DECOMMISSIONING IMPACTS ON WASTE MANAGEMENT

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ABSTRACT

At Sellafield BNFL have a range of industrial scale nuclear fuel cycle plants some of which commenced operation 40 years ago and are now closed down. A decommissioning plan and program has been developed and costed for all of the plant at Sellafield and major decommissioning projects commenced in 1982.

This paper outlines some of the major projects in the decommissioning program and considers the interaction of extent of dismantling, dose uptake, size reduction, waste form and container and disposal costs.

INTRODUCTION

BNFL's Sellafield site in Cumbria has been involved in nuclear operations since the start of the nuclear industry in the United Kingdom in the late 1940's. The site has a wide range of nuclear plants from reactors to fuel storage and cooling ponds, fuel decanning, fuel dissolution and reprocessing, finishing of uranium and plutonium and all the associated waste handling and effluent treatment plants. Over the years several plants have shut down and decommissioning is proceeding in line with the Company's declared plan.

DECOMMISSIONING

Substantial decommissioning commenced in 1982 with the initiation of three major projects which with the shutdown of further plants expanded into a rolling Ten Year Program (1) and (2). This is the front end of the Plan for the decommissioning of the whole Sellafield Site. This program has now been running for five years and there are currently some 18 projects involved.

This paper outlines some current decommissioning projects, and methods of minimizing decommissioning waste arisings for storage and disposal.

- A Decontamination Facility, which handled all types of equipment for maintenance and reuse, including items heavily contaminated with plutonium compounds. This was decontaminated, dismantled and demolished and the site reused.
- No 1 Fuel Storage Pond, built to support the original 1950's Windscale Production Piles. Some fuel is still stored in the plant and there is a requirement to sort skips and remove all unnecessary waste, treat pond sludges and decontaminate large areas of concrete.
- Pile Chimneys, which filtered and discharged cooling air from the Windscale Production Piles. They are of complex construction, expensive to maintain, and are being partially dismantled to ensure their long-term stability. There are severe contamination problems with No 1 Pile Chimney as a result of the 1957 incident (3).
- Co-precipitation Plant (Fig. 1), which produced mixed oxide for fast reactor fuel in a complex glove box line which handled multi ton quantities of plutonium and uranium oxides. The plant was grossly contaminated internally at the start of dismantling in 1987 but decontaminating and dismantling for packaging and interim storage is now completed (4).
- North Group Enriched Residues Plant, consisting of plants for the recovery of highly enriched uranium from various waste streams and also for the production of tritium, which have recently been dismantled and the buildings reused.
- First Primary Separation Plant which was the original UK reprocessing facility site and a major ten story building with four highly active and two medium active cells, which were converted for the treatment of oxide fuels. The challenge is decontamination and remote dismantling of a very extensive plant.
- Caesium Extraction Plant (Figs. 2 & 4) which was a facility for the extraction of radio-caesium from highly active waste liquors for medical purposes. The plant has now been shut down for about thirty years and is grossly contaminated internally.
- Plutonium Recovery Plant. This is a four story building, with two brick clad cells containing pipework, vessels and columns. The plant is grossly alpha contaminated and poses a major challenge in containment and waste preparation during dismantling and demolition.
- Plutonium Finishing Line which produced plutonium metal and plutonium oxide. The facility has high gamma and neutron dose levels to compound the alpha containment difficulty.
- Plutonium Sampling Corridors in the Operational Magnox Reprocessing Plant. Redundant glove boxes

