

SAFE BAG CHANGE SYSTEM FOR ALPHA CONTAMINATED HFC PUCKS

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ABSTRACT

High force compaction is a well-developed volume reduction treatment process for drums of solid radioactive waste. As safety standards improve and permitted operator dose uptake reduces, so the total containment of the high force compactor equipment will become obligatory, particularly when dealing with alpha contaminated materials. Entering such primary containment with drums of waste is already an accepted discipline, employing double airlock door systems to prevent the release of airborne particulate from the containment envelope. The external surfaces of the drums entering the system are radiologically clean and, therefore, present minimal threat to the operators.

During the compaction process, the drums of radioactive material become contaminated, as does the equipment and interior surfaces of the containment. Currently, the only satisfactory developed procedure for transferring these contaminated pucks from the primary containment envelope is the high cost 500 litre overpack drum system and bagless transfer process. Reducing the volume of waste and, therefore, the cost for disposal is largely negated by the need for the expensive overpack system. This review investigates the possibility of designing a cost effective but safe alternative transfer procedure.

The safe bag change system for alpha contaminated HFC pucks addresses the present shortfall in waste transfer technology, exploring the possibility of employing the traditional bagging technique to achieve clean transfer operations, with a bag sufficiently large to accommodate 4 or 5 pucks produced by an high force compactor. Also considered in the review of this transfer problem was the form of that bag, the materials of construction, particularly as the final form of the bag must be designed to support an overall weight of some 1000kgs. and the method of supporting the large bag while it was being loaded. In addition, the difficulty of maintaining the bag in the 'open' attitude under the influence of a negative pressure induced by the containment ventilation system was also given much consideration as was the overall cost. Finally, the sealing of the bag, which is the last step in the overall transfer procedure, was an area for examination.

An important issue under review at all times through this investigation of a suitable transfer system for alpha contaminated HFC pucks, was that of safety.

INTRODUCTION

Currently, the result of compacting LLW beta/gamma emitting wastes results in considerable hands-on or close contact with the contaminated pucks by the equipment operators. Alpha contaminated pucks tend to be transferred from the containment envelope employing overpack drums and the bagless transfer system, where, by virtue of its design, only the interior surfaces of drum lid and cell cover become contaminated. The system leaves the exterior surfaces virtually clean of contamination.

This bagless transfer process has proved to be extremely costly, as it includes the stainless steel overdrum, normally of 500 litre capacity, the need to fill the voids in the 500 litre drum with suitable filler material and the complicated, expensive lid mechanism, which is disposed of with the drum.

The principle objective of the author's work was to investigate a more cost effective, but equally safe, method of effecting a transfer of contaminated pucks from a high force compactor, the investigation concentrating on adapting the well developed bag transfer process.

EXISTING SYSTEMS

The transfer of alpha contaminated pucks from a contained high force compactor is currently undertaken employing the traditional bagless transfer system, where the drum lid and the cell port are locked and sealed together prior to the cell port being opened. The external surfaces of drum lid and cell port remain virtually free of contamination when the assembly is exposed to the atmosphere within the containment envelope. See Figure 1.

Basically, the sealed drum is moved underneath the cell port and then raised to engage the drum lid with the port fitting and at the same time, sealing the drum rim to the fixed section of the port flange. The cell port is locked and sealed to the drum lid by remote control of the systems mounted on the port. Sequentially, the drum lid is disengaged from the drum allowing the port and drum lid top rotate into the containment. As the drum rim is sealed to the port flange, the external surfaces of each component are protected from the contamination. The primary containment is maintained, although slightly extended by the volume of the drum, which is subject to the containment ventilation system, operating at the same negative pressure. The closing of containment and drum employs the exact reverse procedure.

The drum employed in this process, at least within the UK, is a 500 litre drum, which has a top opening sufficiently large to permit the entry of a 200 litre puck supported around the periphery by special grab fingers. It is obvious that the internal diameter of the 500 litre drum is such that there is a generous clearance around the deposited puck and, as a result, to meet the disposal conditions, the space must be filled with an approved material, e.g. cement grout. See Figure 2.

