived, presumed due to irradiation, and the units constituted more waste than they cleaned. Trials of air operated vibrators, to simulate the effect of ultra-sonics, showed that these were reasonably effective and virtually indestructible. A family of vibro-bath cleaners, ranging from a mini-unit for specimens, lap plates etc, Figure 4, up to a dual 50 litre wash/rinse glove boxed sink unit, Figure 5 have been developed and installed. The principles are illustrated in Figure 6, the aqueous detergent solution is heated, electrically or by steam, agitated by the vibrator and continuously recirculated through a compactible filter. Several hundred in-cell items, tools etc, have been cleaned with only a few minor components, eg actual cutter heads, proving incapable of cleaning to ≤ 10 mSv. A few typical examples are listed in Table 1. The wash liquid is re-used, so there is little increase in liquid effluent and the displaced activity is concentrated.
into a small compactible filter. The units have proved to be self-cleaning, require operator attention only to load and unload and even when not in-cell, provided the filter is shielded, the process involves minimal man-dose. Adoption of this system throughout the facility is not yet complete but already the quantity of hard waste sent to silo has been reduced by a factor of five with a significant proportion recovered for re-use.

2. Soft waste, comprises anything which can be compacted under reasonable pressure and as well as the obvious swabs, gaiters, papers and cloths includes glass, aluminium and plastic containers. The earliest disposal procedure involved loading the waste into tins, weighting and sealing with cement and transfer to the wet silo. Following this inefficient procedure, an in-line press was developed to crush the cans; this reduced the volume to about one third and increased the density sufficiently to ensure sinking in the silo without the need to add cement. The next stage, as used at present, Figure 7, employs a more substantial can and multiple shims which retain the waste after compaction and allow full use of the whole can depth. Compaction ratios of up to 20 have been achieved but with a mixed charge a factor of five is more usual and disposals to silo have been reduced by that factor.

Within the category of soft waste, probably the largest and most inconvenient items for disposal are HEPA, ventilation filters. The UK standard, 600 x 600 x 300 mm, units in a steel case do not sink unaided in a wet silo (weighting them is a dirty, dose intensive job) and they occupy a disproportionate silo volume. For these reasons it became customary to monitor regularly the filters and to change them before they exceeded LLW limits ie using only a fraction of their useful filtration life. Attempts at volume reduction (and densification) by compaction have been thwarted by the strength (and elastic recovery) of the case. This necessitated powerful, large and expensive equipment plus some system of retaining the compacted size eg banding. Dismantling systems were ineffectual since much of the collected activity was released and even more waste generated. The success of the small, in-line compactors regenerated interest in HEPA compaction and the idea of pushing the filter media out of its case into a shim-lidded container was developed. A simple press, the platen of which is sized to the internal dimensions of the filter case, Figure 8, boxed in and this containment extracted through a small filter and discharged to the active ventilation system, was constructed. The unit has been used to compact numerous filters into 600 x 600 x 100 mm mild steel boxes with no measurable release to the working environment, or on to the local filter, and the operation has not detectably increased the man dose involved in the filter change operation. The filter case can be disposed of directly, or tank washed and then sheared (to reduced storage volume) as LLW.

It should be mentioned that efforts have been made to reduce the volume of arisings at source, eg by moving to lapping in place of papers for grinding but the impact is small. Most of the in-cell soft waste arises from protective devices, eg gaiters, decontamination/cleaning materials eg swabs, and non-reusable containers.

3. Liquid waste, mainly aqueous, lubricant and washings of grinding and polishing operations, contains a significant quantity of active particulates. It creates two main problems, one is deposition in the active drains, creating dose sources and rendering maintenance difficult; the other is environmental.
The original facility design provided relatively coarse filtration, about 50 μm, at each line of preparation cells with use of running water encouraged eg the inclusion of sparging (wash-down) systems, to give relatively large flows and so dilute the effluent. This did not prevent deposition in the drains and we have gradually moved to a minimum flow regime, replacing water with evaporable solvents where feasible and mini-tank washing rather than flow systems. More recently, work has been carried out to investigate the detailed nature of the effluent to justify our treatment methods, eg the quality of filtration required.

