SPECIAL ENGINEERING FEATURES OF A DRUMMED TRU WASTE PROCESSING AND PACKAGING PLANT

R J Critchley
British Nuclear Fuels plc
Risley, Warrington, WA3 6AS, UK

ABSTRACT

In designing a remotely operated plant for the processing of drummed TRU waste, a number of special engineering features have had to be designed and developed for incorporation in the plant.

These features, which are described in this paper, provide for the entry into containment of 200L (50 gall) and 400L (100 gall) drums, opening of these drums by laser cutting, sorting of contents by use of specially adapted manipulators and the removal of processed waste from containment by use of a double lid drum system. The associated radiometric equipment, which has also been specially developed, is also described.

INTRODUCTION

Unlike a process plant with a feed of consistent specification, the design of a plant for processing drummed TRU waste needs to take account of a number of uncertainties with respect to the feed material.

In designing such a plant, BNFL has had to address the effect of the varying quantities of fissile material and radiation levels, the variety of drum contents and whether they are combustible/shreddable or non-combustible/ non-shreddable, the variety of sizes of drums and their entry into containment together with their mechanical strength and condition. Problems associated with opening drums within containment, their removal, and the removal of process material from containment, have also been addressed.

Special purpose radiometric equipment has been developed to provide for input/output monitoring, process in-line monitoring and drum filling monitoring.

The plant is remotely operated from behind a shield wall and special modifications to lightweight MSMs have been carried out to facilitate their replacement and eliminate the risk of contamination to the operating face. The plant has also been designed to take account of the need to facilitate decommissioning in the future.

Resulting from the above considerations, the following engineering designs have been developed as an essential requirement for the safe operation of the plant.

PLANT CONCEPT

The purpose of the plant (Fig 1) is to process TRU waste into a form suitable for either further treatment or ultimate disposal. The incoming waste in 200L drums, or 200L inside 400L overdrums, is monitored for surface contamination and assayed for fissile content on receipt. The drums are then transferred by autoguided vehicle to a buffer store or to an elevator which transports them to the process line where they are lowered one by one through a 'sphincter' seal into containment.

Once inside, the drums are opened by laser cutting the clamping band. The drum contents are then tipped onto a conveyor where individual packets of waste are removed from the plastic drum liner for X ray, weighing and fissile content monitoring. If the packets can be shredded, then they pass into the 'High' or 'Low' fissile content shredder, otherwise the packets are opened and non-shreddable items removed, assayed and separately drummed.

Spent drums, non shreddable waste and shredded waste are all removed from the process line via specially designed double lid drum ports, for subsequent treatment and storage.