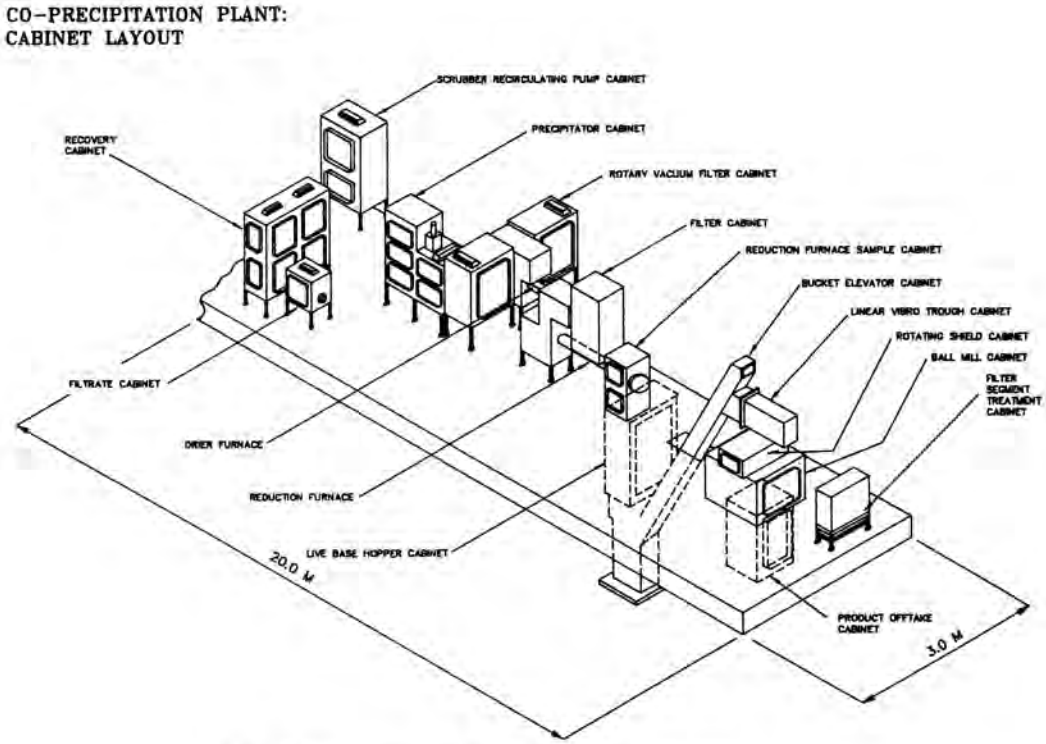

Fig. 1. Co-precipitation plant: cabinet layout.