Examination of cutting and grinding residues has shown that most metallic particles are in the form of swarf, Figure 9, significantly larger than the particle size of the cutting medium eg 2 - 300 μm from 30 μm diamond. However, the reverse applies to UO₂, whatever the grade of abrasive, the particle size of the comminuted UO₂ was almost entirely sub-micron and in filtration tests showed no signs of agglomeration. These tests on unirradiated UO₂, using back-scatter electron microscopy to identify the particles, showed that about 50 per cent of the particles adhered to the cutting medium, Figure 10, but the remainder passed a 5 μm filter. The majority of these could be removed by micro-pore, 0.2 μm filtration (Figure 11). The individual particle activity is very low, less than 1 pCi, as is the bulk activity of the daily discharge, 5 μm filtrate comfortably meets current discharge criteria and this is the standard now adopted with all ingress points to the drain so protected. However, to minimise discharges still further and to prevent deposition in the drainlines of new facilities currently under construction, it has been decided to evaporate all in-cell liquid residues. The technique under test exposes the liquid in a shallow aluminium tray, to an infra-red lamp, also used to cure the impregnation resin. First indications are that one such lamp will easily cope with all arisings from a complete grinding/polishing sequence, including interstage washings, provided these are recirculated ie ultra sonic or vibro-tank. The intention is to continue use of the tray until the activity approaches 10 mSv and dispose to silo via the in-line compactors.

LLW

All items entering controlled areas are deemed to be contaminated unless proved otherwise; very few justify the time and expense of the detailed monitoring required to declare them clean and hence, nearly all is in the end sent out as LLW. The LLW flow diagram is shown in Figure 12.

As far as hard waste is concerned, little can be done except by review of working practices to minimise the quantity brought in, eg unpack outside the controlled area. Soft waste can be reduced by similar means, an example is the use of hot air hand driers instead of paper towels, but soft waste is also amenable to compaction. A simple commercial bag compactor has been in use for about 15 years, with no evidence of any local air contamination. However, the unit is operated in a maintenance area which is inconvenient. Design work is in progress to enclose the compactor in an interlocked, extracted containment box.

Continuing incentives to guarantee the quality of any discharge has necessitated a review of our treatment of low level liquid effluent. With a limit of 0.3 n Ci on any individual particle given as a target we have
concluded that any arisings in a controlled area must be considered as potentially unacceptable without treatment, and that 5 μm filtration is necessary. With no convenient site for installation of a unit to treat the collected arisings it has been decided to install local filters at all access points to the drain. Simple double felt bag filters have been adopted in sizes to suit the application. Floor washings are discharged via an in-house designed bucket sink, Figure 13, and the laboratory sinks are being fitted with similar, but much smaller filters. In new facilities, the same principle has been adopted but reinforced by second stage 5 μm filtration prior to a collection tank with sampling provision should sentencing of the effluent become necessary.

CONCLUSIONS

The simple, robust and relatively cheap devices described, by decontamination, compaction and filtration have reduced the volume of intermediate level waste by a factor of five. When fully implemented in new facilities, a further reduction of a similar order is expected.

Volume reduction of low-level waste has been smaller, but overall a factor of about three has been achieved at negligible cost.

There has been no reduction in the volume of liquid effluent but severe discharge criteria have been met economically and without significant interference with the post-irradiation examination programme.
TABLE 1

