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Operational Experience with Nuclear Glovebox Transfer Systems At Argonne National Laboratory - West

by

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OPERATIONAL EXPERIENCE WITH NUCLEAR GLOVEBOX TRANSFER SYSTEMS AT ARGONNE NATIONAL LABORATORY - WEST

Abstract: Argonne National Laboratory - West (ANL-W) is located on the Idaho National Engineering and Environmental Laboratory in southeastern Idaho near Idaho Falls. The facility has twenty-three gloveboxes on site used to contain radioactive contaminants consisting of mixed fission and activation products, uranium or plutonium. The operational experience using transfer doors, locks, bags and double door transfer containers is discussed. Specific problems that have been resolved include using transfer locks on highly contaminated transuranic gloveboxes and using heat sealed bag transfer systems for transuranic waste that meet waste packaging criterion. The Argonne administrative controls on the level of personal protective clothing used during transfers are provided and discussed. Recommendations based on operating experience are provided.

BACKGROUND

Argonne National Laboratory - West (ANL-W) is located on the Idaho National Engineering and Environmental Laboratory in southeastern Idaho near Idaho Falls. Major facilities on the site are the Experimental Breeder Reactor - II [operations ended in October 1994, it has been defueled and is currently being placed in a safe status by removing and treating the sodium coolant], the Fuel Conditioning Facility, the Hot Fuel Examination Facility, Waste Isolation Pilot Program (WIPP) Waste Characterization Area, Fuel Manufacturing Facility, and Analytical Laboratory. These facilities have twenty-three gloveboxes that are used to contain radioactive contaminants consisting of mixed fission and activation products, uranium or plutonium. These gloveboxes support the current programs of spent reactor fuel treatment and characterization of transuranic wastes. Approximately half are used to contain mixed fission and activation products and the other half are used to contain uranium or transuranic elements. Ten of the gloveboxes have inert atmospheres, usually argon, while the rest are air atmosphere gloveboxes. Radioactive contamination levels vary from low level (1 to 100 times free release levels) through high level (greater than 100 to 10,000 times free release levels) to very high level contamination (greater than 10,000 times free release levels).

TRANSFER SYSTEM EXPERIENCE

Single Doors

The simplest form of transfer system may be the single door, which consists of a door that opens to provide access to the glovebox. Material is transferred in or out of the glovebox by simply opening the door and placing the material in the box or removing it directly through the open door. Gloveboxes that use a single door are ventilated such that with the door fully opened, there is sufficient air flow into the glovebox to capture contamination.

In the 1960 and 1970's many of the gloveboxes at ANL-W used single doors as their transfer system. If the glovebox became even moderately contaminated, then contamination would spill outside the glovebox when the door was opened. Even with adequate airflow into the glovebox the contaminated side of the door would provide a source of contamination. Material being removed would need to be immediately bagged to contain the surface contamination. Frequently the floor under gloveboxes would become permanent contamination areas due to the many spills involved with the single door transfer system.

Today there is only one glovebox at ANL-W that uses a single door system. It is only used to transfer noncontaminated material and equipment into a small hot cell complex. A different glovebox is used to transfer contaminated material out of the hot cell. The glovebox is surveyed on a daily basis to ensure that it remains free of removable contamination.

Transfer Locks

A transfer lock is formed when two doors are used on a chamber or air lock that is attached to the glovebox. The chamber and two doors provide a way of transferring material in without ever directly opening the glovebox to atmosphere. It is commonly used on gloveboxes that are atmospherically controlled to remove the air from around the material prior to transferring them into an inert atmosphere glovebox. The transfer lock is similar to a single door in that a door is opened and material to be transferred is placed into or removed from a lock. The lock may be evacuated and backfilled to change the atmosphere prior opening the second door and continuing the transfer.

Transfer locks have similar problems as the single door systems. During the placement or removal of material from the lock to the glovebox, contamination may be transferred to the lock. This contamination presents a hazard to the workers who open the outside of the lock. The lock then becomes a miniature single door system with the source term limited to the contents of the lock.