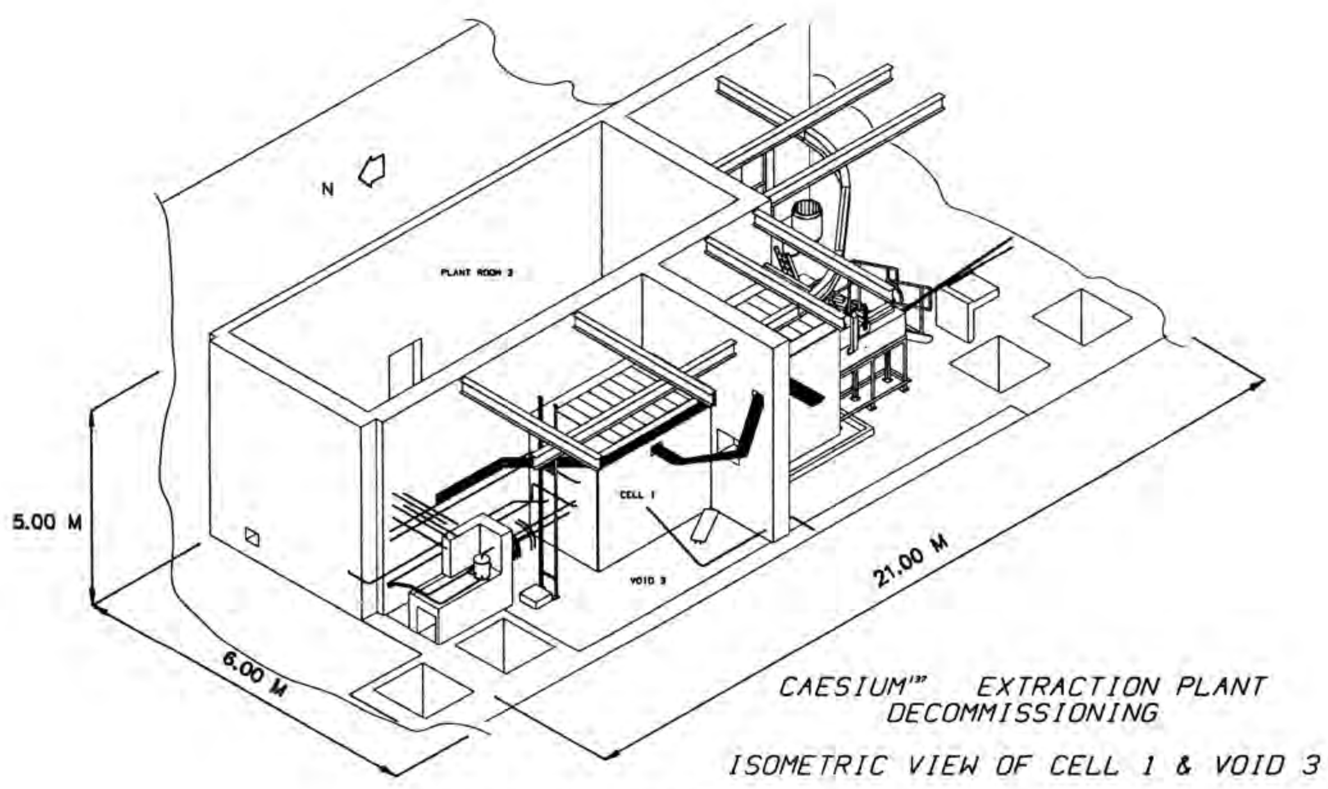

Fig. 2. Isometric view of cell 1 & void 3.

and ejector bulges are being removed and the corridor areas decontaminated (Fig 3).

WASTE CATEGORIZATION

The following classification is used within the United Kingdom:

a) High Level (heat generating) Wastes (HLW), are those wastes in which the temperature may rise significantly as a result of their radioactivity, influencing the design of storage or disposal facilities.

b) Low Level Wastes (LLW), are wastes containing radioactive materials other than those acceptable for dustbin disposal (very low level), but not exceeding 4GBq/t alpha or 12GBq/t beta/gamma. These are disposed to shallow land burial at BNFL's Drigg facility which has been in operation since the 1950's.

c) Intermediate Level Wastes (ILW), are wastes with radioactivity exceeding the boundaries for Low Level Wastes but which do not require heat generation to be taken into account in the design of storage or disposal facilities. A specific category is Plutonium Contaminated Material (PCM). Current policy is that ILW from decommissioning operations be stored where possible in existing refurbished buildings pending availability of the UK NIREX underground repository.

DECOMMISSIONING WASTE ARISINGS

For the Decommissioning Program at Sellafield it is estimated that raw waste arisings until about 2005 will be some 4,700m^3 of ILW. Some LLW will arise but a major consideration will be the potential cost of ILW treatment and disposal. If 500 litre drums were to be used conditioned volumes for disposal could be 2.3 times raw volumes. The close down of all facilities associated with reprocessing for the UK Magnox power generating stations will result in a significant increase in about 15-20 years time.

RELATIONSHIP OF WASTE ARISINGS TO DECOMMISSIONING STAGES

Post Operational Clean Out (POCO) prior to Initial Decommissioning should be considered as the final operational phase rather than decommissioning although it will normally be done immediately prior to starting decommissioning. Waste arisings are similar in nature and proportions to those during plant operations and maintenance.

The main part of the Initial Decommissioning stage involves a period of intensive decontamination and removal of radioactive inventory and residues. This will require significant dismantling of plant and equipment beyond nor-