Typical vibro-tank results

<table>
<thead>
<tr>
<th>Item</th>
<th>Material</th>
<th>Radiation Level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Initial R/hr*</td>
</tr>
<tr>
<td>Air Pick</td>
<td>Steel</td>
<td>200 cps</td>
</tr>
<tr>
<td>Test Pieces</td>
<td>Steel</td>
<td>50 - 250 mR</td>
</tr>
<tr>
<td>Tong Sphere</td>
<td>Tungsten</td>
<td>1</td>
</tr>
<tr>
<td>Sphere Housing</td>
<td>Lead</td>
<td>1</td>
</tr>
<tr>
<td>G/P Machine Body</td>
<td>Aluminium</td>
<td>1.5</td>
</tr>
<tr>
<td>Flask Extension</td>
<td>Steel</td>
<td>4</td>
</tr>
<tr>
<td>Active Drain (5' T Piece)</td>
<td>St Steel</td>
<td>5</td>
</tr>
<tr>
<td>Tong Heads</td>
<td>St Steel</td>
<td>5</td>
</tr>
<tr>
<td>G/P Machine</td>
<td>Various</td>
<td>8</td>
</tr>
<tr>
<td>Drain Pump Motor</td>
<td>Various</td>
<td>11</td>
</tr>
<tr>
<td>Cropping Machine</td>
<td>Steel</td>
<td>25</td>
</tr>
<tr>
<td>Slitting Machine</td>
<td>Various</td>
<td>30</td>
</tr>
</tbody>
</table>

* Except where shown
+ Clear by swab, fixed in blades
FIG. 1  FLOW SHEET FOR HIGH LEVEL WASTE

HIGH LEVEL WASTE

FISSILE

CUT

SAMPLE

MOUNT

PREPARE

EXAMINE

BREAK OUT

DE-ARALDITE

CAN

REPROCESS

UN-CUT

WASTE

NON-FISSILE

CUT

SAMPLE

MOUNT

PREPARE

EXAMINE

WASTE

UN-CUT

SILO

HIGH ACTIVE STORE
FIG 2 VACUUM 'DE ARALDITING' FURNACE
FIG. 3 FLOW SHEET FOR INTERMEDIATE LEVEL WASTE
FIG 4  MINI-VIBRO TANK, PERISTALTIC PUMP & FILTER
FIG 5  GLOVE-BOXED VIBRO-SINK UNIT
FIG 6 DIAGRAM OF IN-CELL RECIRCULATED VIBRO-TANK
FIG 7 IN-LINE COMPACTION PRESS
FIG 8 HEPA FILTER COMPACTOR. BEFORE ENCASEMENT
FIG 9  GRINDING SWARF - ZIRCONIUM

FIG 10  UO2 DEBRIS ON SILICON CARBIDE

FIG 11  UOS DEBRIS ON 0.2 μm FILTER
FIG. 12  FLOW SHEET FOR LOW LEVEL WASTE
FIG 13 BUCKET SINK AND FILTER
DISTRIBUTION

Mr A C Demildt
Mr G Böhme
Mr Potts
Mr Carlsen
Mr J-C Van Craeynest
Mr B Marsico
Mr H J Wervers
Mr J B Sayers
Mr J Skinner
Mr J Cauwe
Mr G Samsel
Mr Quicheron

SCK/CEN-LHMAm 200, Boeretang, B-2400 Mol, Belgium
Kernforschungszentrum Karlsruhe, Abt.
RBT-IT, Postfach 3640, D-7500 Karlsruhe, Federal Republic of Germany
Kernforschungsanlage, Heisse Zellen,
Postfach 1913, D-517 Jülich 1, Federal Republic of Germany
Danish National Laboratory Risø, 400 Roskilde, Denmark
DTEC SELECI - Saclay BP2, F-91190 Gif-sur-Yvette, France
CNEN, Laboratorio Operazioni Calde -
Casaccia, Casella Postale N 2400,
I-00100 Roma, Italy
Energie Onderzoek Centrum, Petten(NH),
Nederland
UKAEA, Atomic Energy Establishment,
Winfrith, Dorchester, Dorset, DT2 8DH, UK
UKAEA, Windscale Laboratory, Northern
Research Laboratories, Sellafield,
Seascale, Cumbria, CA20 1FF, UK
Centro Comune di Ricerche LMA EURATOM,
I-21020 Ispra (VA), Italy
Europäisches Institut für Transurane,
Postfach 2266, D-7500 Karlsruhe,
Federal Republic of Germany
Commission of European Communities,
SCIC/CCAB-3/102, 200 Rue de Loi,
B-1049, Brussels