The overall result of using the drum overpack system is a very high cost associated with using a stainless steel 500 litre drum, the complicated bagless lidding system left on the disposal drum and the need to employ a filler around the pucks. An aspect of the bagless transfer system which is difficult to cost, but which must be considered a high-risk element, is the vulnerability of the system's sophisticated seals and mechanisms.

SAFE BAG CHANGE SYSTEM

The traditional safe bag change system relies on a bag with a specially designed ring around the opening, this ring having a degree of elasticity, to permit it to be threaded into one of two grooves around the cell port flange. Once the ring is in place, it is possible to open the cell port, permitting the bag to act as an extension to the containment atmosphere and prevent the release of contaminant. The interior of the bag will be influenced by the containment's ventilation system and will be at the same negative pressure as the containment. When the transfer is complete, the cell port is closed, leaving a negative pressure within the bag. The neck of the bag is twisted until it forms a tight 'rope', when it can be taped and cut, producing two elements – the bag with a sealed and virtually clean neck, and the top of the bag, also sealed and clean, hanging from the cell port flange. The final operation is to ensure that the bag remains are moved to the lower of the two grooves in the port flange, and that a new bag is installed on the top groove. At that point in the procedure, the remains of the bag, the tail, can be manoeuvred off the groove and dropped into the new bag and the process can be repeated. This safe bag system ensures that there is always a bag tail or a new bag covering the cell port, which has its external surfaces contaminated through entering the containment envelope. The system developed in this review is based upon the safe

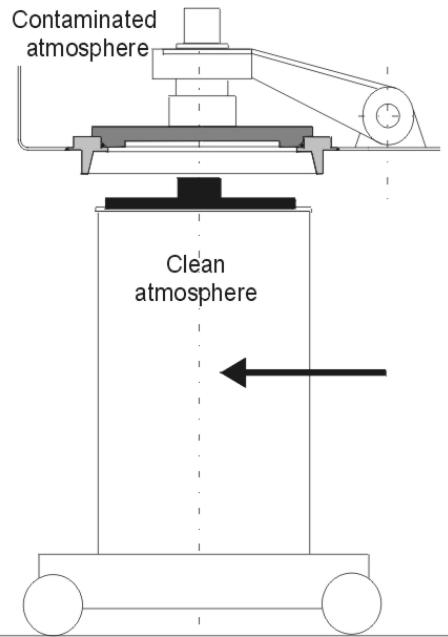


Fig. 1a – Cell cover sealed to containment structure. Sealed drum aligned with cell cover

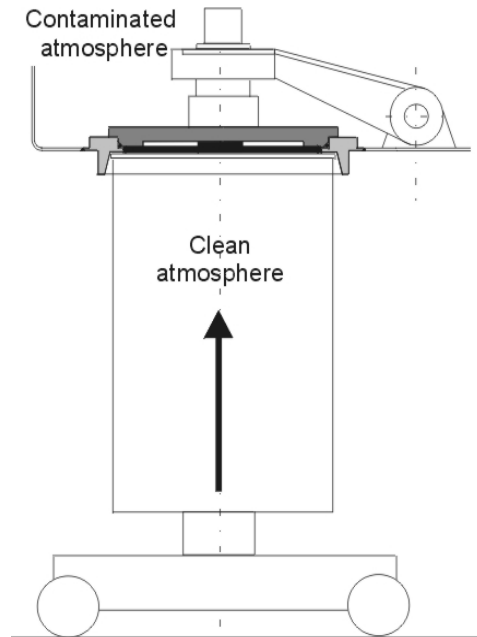


Fig. 1b – Drum raised, cell cover & drum lid locked together. This action seals drum lid to cell cover and drum to containment structure