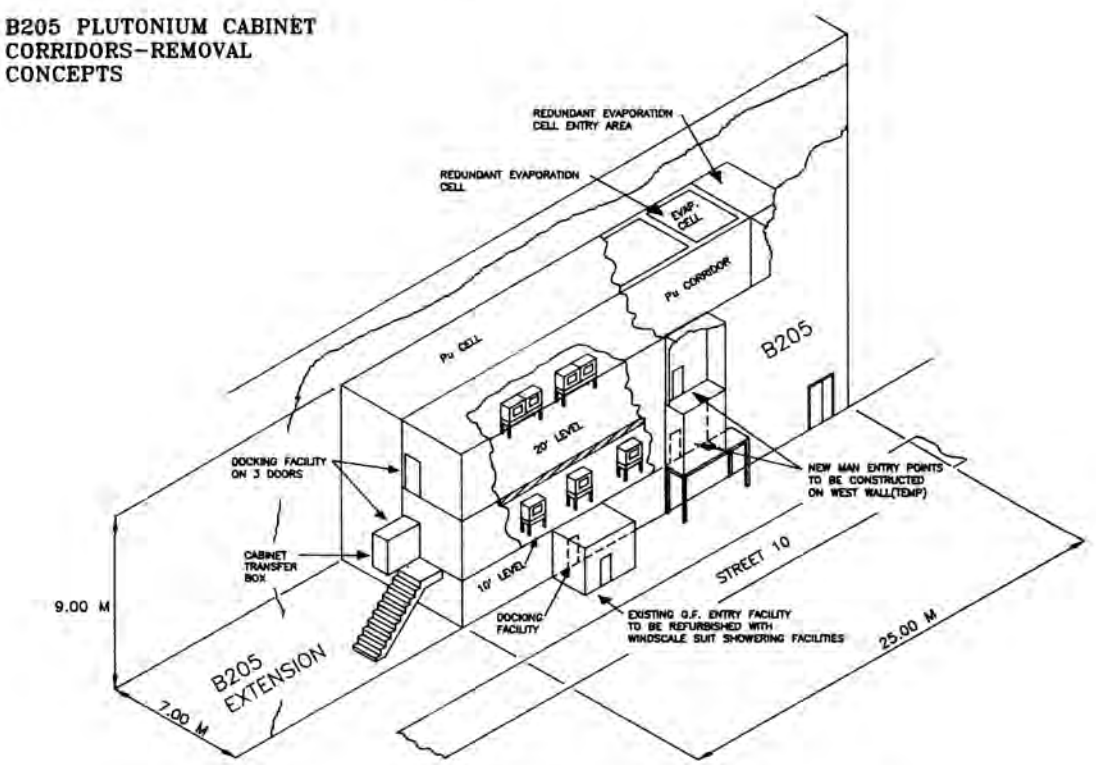

Fig. 3. B205 plutonium cabinet corridors - removal concepts.

mal maintenance techniques and consequently wastes generated will be largely ILW.

The Dismantling stage will produce a mixture of ILW and LLW, with proportions depending on plant type. Primary wastes, ie actual plant and equipment, will tend to be ILW, almost exclusively so for actinide or plutonium facilities. Secondary wastes such as tools, protective clothing and temporary containment will however be largely LLW except in specific cases. Again plutonium plants will generate a significant proportion of ILW/PCM as secondary wastes.

If dismantling achieves its objective of removing the most significant activity then the final Demolition Stage of building structures will produce largely LLW.

POTENTIAL FOR WASTE REDUCTION

The scope for minimizing decommissioning wastes, storage and disposal costs and especially ILW, depends on a number of techniques:

Minimisation of secondary waste arisings and degree of contamination by:

- Adequate clean out of plant items before dismantling.
- Satisfactory control of spread of contamination, using adequate containment, ventilation and tie down methods.

A particularly successful technique for waste minimisation has been the use of reusable enclosures, combined with strippable coatings. This combination has been used for plutonium plant decommissioning and eliminates the need for permanent structures which would themselves add to the overall waste burden.

- Maintaining containment within pipes and vessels during size reduction.

Measures to reduce the category of waste by:

- Decontamination including sectioning and removal of the more contaminated components.

Concepts are being developed for a mobile decontamination rig with the potential to allow recategorisation of waste by decontamination. The rig will allow use of a variety of decontaminants and include effluent clean up with recycle.

- Rigorous waste segregation.
- Sophisticated assay equipment at the ILW/LLW and LLW/Deminimis boundary.

The extent to which these or other techniques are applied depends on the balance between the cost of their application and the costs of waste disposal. The impact of dose uptake for the various techniques also has to be considered.

INTERIM STORAGE AND WASTE DISPOSAL

Preparations are in progress by NIREX to make the first UK deep repository available by the year 2005. Geological surveys are being carried out to assess the the suitability of siting at Sellafield and Dounreay. Specification of the final waste form acceptable to the repository, ie. containers and product quality of waste within the container has still to be finalised.