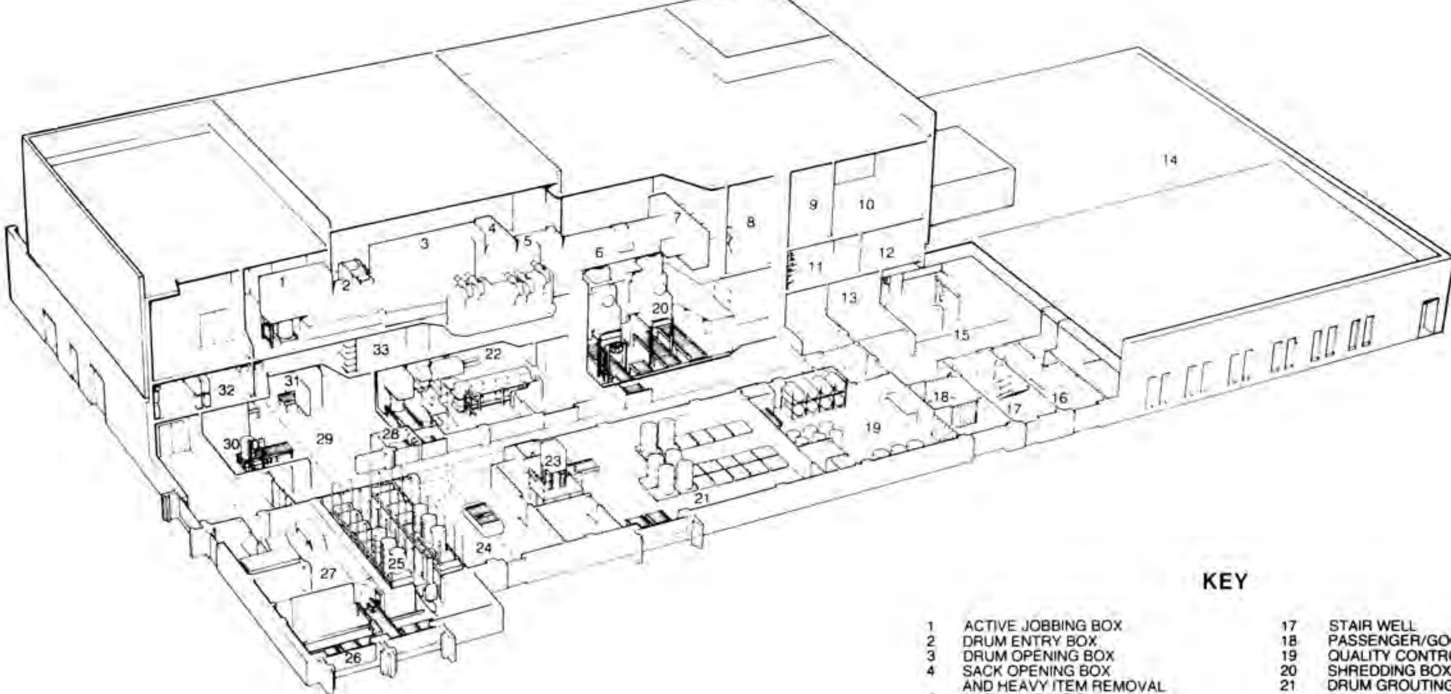
Due to the airborne alpha activity arising from the waste, the process equipment is housed in high integrity stainless steel glovebox containment. Because of the predicted direct radiation levels, a shield wall is interposed between the glovebox line and the operator with sufficient access to permit the necessary "hands-on" maintenance on both sides of the process line.

Decommissioning considerations at the design stage and the need to minimise the potential for decontamination have led to the provision of a service void between operating floors to cater for ventilation ductwork, electrical and instrumentation supplies and mechanical services distribution to the various operating areas and cells.

SPECIALIZED EQUIPMENT

Sphincter Seal (Fig 2)

Since waste is received in the plant in various sizes of drums, it has been necessary to design a method which would allow transfer of each drum from the cell into containment while preventing any back diffusion of contamination. The 'sphincter' seal, consisting of a flexible diaphragm and nylon filaments, which forms a close seal around the drum during 'posting in' operations, has been successfully developed to accommodate the size range. A method of



KEY

1 ACTIVE JOBBING BOX
2 DRUM ENTRY BOX
3 DRUM OPENING BOX
4 SACK OPENING BOX AND HEAVY ITEM REMOVAL
5 'X' RAY AND WEIGH
6 SHUTTLE CONVEYOR BOX
7 PACKET OPENING BOX
8 M.S.M. OPERATIONS
9 ACCESS TO BOX VENTILATION FAN ROOM
10 OFFICE
11 SERVICE VOID
12 INST. ROOM
13 OFFICE
14 AMENITIES BLOCK
15 COVERALLS/BOOT BARRIER
16 LAUNDRY RECEIPT AND DESPATCH
17 STAIR WELL
18 PASSENGER/GOODS LIFT
19 QUALITY CONTROL
20 SHREDDING BOXES
21 DRUM GROUTING AREA
22 DRUM/FILTER CRUSH CELL
23 GROUT FILLING GLOVE BOX
24 VEHICLE MAINTENANCE AREA
25 BUFFER STORE
26 RECEIPT AND DESPATCH
27 DRUM SURFACE CONTAM^{N} MONITOR AREA
28 DRUM LIFT TO OP's CELL
29 MONITORING ROOM
30 GAMMA SCANNER
31 NEUTRON COINCIDENCE MONITOR
32 INST. ROOM
33 SERVICE VOID

Fig. 1. Waste Treatment Complex Process Block - Phase 1.

