Double Door Transfer Ports (DPTE™) Use to Maximize ALARA in Contained Transfer Operations

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ABSTRACT

Nuclear material transfers between gloveboxes have often been associated with increased dose to operators namely due to the tedious nature of the process. The double door transfer port (DPTE™) [1] was originally developed to improve efficiency and safety of nuclear material transfers over 40 years ago. Alpha and Beta exposures and Gamma dose can be greatly reduced if not eliminated with the use of DPTE™ technology as compared with many other box to box transfer methods used in the U.S. today. This paper will discuss the methods and give examples of where As Low As Reasonably Achievable (ALARA) improvements are realized.

INTRODUCTION

For many years, bag operations and open hood airlocks have been used for many nuclear material transfer operations. Maintaining containment during these operations has always been a major variable. ALARA improvement during contained transfer operations is possible if the variability of the transfer methodology is minimized. Any transfer methodology requiring multiple administrative controls (operator intensive) make it very difficult to minimize the containment variability. Engineered controls are much more effective in minimizing variability. Minimal variability allows for measurable consistent containment, thus more consistent dose control for ALARA concerns. Unfortunately most contained transfer methods are very operator dependent. As with bag operations, if the operator is well trained and careful, the transfer can occur with little contamination transfer. The problem is, this same operator could have a bad day and be in a hurry, which can change the contamination transfer level by a large margin.

Double door transfer port technology was developed in the early 1960s by a French company for the French nuclear industry. The technology evolved quickly and expanded throughout Europe and Japan where it has become a standard for contained transfers of nuclear materials, samples, and waste. The technology was introduced to the U.S. market through a license agreement with a U.S. manufacturer in the early 1970s.

The first double door transfer port, the DPTE™, invoked numerous engineering controls to provide a very consistent operation and maintain consistent containment controls. The concept utilizes four surfaces that mutually cover each other during different phases of operation maintaining containment between the inside and the outside of the glovebox at all times.

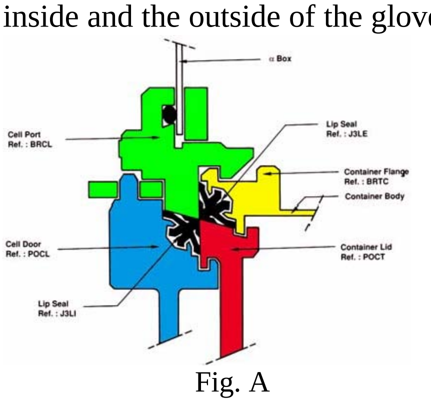


Fig. A

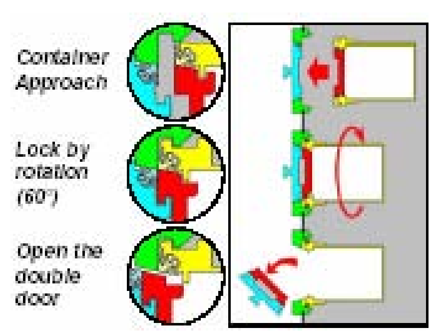


Fig. B

The double-lipped double-face seal design (Figure A) and tight manufacturing tolerances of the seal, enable the DPTE™ to contain even sub-micron size particles. The pharmaceutical industry uses the DPTE™ for both containment and sterility applications because it has been proven to contain even live spores during transfers. Fine particle surrogate material testing was used to prove the DPTE™'s Transfer Containment Ratio (CR) (contamination in glovebox/contamination outside glovebox). Worst-case conditions were used in the testing and the CR for the DPTE™ was measured to be 2.9 E06 ±30% [2].

Fig. C
Containment Ratio Calculation:
If the contamination activity or mass inside containment is known, it can be multiplied by the reciprocal of the CR to establish a value of what could be expected outside of containment after a transfer.
(Example) 1.0 E08 DPM inside containment X 3.44 E-07 = 34.5 ±30% DPM outside containment after the transfer.

The DPTE™ is the only known, proven, and consistent means of contained transfer that has a known method to determine possible dose for ALARA concerns.