Because of the limited source term, ANL-W has had less contamination spread during transfers with locks than single door systems and have been able to successfully use locks for low-level contamination control. For high-level contamination control in inert atmosphere gloveboxes we have modified the glovebox to allow transfers out of the glovebox using a bag system instead of the transfer lock. Air atmosphere gloveboxes that are highly contaminated have converted to bag transfer systems, as they are better able to control contamination. The transfer lock on inert atmosphere boxes is maintained as the only reliable method of transferring in equipment and materials without compromising the inert atmosphere. In highly contaminated gloveboxes this system of using the transfer lock for in transfers and a bag system for out

transfers has been successful in controlling contamination. If the glovebox becomes very highly contaminated, the transfer lock can not be used without contamination spread during the transfer. This is due to cross contamination between the lock and the glovebox when the inner door to the lock is open.

If the transfer lock is still required to maintain an inert atmosphere's purity, ANL-W has sacrificed glovebox space to install a partition with a HEPA filter and bag transfer system between the very highly contaminated sections of the glovebox and the transfer port. The newly created space is then maintained radiologically clean. By placing the partition such that the glovebox ventilation supply is returned to the clean side of the partition and the exhaust is on the contaminated side of the partition, a slight differential pressure is created across the HEPA filter that aids in maintaining contamination control.

Bag Systems

Bag systems were devised to overcome some of the containment issues with transfer doors and transfer locks. A bag system uses a plastic bag attached to the glovebox to introduce or remove material from the glovebox. Several methods may be used to attach the bag to the glovebox and likewise several methods may be used to seal a bag during material transfer. The two methods used to attach bags to gloveboxes at ANL-W are the bag-on-bag method and the push-thru method. Sealing of the bags are also performed at ANL-W with two different methods, which are the tape and cut method and the heat seal method.

The bag on bag system consists of a bag clamped to a ring. To change the bag the clamp is removed and the bag is maintained on the ring by a neoprene o-ring or an elastomer band. The old bag is folded or slid to the end of the ring and a new bag is placed over the old bag and clamped to the ring above the old bag. The old bag may then be pulled off the ring into the glovebox. The difficulties with this system consist of exposing contamination when the old bag is folded or slid to the end of the ring. This uncovers contamination that has worked its way out of the glovebox and up between the ring and the bag. On very high contamination gloveboxes, additional contamination control measures including respiratory protection are often necessary.

The push-thru bag system consists of a bag on a nylon ring that is pushed into a larger metal ring attached to the glovebox such that the bag is held securely between the flexible nylon ring and the metal ring. To change the bag, the new bag is attached to a new nylon ring and both are forced into the metal ring until the old bag and its flexible ring are forced into the glovebox. The containment problems of the bag-on-bag system are not seen with the push-thru bag system.

The two methods of sealing bags are not equivalent in their contamination control abilities. The tape and cut method usually allows small amounts of contamination to be transferred to the cutting tool and occasionally fall to the floor. The cut stubs always have some quantity of removable contamination available and must be taped over to prevent further contamination spread. The heat seal method overcomes most of these problems. During the heat sealing process the removable contamination is bound in the plastic matrix. The cutting tool is usually not contaminated and generally no contamination is seen on the cut stub. This is only generally the case, since on very highly contaminated gloveboxes some small amount of transfer to the cutting tool or on the bag stub has been seen occasionally with the heat seal method.

Experience with bag systems has shown them to be reliable transfer systems that are currently our best general all around glovebox transfer method. Some additional precautions have been prescribed to ensure the safety of our workers. These are shown in the Table 1. Full anti-contamination clothing (Anti-C's) consists of a single set of coverall, gloves and shoe covers, while double Anti-C's would be two sets of coveralls, gloves and shoe covers.