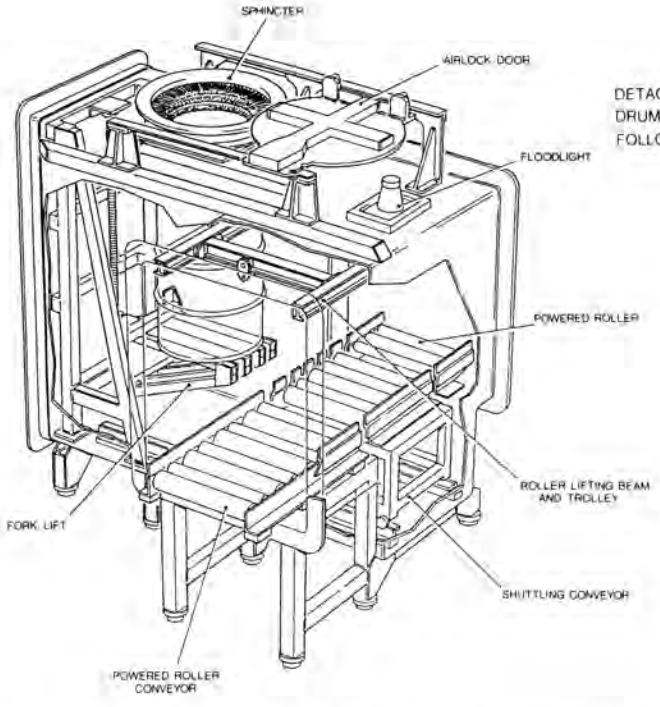


Fig. 2. Sphincter Seal in Drum Entry Glove Box.

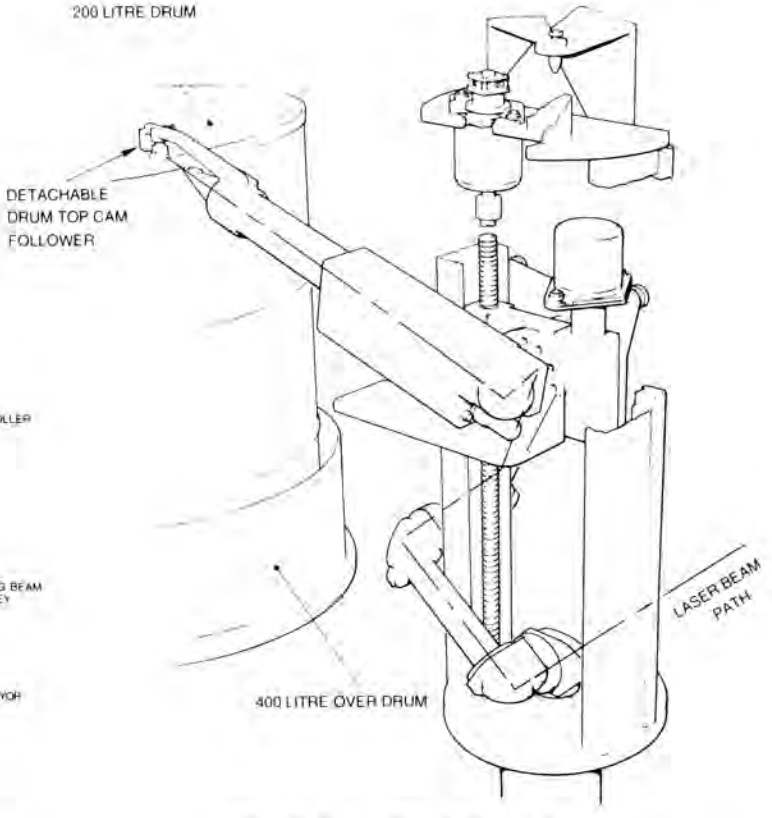


Fig. 3. Laser Head Manipulator.

replacing the seal while maintaining the integrity of the containment has also been developed.