The waste strategy includes for decommissioning ILW to be stored in decommissioned buildings at Sellafield until the repository is available. This requires consideration of the following issues:

- In the early part of the program, wastes have to be removed from the plant being decommissioned, so work can continue, until enough storage space is available within the plant of origin or an interim store is created from a decommissioned building
- Buildings housing plant above ground floor level have to withstand structural loading of the waste and disposal container
- Containerized waste may occupy a greater volume than the original plant volume and additional secondary wastes are generated.

Storage problems are, however, being eased as plants generating largely LLW are cleared and these areas re-used for interim storage of mainly ILW. Disposal of LLW is by Shallow Land Burial at BNFL's Drigg site as noted earlier.

DISPOSAL WASTE FORM AND CONTAINER

The final waste form acceptable to the UK repository depends on the disposal container and the product quality of waste within the container. A range of containers is required which will all meet the transport and disposal criteria. The containerized waste will also need to meet interim storage and repository criteria. This will be achieved by encapsulation in a cement matrix for some items.

The present status of container design and specification for disposal in the repository is as follows:

	MAX EXTERNAL DIMENSIONS (M)	MAX GROSS WEIGHT (Te)	STATUS
500 l Drum	00.8 x 1.2	2	Approved and in use for operational waste
$3M^3$ Box	1.72 x 1.72 x 1.2	15	Approval of design and specification is expected by end 1991. A temporary shielded overpack will be required for transport purposes
$12m^3$ Box	4.0 x 2.4 x 1.85	50	Design and specification in progress. Container will be self shielding
Large Box	5.5 x 2.4 x 2.6	50	Assessment currently underway to determine if boxes greater than $12m^3$ can be used for disposal of waste

A draft waste form specification is expected to be available in early 1991 from Nirex and will include the following criteria for the disposal of waste in the repository:

- Proportion of Organics Acceptable
- Fissile material limits
- Physical strength of waste matrix
- Impact resistance
- Leach rates
- Voidage
- Homogeneity.

It is necessary to standardise container weights sizes and waste form to ease transport and handling and to ensure product quality enables safe disposal with due consideration of any environmental impact.

Early definition of waste form will enable waste to be prepared for disposal, as it arises and avoid costs and dose associated with any future processing to produce a disposal waste form.

TREATMENT, DOSE UPTAKE, CONTAINER SIZE AND DISPOSAL COST

In general increasing container size offers the potential to minimise size reduction for waste. The reductions in operational decommissioning costs, secondary waste generation and dose uptake are offset by an increase in disposal costs and building modifications which may be required to allow access for large containers. Temporary packaging may be employed to allow component transfer to the disposal container.

CO. PRECIPITATION PLANT

An example of the potential benefits of minimum processing is the oxide Co-Precipitation plant, Fig 1, a glove box line which handled mixed oxide fuel. The plant has now been successfully decommissioned by manual size reduction methods although a relatively high dose uptake to personnel was incurred. A 'Hindsight' review confirmed that significantly less total dose was accrued for glovebox removal without size reduction and the results are tabled below. The review considered individual glove boxes which all handled dry powders.

Minimum processing techniques, which are potentially very attractive to reduce dose uptake, propose that sufficient work should be carried out to allow disconnection of equipment without size reduction. Waste is transferred to a temporary storage container pending treatment or placed into a disposal container. The principle disadvantage is that the increase in waste disposal volume resulting from minimum processing would have been of the order 1.5 - 2 times greater than for the decommissioning operations as actually performed.

PLUTONIUM FINISHING AND SAMPLING PLANTS

In the case of the Pu Finishing Line Radiation levels on the plant (up to c.3.5mSv/Hr @ 300mm from the Glove box face) are such that minimum processing combined with remote techniques may be essential to reduce dose uptake to personnel. It is proposed that whole glove boxes are removed from the plant into a separate conditioning and packaging facility. Disposal container size and content will be determined by fissile material limits (influenced by criticality considerations) as well as component size. Investigations are being carried out to determine whether large boxes can be divided into compartments, such that total fissile material for the box can be increased and the minimum fissile limit applied to any one compartment within the container.

