Bagless Transfer Technology Applications in Hanford's WRAP-1 Facility

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I. INTRODUCTION

The Waste Receiving and Processing Facility, Module 1 (WRAP-1) is currently under construction at the Hanford Nuclear Site in south-central Washington State. The facility is scheduled to begin operation in 1996. Designed as a joint venture by Raytheon Engineers and Constructors and British Nuclear Fuels, Ltd (BNFL), its mission is to annually receive more than 6,800 55-gallon drums of both newly generated and retrieved contact-handled solid waste and prepare them for certification and disposal. While 3,800 drums will require only waste acceptance criteria certification using the WRAP-1 NDA/NDE functions, 3,000 drums also will need to be repackaged. The WRAP-1 Facility will use two separate glovebox lines to annually repackage more than 1,500 drums each of transuranic (TRU) and low-level waste (LLW) to meet current disposal guidelines. When complete, WRAP-1 will be the first facility of its kind to perform these tasks on a production scale. Completing this challenging task is made possible by using large-container (drum) bagless transfer technology and state-of-the-art glovebox design.

Bagless transfer technology is becoming a mainstay of international glovebox design, although its application in the United States has been limited to use for small-item transfer and low-production, specialty applications. Large (55- and 85-gallon-drum size) bagless transfer systems have not progressed beyond the test phase in this country and worldwide applications are limited. The WRAP-1 facility will be the first facility in the United States to use large-container bagless transfer on a production scale.

II. BAGLESS TRANSFER TYPES

Three main types of bagless technology exist:

- Airlock technology. While the method of partitioning air spaces works well, contamination tends to migrate backward through the airlock. The housekeeping required to control this migration limits the use of airlocks to inserting items only and, usually, LLW applications.

- Double-Lid Technology. This technology makes bagless removal, as well as insertion, of items possible. This type of system can be used in highly contaminated areas and is particularly well suited for TRU processing applications.
The technology gets its name from the technique of mating the container lid with the transfer port door. As the transfer port door is opened, the surface covered by the container lid is kept clean. When the port door is closed again, the lid is simultaneously inserted into the waste drum. In this manner, contamination is contained within the drum and by mating surfaces.

A characteristic of double-lid systems is the possible ring of contamination at the perimeter of the mating surfaces. The ring is a result of the gap necessary to permit the port door and lid assembly to enter containment. A second, outer lid is usually added for drum transport and to confine the small ring of contamination. The ring size is usually minimized by designing the system and mating containers to extremely close tolerances. Because of their custom design and close manufacturing tolerances, containers used with bagless transfer systems are usually expensive, so they are used for transfer applications rather than disposal.

- Sphincter systems. These systems, which are limited to item entry, operate by shuttling items through an elastomer diaphragm. The simple design maintains confinement, as long as the sphincter is not emptied.

III. WRAP BAGLESS TRANSFER APPLICATIONS

One benefit of the bagless transfer system developed for the WRAP-1 facility was reduced container costs. Using standard drums as the base component in the bagless transfer containers enhanced the containers’ cost effectiveness as a disposal system.

A. Entry/Exit Bagless Transfer System

The entry/exit system was designed and extensively tested specifically for the WRAP-1 facility. This system is different from other double-lid bagless transfer systems because it uses air flow rather than a high-precision mating surface to maintain confinement. This feature permits standard drums to be used without the addition of a flange and inner lid assembly and allows the full opening to be exposed to the glovebox confinement. As its name implies, this system can be used for removing items from LLW enclosures, as well as inserting items into them.

This system is designed primarily to access retrieved 55-gallon drums overpacked in 85-gallon drums to the WRAP-1 process lines. If the overpack drum remains uncontaminated, it can be returned to retrieval for reuse. Another advantage in the WRAP-1 facility is that the same system can be used for LLW disposal. This reduces waste generation because 85-gallon overpack drums found to be internally contaminated at retrieved-drum entry can be used as disposal containers for LLW.

One of this system’s novel features is its two-stage opening and closing process. This ensures that air expelled from the drum when the lid is closed is not released from the glovebox. Another feature is that its simple concept can be used with any size drum, although the WRAP facility uses only 55- and 85-gallon drum systems.

To operate, a scissor lift raises the drum until it mates with the port’s underside, as shown in Figure 1. The port door then grasps the drum lid, sealing the lid to the port door. The scissor lift continues upward an additional 12.7 mm (0.5 in.), opening the port door. At this point, an air curtain with a capture velocity of 46 m/min (150 ft/min.) is formed by the glovebox’s operating differential pressure. Once this air curtain is formed, the port-door/drum-lid assembly lifts vertically from the drum, then rotates to its completely open position. At this point, the drum can be filled or emptied.

Figure 1. Entry-Exit Port Operation.
The potential ring of contamination for this system was measured at less than 2 millimeters (0.06 in.). The drum’s ring of contamination, while 8.5 millimeters (0.25 in.) wide, is covered by the clamp band. Air flow testing also confirmed the confinement integrity of the air curtain, finding it to surpass high-efficiency particulate (HEPA) filter confinement requirements.