Laser Manipulator (Fig 3)

Because of the variety of sizes and potential mechanical weakness of the feed drums, it is necessary to provide a method of cutting which does not apply high reaction forces. The laser manipulator has been developed to remotely position a laser cutting head in the correct orientation to produce a clean circumferential cut of the lid retaining ring without any mechanical force being applied to the drum. Laser cutting eliminates the need to clamp the drum and also the requirement for routine replacement of consumables such as saw blades, cutting discs etc, necessary when using mechanical cutting methods.

Master Slave Manipulators (Fig 4)

In order to provide the flexibility of manual dexterity within the process line, yet keeping operators behind the shield wall, a commercially available 'lightweight' MSM was modified to bridge the distance between the shield wall and the containment. A unique feature of this design allows the slave arm within containment to be detached/replaced without removal of the master arm on the operating face, thus preventing any loss of containment between the process line/cell and the operating face.

Radiometrics

Special purpose monitoring equipment using standard detectors has been developed for the Waste Treatment Complex (WTC).

Drum Assay

Feed drums and the product drums are assayed for fissile material content when they are received into the WTC and before they are dispatched. This function is performed by a passive neutron coincidence counter (Fig 5), for measuring plutonium content, and a gamma spectrometer (Fig 6) to determine the Pu isotopic composition and detect the presence of U235.

High/Low Packet Monitor

After the drums have been opened, the packets are monitored individually to categorize them into 'High or Low' Pu and U235 content, 'High' and 'Low' being defined numerically according to transport, disposal and/or storage limits for product drums, typically 15gms and 200 gms.This is achieved using four low resolution gamma scanners, two each side mounted on the outside of glovebox containment,

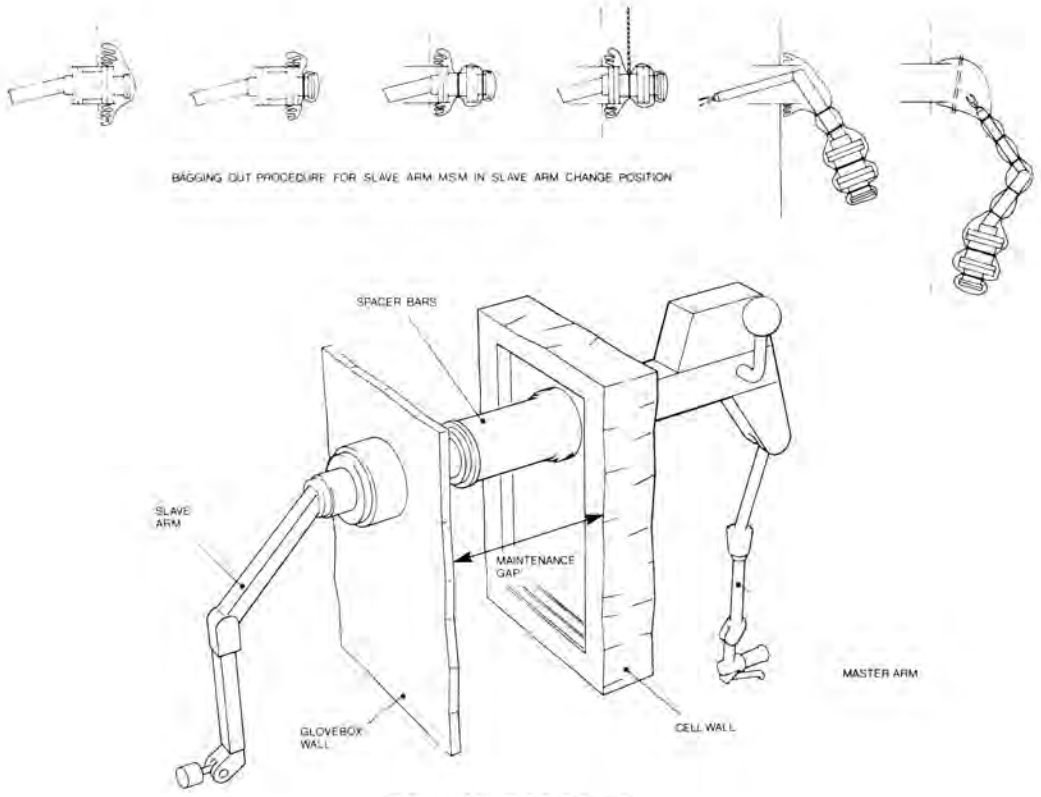


Fig. 4. Modified MSM.