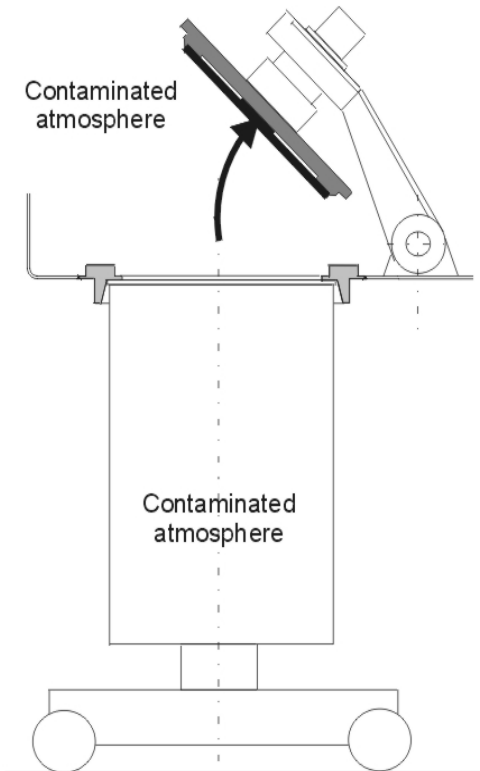


Fig. 1c – Drum lid unlocked from drum, and cell cover from cell. External surfaces of drum lid and cell cover remain isolated from contamination in cell. Drum interior now accessible for transfer of material.

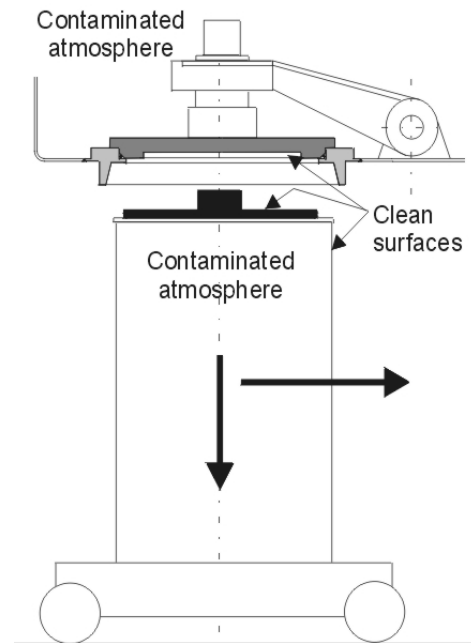


Fig. 1d – When waste transfer is complete, cover and lid assembly hinged to closed position. Cell cover locked to cell structure and drum lid to drum. Cell cover unlocked from drum lid and drum lowered for removal.

Figure 1 – Traditional Bagless Waste Transfer System

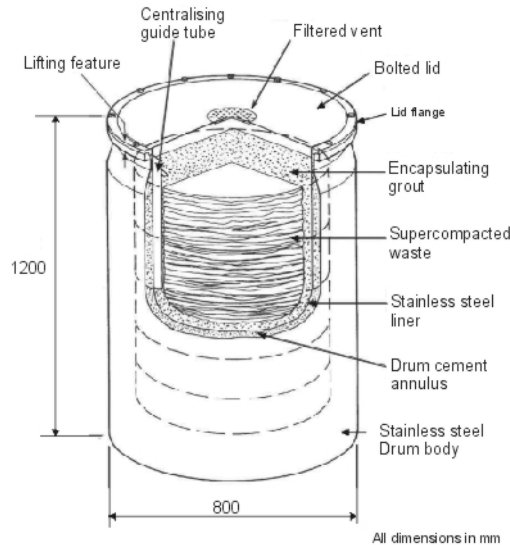


Figure 2 - 500 litre Overpack Drum for Pucks
(Courtesy of NIREX Ltd.)

change procedure described in the previous paragraph but specifically addresses the following problem areas:

- Bag system to be capable of supporting the weight of 4 or 5 pucks, (compacted 200 litre drums), and amounting, say, to a total load of 1000 kgs.
- The bag should have lifting handles for easy loading into open top ISO freight containers.
- The material of construction to be easily twisted to produce a rope and be resistant to damage if dropped.
- The system must be designed to allow free access to interior under the influence of a negative pressure.
- The tail of the bag must not cause an instability situation for the stacked pucks when dropped in bag.

The proposed **Safe Bag Change System** is shown in Figure 3 and consists of the following two components:

The **Stillage** which comprises a 4 wheeled trolley, running on a pair of rails to keep it in line with the cell port in the containment envelope. The top surface of the stillage can be raised and rotated, hydraulically, electrically or manually. Positioned on the top surface are 4 vertical pillars.