TABLE 1

ANTI-C REQUIREMENTS FOR TRANSFER SLEEVE OPERATIONS

Containment Contamination Level	Containment Pressure			
	Always Negative		Potentially Positive	
	Transfer Method		Transfer Method	
	Tape & Cut	Heat Seal	Tape & Cut	Heat Seal
Low	Lab Coat & Gloves	Lab Coat & Gloves	Respirator & Full Anti-Cs	Respirator & Full Anti-Cs
High	Respirator & Full Anti-Cs	Lab Coat & Gloves	Respirator & Double Anti-Cs	Respirator & Full Anti-Cs

A heat-sealed bag of a push-thru transfer sleeve is currently the best transfer method with regards to radioactive contamination control. Using this method of transfer, the material removed from a glove box ends up in a sealed container. This is an ideal situation unless the material is transuranic waste that is destined to go to the Waste Isolation Pilot Plant in Carlsbad, New Mexico. The current waste acceptance criterion excludes heat sealed containers that are larger than four liters. In order to meet the acceptance criteria and still use heat sealed transfer sleeves where possible, ANL-W has devised a system where the heat-sealed sleeve may be safely cut prior to being placed into the final waste container. The procedure is outlined in Figures 1 through 5.

Figure 1

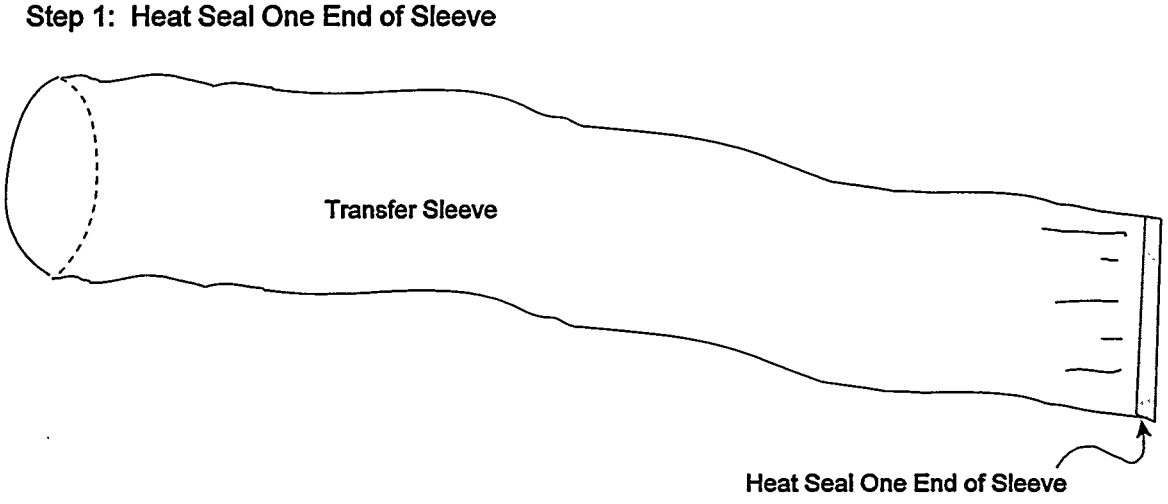


Figure 2

Step 2: J-Seal the End that is Heat Sealed Leaving the Heat Seal Exposed

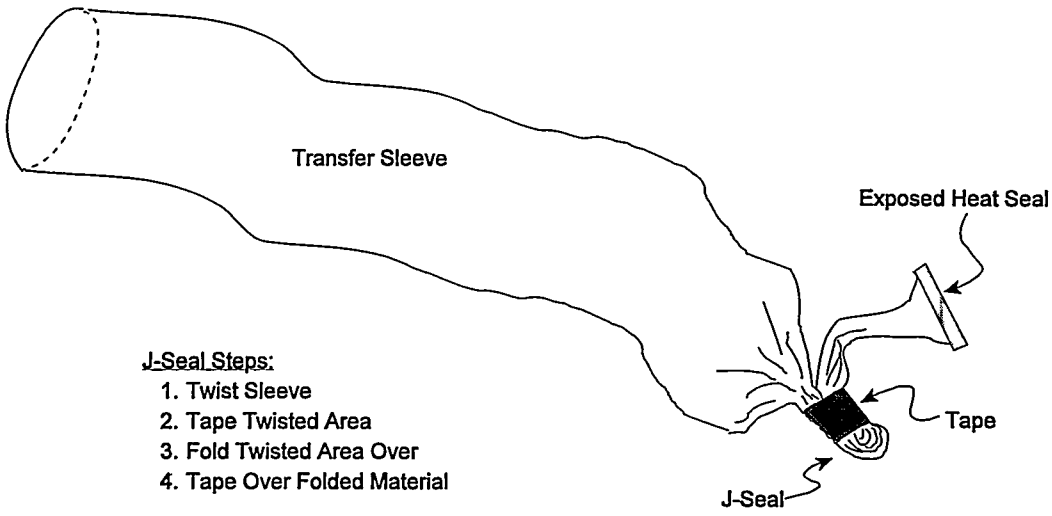


Figure 3

Step 3: Attach Sleeve to GloveBox

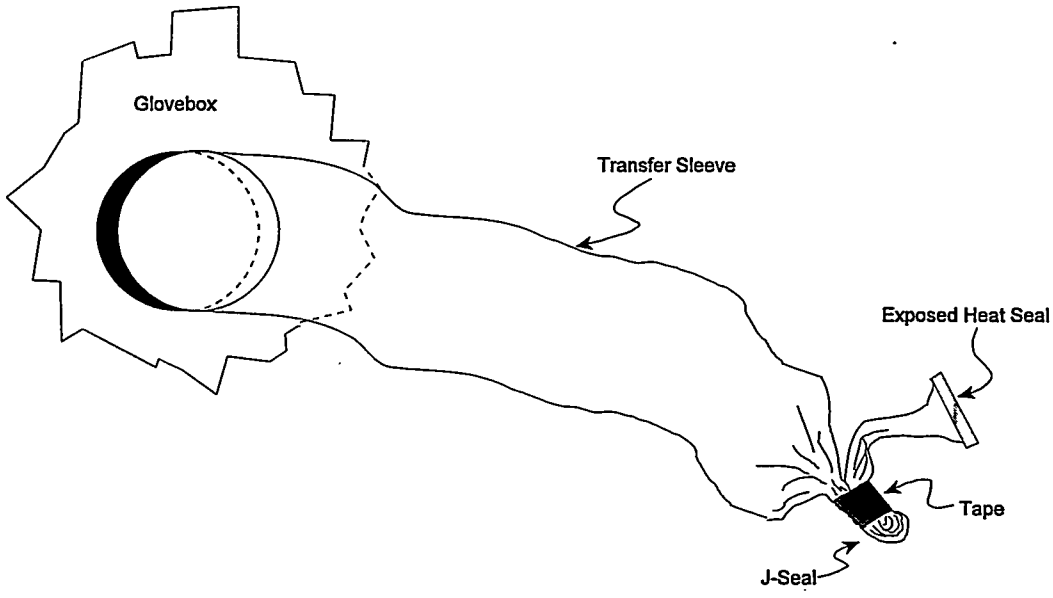


Figure 4

Step 4: Heat Seal Off Loaded Transfer Sleeve

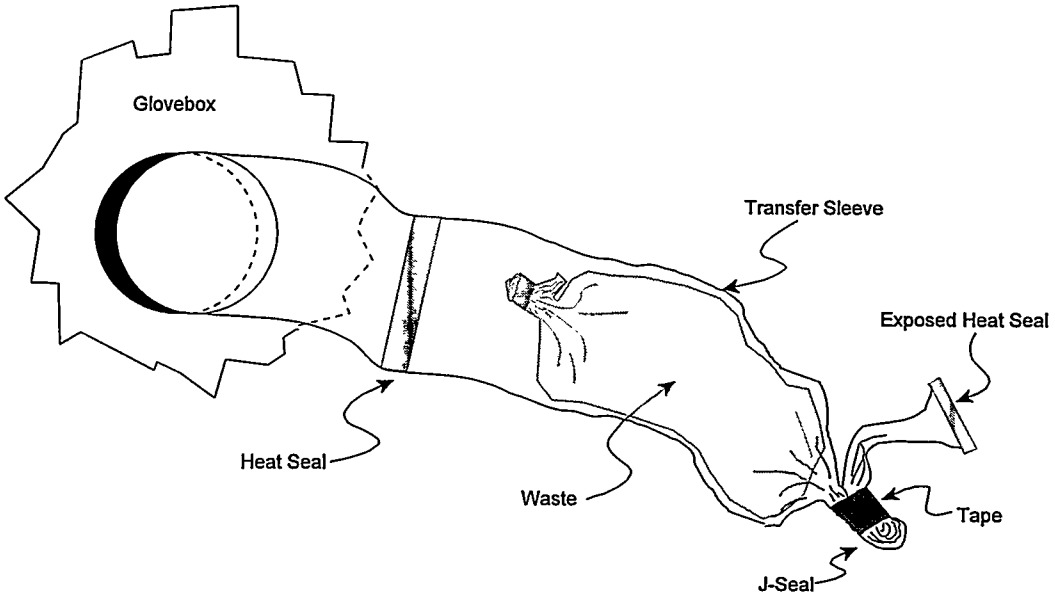
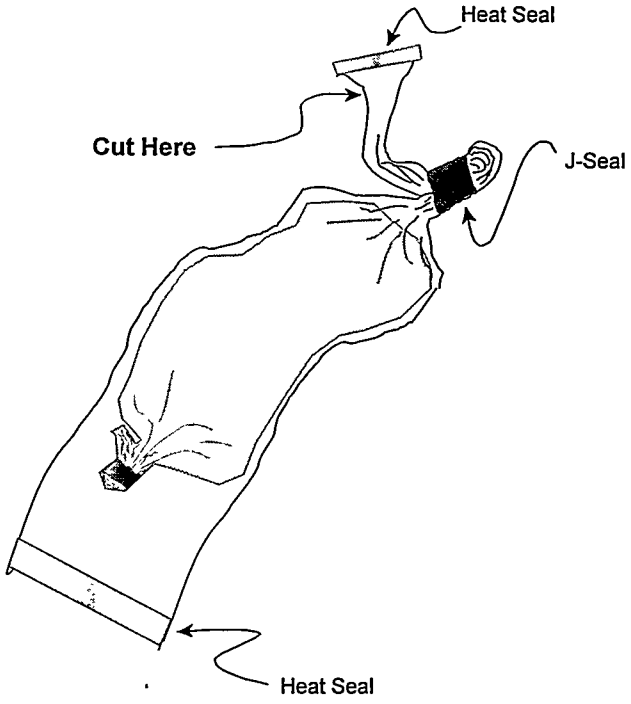


Figure 5

Step 5: Cut Heat Seal Near J-Seal and Dispose of Transuranic Waste



Double Door Transfer Containers

Double door transfer systems are engineered systems that attempt to over come the shortcomings of bags and transfer locks by providing hard, usually metal or plastic, container that may be attached to a glovebox. The double door containers are closed when removed from the glovebox and are opened from the inside of the glovebox to reveal the contents of the container. The double door consists of the door on the container and the door to the glovebox that inter lock together when the container is attached to the glovebox. By interlocking, they protect the covered surfaces from becoming contaminated.

The containers provide a robust containment for transfers. The ones in use at ANL-W do not have the ability to be purged and are only used on air atmosphere gloveboxes. The only contamination control issue is the seal between the lid and the container or the glovebox door and the glovebox. In both locations, contamination has been detected as the contamination has migrated across the seal area through repeated usage. This has resulted in periodic full decontamination of the transfer containers and the glovebox doors.

SUMMARY

There has been significant improvement over the years in the ability of glovebox transfer systems to control radiological contamination. Because of these improvements, gloveboxes are increasingly being deployed to solve a range of containment issues at the ANL-W site. There is still a need for continued improvements in glovebox transfer systems to handle the issues of radiological contamination control.

ACKNOWLEDGMENT

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