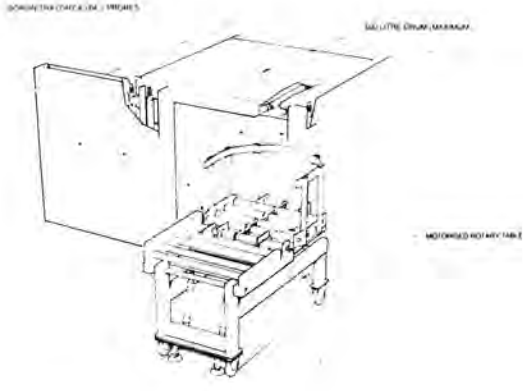


Fig. 5. Neutron Coincidence Monitor (Up to 500L Drum Capacity).

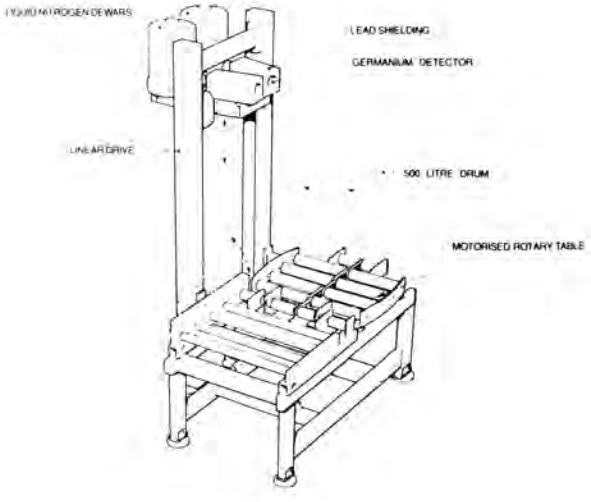


Fig. 6. Gamma Scanner (Isotopic Detection Composition).

and two high resolution gamma scanners, each mounted between each pair of low resolution scanners.

Hard Waste Monitor

Packets containing hard non-combustible waste, which cannot be shredded, require to be opened in order to separate the hard waste from the shreddable packaging. The hard waste is then assayed to categorize it into 'High' or 'Low' Pu/U235 content as before.

Special purpose monitoring equipment has been developed to enable individual packets and single items to be measured for Pu and U235 while still in containment. The detectors for both packet and hard waste monitors are housed outside of containment to prevent contamination and allow replacement of instrumentation. The performance of both monitors allows sentencing of waste to be achieved.

Pu Build Up Monitors

After processing a batch of waste containing a predetermined quantity of Pu, criticality safety considerations make it necessary to monitor the process line to detect any possible build up of Pu which may have accumulated during processing. The Pu build up monitors have been designed to measure this build up and detect 'high' spots. The detectors are situated under the gloveboxes along the full length of the process line, around the 'High' and 'Low' shredders, and the drum and filter crush areas. The count and check is done for all the detectors at once. If any of the counts are above the background count rates, the operator must check the process line for waste accumulation and clear this away before the process line can be started up again.

Product Drum Filling--Pu Content Monitor

Each product drum fill position has Pu level monitors around them to assay the Pu content as the drums are filled. These act as a "back up" to the High/Low packet monitors and are also used to prevent the "overfilling" of drums in relation to the 200gm fissile content limit. The monitors consist of two low resolution gamma scanners which assay the contents every 20 seconds while the drums are being filled.

Product Drum Filling Level Indicator Units

These units have been designed to prevent the over-filling of the shredded waste drums when they reach the physically full level.

Each unit has two detectors mounted at 90° to each other and two Co 60 and two Cs 137 sources. Each detector looks across the drum to the source which is positioned diametrically opposite.

The detectors continuously check the drum content level and automatically signal when the drum is full and stop the shredding machine.

The drum is then vibrated for 10 seconds after which the level is checked again. If this has shown that the drum is no longer full, the shredder is restarted and run until the 'drum full' message is sent. At this point the drum is not vibrated but sealed, removed and replaced with an empty one.