Decommissioning of the Plutonium Sampling glove boxes is being carried out by minimum processing techniques to avoid spreading contamination into operational areas of the Magnox reprocessing plant and therefore interrupting mainstream plant operations,

CAESIUM EXTRACTION PLANT

This project poses particularly difficult problems as it was built on top of another building at approximately 12M above ground level. Radiation levels in the plant dictate that all operations have to be carried out remotely. Building structure loadings prevent disposal boxes being placed on the building roof and consequently an internal transport basket is being used to carry decommissioning wastes from the caesium plant to the disposal box at ground floor level, Fig 4. Lifting and handling restrictions limit the volume of waste which can be removed from the plant at any particular time and lowered to the disposal container.

STUDY OF TREATMENT AND DISPOSAL OF DECOMMISSIONED PIPEWORK

The benefit of minimum processing and direct packaging of waste is based on the fact that savings in capital and operational costs are not eroded by increased waste disposal costs. Recent studies for specific waste arisings eg. pipework, vessels have indicated that there may be instances where size and volume reduction processes could have financial benefits.

Comparison of various options for pipework processing and packaging (Fig. 5) shows that significant overall savings can be made if volume reduction is utilised. Use of low capital equipment such as a baler shows significant saving over random or specific packing, since cost of waste disposal for the latter contributes significantly to overall cost. An important criterion is the provision of simple and cheap plant to carry out the process with minimum dose uptake. A large raw volume of waste is required to maximise the savings and this could be achieved by utilising mobile or transportable equipment, relocated at plants as appropriate. The effect of increasing disposal cost increases the cost differences of the options (Fig. 6). Random and specific packing become significantly more expensive,

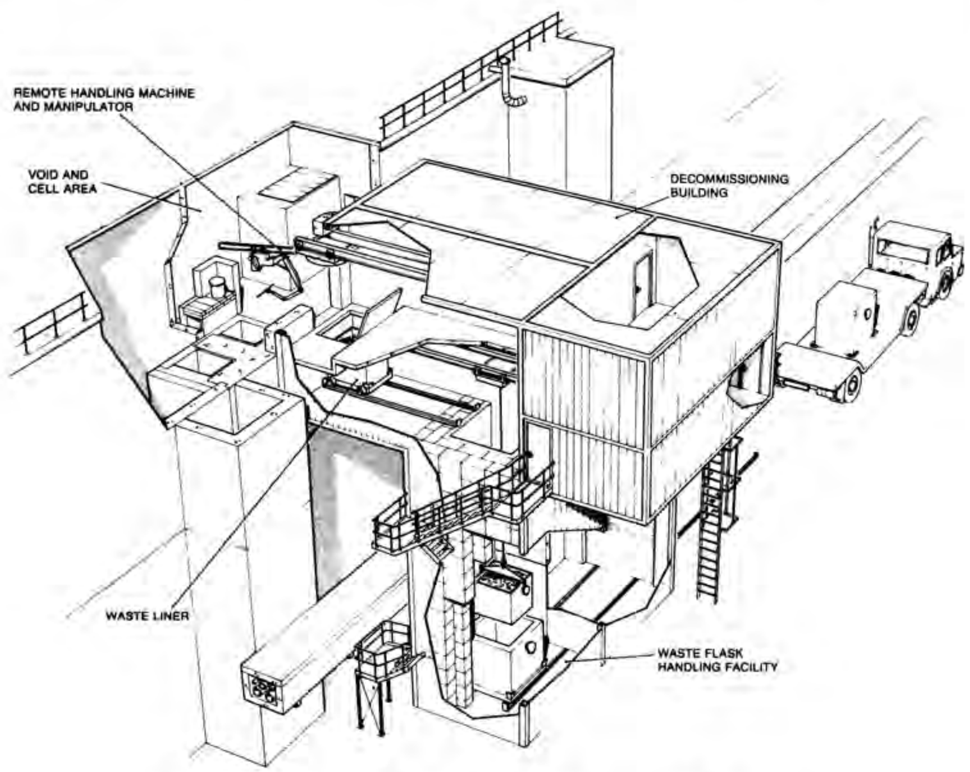

Fig. 4. Remote handling concept B212 caesium plant.

whereas low capital volume reduction processes (baling) are relatively insensitive to disposal costs.

Similarly, for vessels, size reduction and effective packing, provided it can be achieved with low investment, can yield financial benefits.