The **Bag** which is large enough to allow the pucks (approx. 640 mm diameter) to enter easily. It is long enough to provide sufficient material at the top to permit it to twist into a rope form. The section which is in direct contact with the pucks is constructed from thick reinforced PVC while the top section which is to be subject to twisting, and needs to be very flexible, is made from normal, thinner gauge PVC. The lifting handles are also constructed from thick reinforced PVC which are welded to the thick bag material and pass down the length of the bag, traverse the underside of the bag and up the opposite side. There are two lifting handles per bag. Also welded into the reinforced section of the bag are ties to enable the bag to

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be fixed to the vertical pillars of the stillage. Finally, there is a round section ring molded into the flexible top section of the bag. Figure 4 shows an illustration of the complete bag.

The material for the construction of the bag has been determined after discussions with suitable manufacturers of bags designed, for example, to transport 1m^3 of wet sand which weighs approximately 2000 kgs – double the requirement of the safe change bag.

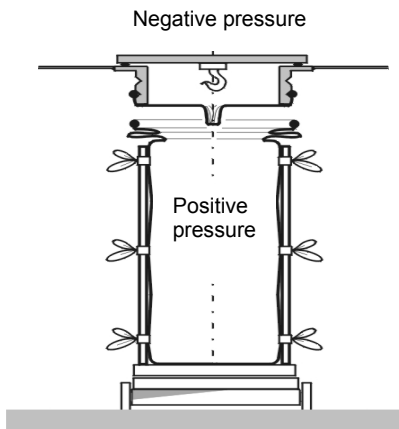
THE SAFE CHANGE PROCEDURE

Employment of the safe change bag system is based on that described for the traditional system and is illustrated in Figure 3

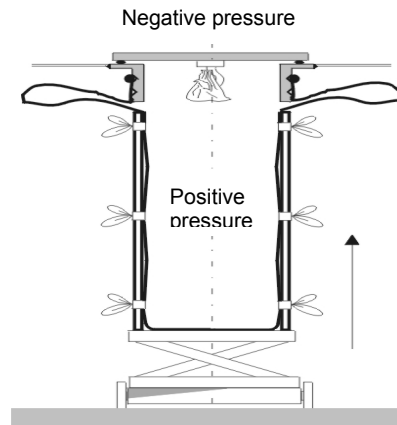
- Position 3a A new bag is placed on the stillage and fixed to the 4 columns using the ties provided on the bag. These ties will prevent the bag sucking flat under the influence of the negative pressure within the containment envelope when the cell port is opened. The bag tail from the last transfer covers the cell port
- Position 3b Stillage is rolled into position below the cell port and the old bag tail is carefully moved down to the lower groove. The new bag ring is fitted to the upper groove, sliding over the old bag tail. Once the new bag is correctly fitted to the cell port ring, the old bag is removed, the operator achieving this taking advantage of the copious spare material provided. The bag tail is hooked on to the underside of the cell port door. The stillage to be raised to position the vertical columns as close to the cell port as possible
- Position 3c The cell port should now be opened, subjecting the bag to the containment's negative pressure. Loading of the compacted pucks can now proceed until optimum packing has been achieved.
- Position 3d the cell port to be closed and the stillage lowered. With the old bag tail now accessible, the tail to be released from the hook, again by the operator manoeuvring through the surplus material, and dropped in on top of the last puck to be loaded. The bag ties to be released resulting in the bag material closing on the pucks, giving the effect of shrink-wrapping. At this point in the procedure the stillage top surface is to be rotated, effecting a twisting of the surplus bag material into a form of rope. When the rope has taken up all of the excess flexible bag material, the twisted material to be fixed by wrapping in suitable adhesive tape over the length of the rope.
- Position 3e With a knife or shears, the twisted and taped material is to be cut halfway along the taped length, leaving the bag tail in place on the cell port. The stillage to be rolled from under the cell port until the carrying straps are fully accessible.
- Position 3f Using the straps, the bag is lifted away from the stillage and transported to the next phase of its journey.