X ray

An X ray machine is included in the process line to determine if packets contain items which cannot be shredded. This is an airport baggage X ray machine adapted to scan the packages from outside the glovebox containment. Each package passes through the X ray on a conveyor and a picture is built up on the operator's screen. The picture is also recorded on a video machine.

The X ray head is positioned above the process line and 'sees' through a panel set in the top of the containment. A diode tray is situated in a sealed housing immediately below the conveyor belt and is accessed without breaking containment.

Drum Ports

The current plant concept allows for two processed waste forms to be removed from the plant, the first being

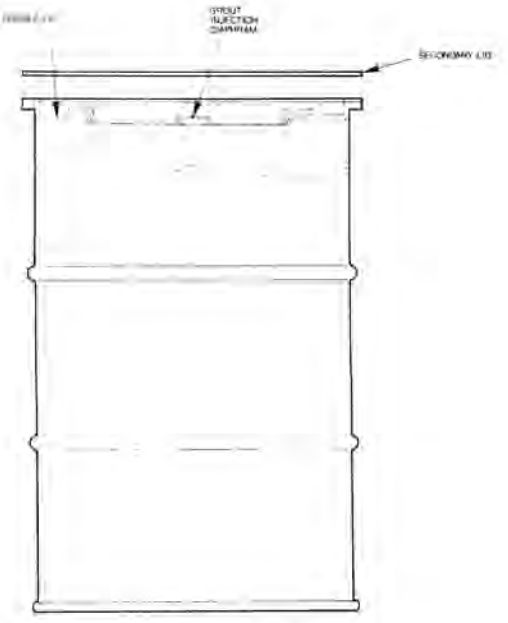


Fig. 7. 'One Trip' Double Lid Drum.

'low' fissile content combustible and non-combustible waste which is collected in 'one trip' drums (see Fig 7) for subsequent encapsulation and disposal. The second is for 'high' fissile content material which would need to be stored awaiting possible further treatment. Consequently a long term storage drum with a rigid plastic inner drum, complete with double lid system which will enable the contents to be retrieved, has been developed (Fig 8).

The 'one trip' drum contains a thin disc in the drum lid which can be punctured by a grout injection nozzle to enable cement grout injection to infill any voids without loss of containment and release of airborne contamination.

Special attention has been given to safety interlocks, maintenance and replacement of seals. The system is very flexible as it can be adapted for use with 200L, 400L and 500L drums although the drum aperture of 457 mm ∅ (18ins) remains constant.

CONCLUSIONS

The special engineering features described above have been successfully developed and extensively tested. They have now been incorporated in the plant and await plant commissioning. Some of these features have a place in the non-nuclear field, particularly the double lid drum system.

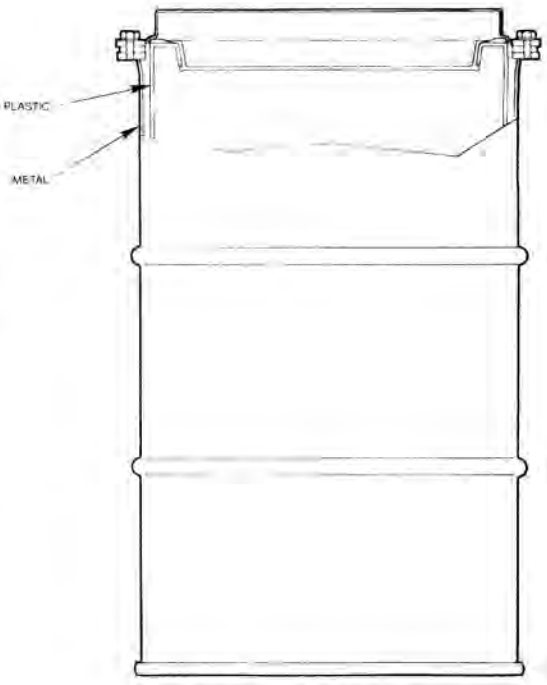


Fig. 8. Double Lid Drum.