SUMMARY

The decommissioning program in progress at Sellafield produces active waste which requires appropriate packaging for disposal. Relationship between waste arising and decommissioning stage has been identified and potential techniques for waste reduction highlighted. While a disposal route exists for LLW, ILW will require interim storage and subsequent transport to a repository. The size of container and form of waste for storage and disposal are influenced by a number of factors such as plant accessibility, cost and dose benefits of waste processing, (eg. decontamination for recategorisation, volume reduction) fissile content and the disposal waste form. A range of containers is required for all waste arisings and projects will identify the most appropriate for particular circumstances.

Simple, cheap and potentially mobile equipment for decontamination or volume reduction could have financial benefits.

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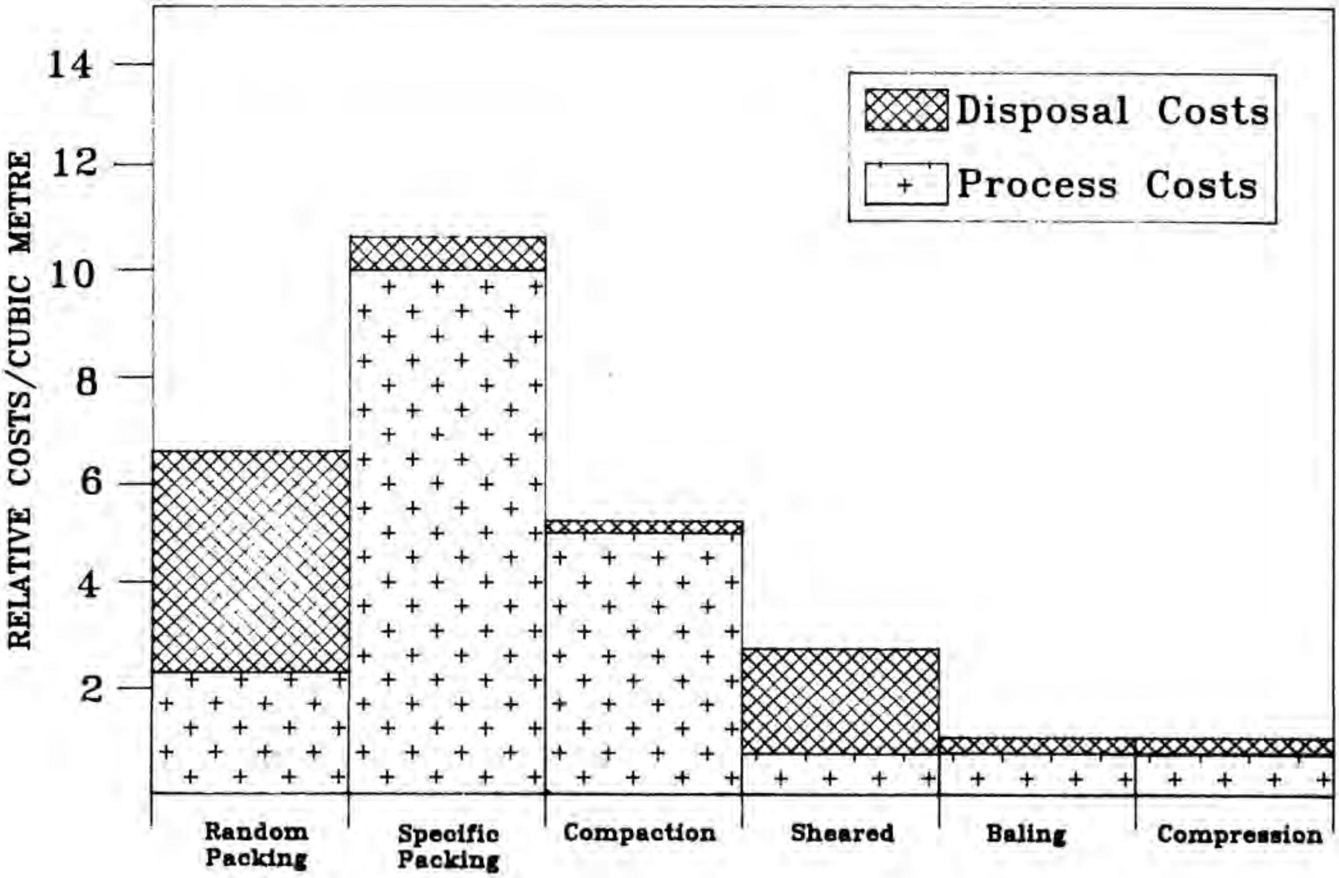

Fig. 5. Average relative costs for ILW pipework processing.