DEVELOPMENT PROGRAMME

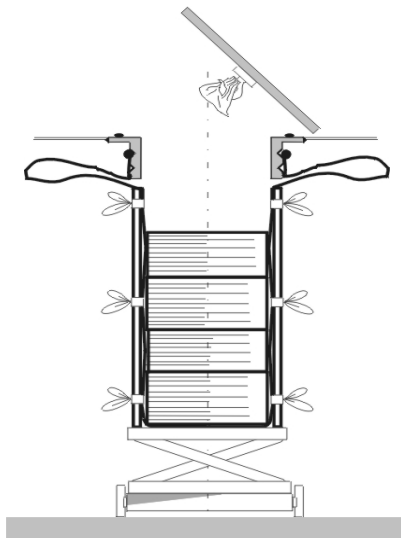
The review work undertaken to date has only involved theoretical design considerations based on sound engineering experience. No practical development work has yet been done, although it is important to recognise that testing should be the next phase. That testing will concentrate on finalising the detail design of the bag, a provisional illustration of which is shown in Figure 4



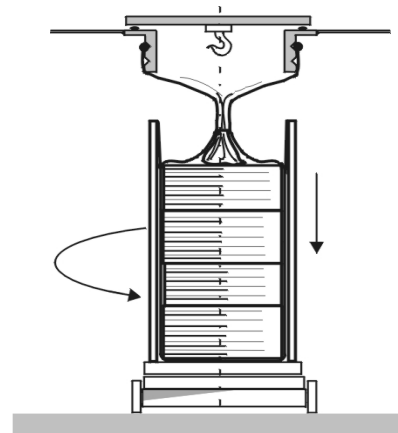
Pos. 3a – Bag tied to stillage and rolled beneath posting port. Tail of previous bag moved to lower groove



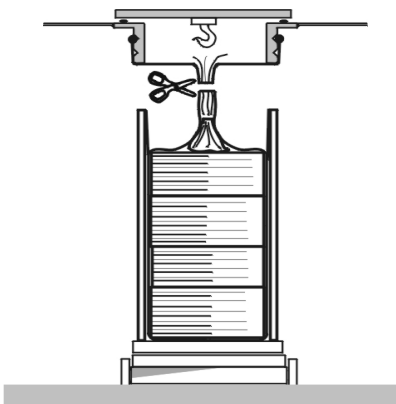
Pos. 3b – Bag positioned on top groove and tail of previous bag attached to hook on posting port. Stillage raised to highest position



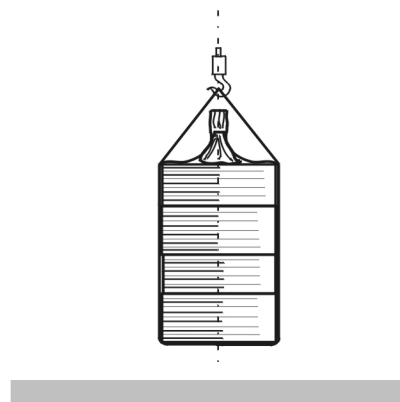
Pos. 3c – Posting port opened, bag now subject to negative pressure. Pucks loaded into bag



Pos. 3d – Stillage lowered and previous bag tail dropped into bag. Bag untied from stillage and stillage rotated to twist neck of bag.



Pos. 3e – Twisted neck of bag taped & cut. Bag and stillage rolled out from under posting port



Pos. 3f – Bag handles used to lift loaded bag into disposal container

Figure 3 – Bagging Transfer System for HFC Pucks

The 1st phase of the development programme can be executed employing a non-radioactive environment and carbon steel components. Wooden mock-ups of the compacted pucks will suffice to develop the bag features.