B. BNFL One-Trip Bagless Transfer System.

This double-lid-type system has been chosen to package 55-gallon drums of TRU solid waste for disposal. The system was originally designed by BNFL for use in the United Kingdom and was customized for use in the WRAP 1 facility. One feature added for the WRAP-1 design is the enlargement of the bagless transfer opening to 53.3 cm. (21 inches). During WHC’s development testing, other improvements were identified and made to address system fabricability, tolerance sensitivity, and operational reliability. A potential ring of contamination of just 1 mm. was measured with this system.

This system’s single-use container is based on a standard DOT 17H 55-gallon drum. Drop testing to ensure its conformance to DOT Type 7A performance requirements is to be completed this summer.

The drum’s bagless transfer capabilities are made possible by adding the double-lid assembly to the drum immediately underneath the stock drum’s lid, as shown in Figure 2. The flange and seal assembly are attached with an adhesive and located to permit the seal to compress correctly when the drum is hard-stopped against the port’s underside. Both the lid and flange are rolled to cost effectively achieve the necessary manufacturing tolerances.

In operation, the drum, with outer lid removed, is first positioned under the port with a scissor-lift conveyor. Then the drum is lifted until it is hard-stopped against the port assembly. The inner-lid grasping feature pulls the inner lid into the port door seal. The port-door/inner-lid assembly is then pulled into the glovebox, opening the drum to the glovebox.

To close the port, the port-door/drum-lid assembly is lowered into the port, repositioning the drum lid back into the drum. A swaging operation then fastens the lid to the flange. Once complete, the lid is unfastened from the door assembly and the scissor-lift lowers the drum away from the port. The operator then checks the inner-lid assembly for contamination and fastens a standard drum lid to the drum using a clamp band.

Figure 2. Double-Lid Assembly.

C. BNFL "Sphincter Seal"

The BNFL Sphincter Seal was originally developed by BNFL for inserting 55- and 85-gallon drums into process enclosures. It is considered a partial confinement system and, by itself, is suited only to LLW applications. In its original alpha waste applications in the United Kingdom, it was combined with an airlock to enhance system confinement.

In the WRAP-1 facility, the same philosophy was used, combining it with the entry/exit system in the process line’s TRU-entry glovebox. This glovebox, while serving as an airlock, is used to remove retrieved waste drums from their overpack and perform drum surface contamination checks.

As with any sphincter system, a drum must always be positioned in the seal to maintain confinement. In this application, shown in Figure 3, the drum’s position is maintained or the seal is maintained by a drum transfer system that holds and passed drums through the seal in a series of operator-initiated automated sequences.

The sphincter seal system was originally designed and tested in the United Kingdom, but was modified specifically for the WRAP-1 facility. Features
added to the design include a push-through replaceable sphincter cartridge. Through testing, this system has been demonstrated to operate for more than 1,200 cycles without significant wear and without a loss of confinement integrity. The system was also found to accommodate new, wrapped, and even dented drums without losing confinement.

D. Drath and Schrader Double-Lid System

One of WRAP-1's key operating advantages is that the repackaging gloveboxes are designed for high throughput and minimal operator input. Stabilization of non-compliant waste and other operator-intensive activities are performed in the Restricted Waste Management gloveboxes. The Drath and Schrader System transfers the waste between the two process lines.

Drath and Schrader double-lid systems have been used extensively in Europe for various bagless transfer applications. This particular Drath and Schrader product has a reputation for high reliability and confinement integrity and, because of its design, can be used in TRU processing operations.

The Drath and Schrader double-lid system uses a classic double-lid-type bagless transfer technique. The unit's confinement integrity comes from both the application of high-precision port manufacturing and its use of a drum designed specifically for the port.

When a drum enters the repackaging glovebox, waste packages that contain non-compliant items are removed from the drum and placed on a two-tiered, partitioned storage rack, dubbed a "cake stand." When its partitions are filled, the cake stand is passed through the Drath and Schrader port into the Drath and Schrader drum. The port is then closed and the drum is transported to the RWM glovebox.
At the RWM glovebox, the drum is opened and the cake stand removed. Each packet is then removed, opened, and the non-compliant article removed. The non-compliant article is then sampled and replaced on the cake stand. Once all non-compliant items have been removed from their packets and returned to the cake stand, it is again inserted in the Drath and Schrader drum. The drum is then sealed and moved to a storage area. The drum is returned to the RWM glovebox when sample analysis is complete approximately 2 weeks later. Through the use of bagless transfer technology, the WRAP-1 Facility’s conduct of operation has transformed waste processing from a labor-intensive and costly operation to a production-scale, cost-effective endeavor.

IV. CONCLUSION

The design and development done in support of the WRAP-1 facility has expanded the boundaries of bagless transfer technology beyond small-scale nuclear processing to where it can be used by a variety of fields that require handling of hazardous materials. The work also has developed systems that can use commercially available containers, thereby reducing operating costs.
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