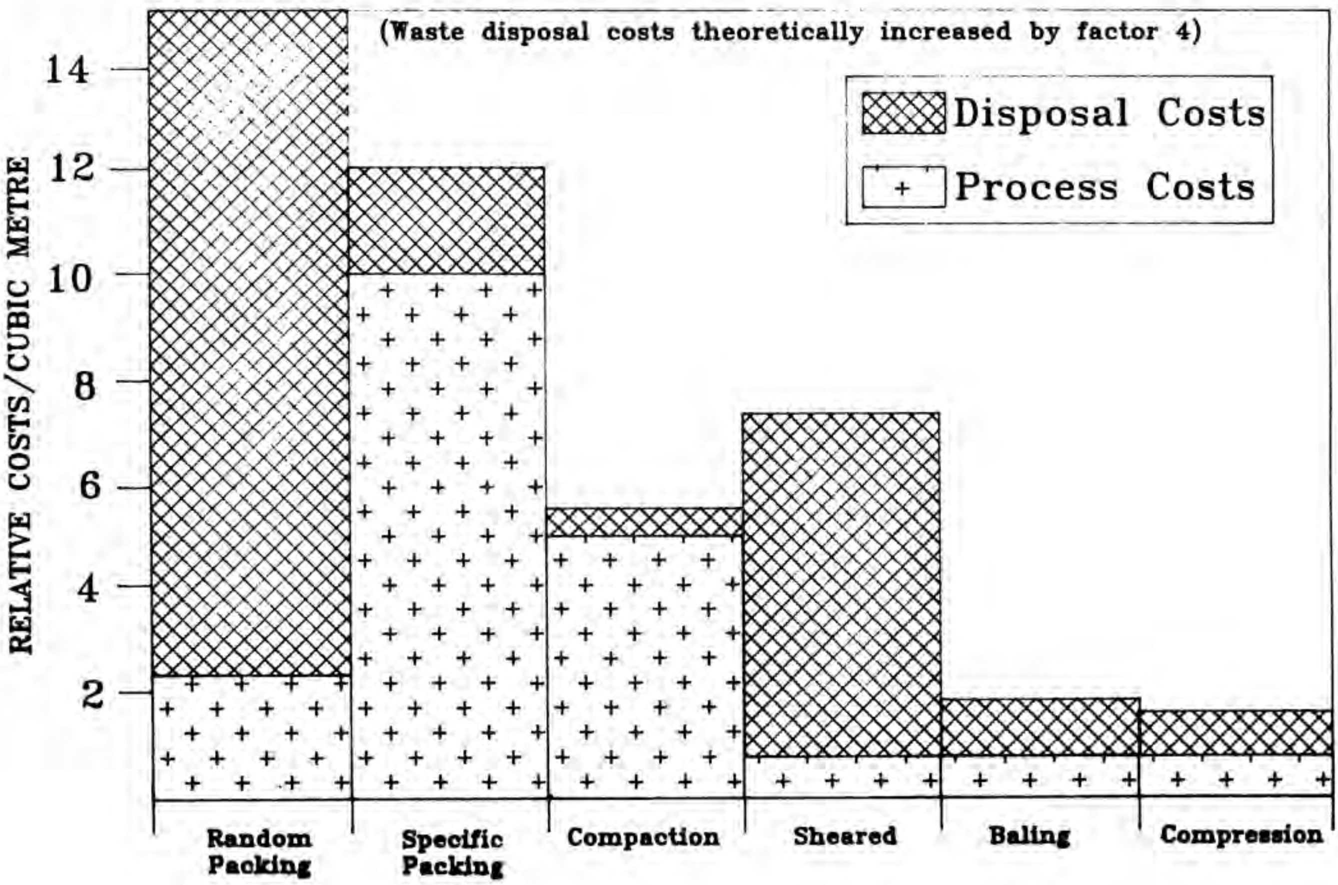

Fig. 6. Average relative costs for ILW pipework processing by factor 4.