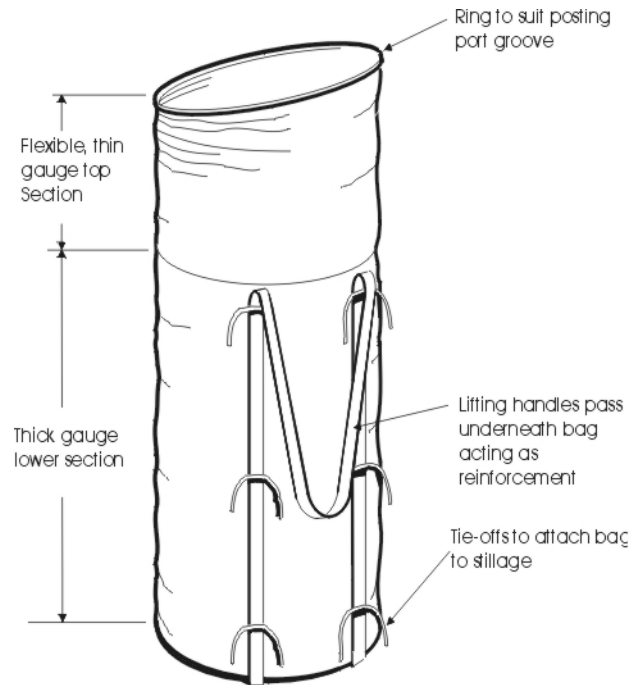


Figure 4 - Concept of Overpack Bag for HFC Pucks

The 2nd phase will be done employing a negative pressure to represent the radioactive atmosphere and to test whether the bag ring is sealing correctly. An important part of the test programme is to determine how easy or otherwise the operator can manage to complete the procedures of the system.

DISCUSSION ON THE FEATURES OF THE SAFE BAG CHANGE SYSTEM

There are a number of important aspects of this Safe Bag Change System for Alpha Contaminated HFC Pucks, which need emphasising, i.e.

- Discussions with disposal authorities (ref 1) have indicated that providing there are no trapped air pockets within the bag, the plastic wrapped pucks should be acceptable. As has already been mentioned, the negative pressure contained within the bag atmosphere will ensure that the disposal authority's conditions will be met.
- These same discussions considered the complicated bag structure and an indicative cost was established of some \$200 (ref. 2) which shows considerable savings over the quoted cost of \$2,400 for the 500 litre drum. The avoidance of the fill material and the complicated bagless transfer system remaining on the disposal drum will add to the cost savings.
- There are similar savings to be made on the ultimate disposal costs. For example, if it were assumed that each drum is compacted by 25%, then the volume of each puck would be 50 litres. If it is also assumed that there are 5 pucks per bag, representing a total of 250 litres. Added to that figure should

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be around 50 litres for the gathering of bag material on the final package making a total estimate of 300 litres for 5 bagged pucks. Bagging the pucks will, therefore, show a volume reduction of 200 litres over the standard 500 litre drum overpack system, representing a volume reduction of 40% which will show similar reductions in overall disposal costs.

- The moment chosen for dealing with the old bag tail is very important. If, for example, the bag tail were dropped into the bag before any pucks were transferred, the stack of pucks sitting on the old tail would provide a very unstable structure. By placing the pucks directly on the flat stillage platform, and the old tail loaded last, a stable structure is achieved.
- A safety aspect which has been given considerable thought is that of possible damage to the bag resulting from sharp protrusions from the puck after compaction, or damage caused by accidental dropping of the bag during any transfer operation. The review of this subject consisted of a stringent safety appraisal with the following summary: Dropping of the bag was a possibility although a rare event, in which case the resulting contamination on the floor of the facility would be monitored and quickly cleaned. The resultant hole in the bag would require taping closed and any contamination around the repair cleaning to an acceptable level.

The review of possible sharp edges causing breaches in the bag structure was considered and dismissed as an even rarer event than dropping, based on the review team's experience of many thousands of drums compacted in a 2000 tonne press. The reviewers decided that if the sharp object became a problem to the plastic bag solution, it would always be possible to install a cardboard drum inside the bag to protect the bag material, without adding significantly to the overall cost of the system and without compromising the operation.

CONCLUSION

The cost comparison between the currently employed steel drum overpack process and the safe bag change system reviewed in this paper shows the bag arrangement at a distinct advantage. The other main advantage is that the bag system uses no complicated seals and mechanisms, or any cement grout fill.

There is, as a result, motivation to move on to the development phase to test the validity of the system, particularly to investigate the operator's capability to utilise the system satisfactorily in a radioactive environment. The operator tests will also establish the time required at the work station and, therefore, the acceptable throughput.

If successfully developed, the system proposed for alpha contaminated pucks could also be applied to LLW beta/gamma emitting pucks – improving on current operating safety standards.

REFERENCES

1. Personal discussion with BNFL in 1995
2. Personal discussion with Industrial Bag Manufacturer Ltd, Stockport, Cheshire, England. 1995 and 1999
3. Design of a Fully Mobile Supercompaction System by Paul B. Woollam and John Sims. WM'95 Tucson 1995