The DPTE™ comes in a range of sizes to encompass many nuclear applications:

- Pneumatic transfers with the 90mm diameter
- Sample and small material transfers with the 105mm diameter
- Material and waste transfers with the 270mm and 350mm diameters
- Waste disposition and handling with the 460mm diameter

System interlocks eliminate inadvertent containment breach, protecting operators from Alpha (•) and Beta (•) radiation exposure. Due to the speed of the DPTE™ operation (Figures B), the operator handles the material for much shorter intervals, minimizing ALARA levels due to Gamma (•) radiation exposure.

APPLICATION COMPARISON

We compare the complexity and nature of contained transfer using bag operations, open-hood airlock operations, and DPTE™ operations to clarify the ALARA benefits of well-engineered containment control solutions.

SAMPLE and MATERIAL TRANSFERS

BagIn/BagOut

During bag operations, dependent on the level of contamination in the glovebox, the operators normally must wear PPE (Figure D) to reduce their chance of exposure in the case of a bag breach. The item being transferred is passed into the bag-out bag, the bag is twisted to form a "horse tail," and the "horse tail" is taped, sometimes zip tied. The "horse tail" is then cut in the middle (Figure E) and the cut ends are taped over to contain contamination on the ends. Often the cutting tool, which is contaminated, is disposed of after the cut to avoid possible spread of contamination. The bagged item is taken to the next glovebox where it is placed into another bag, the new bag is stretched over the previous bag remnant on an entry bag ring and through a series of steps is able to enter the next glovebox. Not a simple operation.

BagIn/BagOut continued…


Fig. D


Fig. E

Airlock or Open Hood

Airlock/hood operations (Figures F & G) are primarily used when removing small volume samples and rarely used for bulk material transfers. Multiple glove layers and high volume airflow of the hood protect the operator. The operation is described below:

- A clean bag is placed into the glovebox through the airlock, the vial is placed into the clean bag, the bag is tapped, and the glovebox/airlock door is closed. The airlock may be cleaned and a clean wipe placed on the airlock floor from the hood entry port door and the hood entry port door is closed.
- The bagged sample is then placed on the clean wipe in the airlock and the glovebox/airlock door is closed.
- The hood entry port door is opened and the bagged sample is removed from the airlock into the hood, the hood entry port door is then closed.
- The operator's gloves are changed and a new bag is placed into the hood.
- The bagged sample is then placed into the new bag and properly taped.
- The double bagged sample is placed into a third bag held by an additional operator at the hood face and with special care the third bag is tapped.
- The triple bagged sample is taken to the next glovebox/airlock/hood and passed into the glovebox through the hood/airlock, where the bags are removed and discarded.

Not a simple operation.


Fig. F

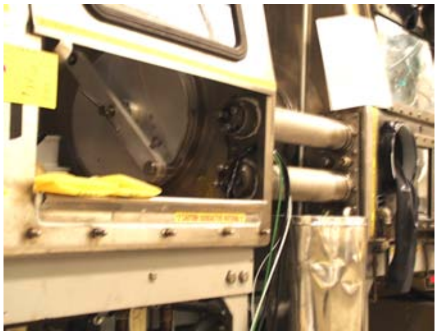
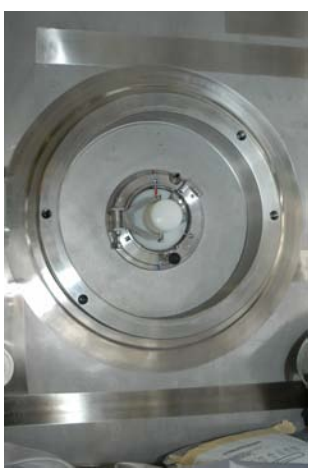


Fig. G

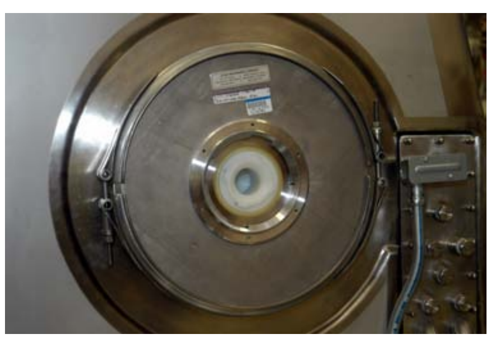
DPTE™

The DPTE™ transfer operation consists of connecting the container, reaching in a glove and unlocking and opening the doors, placing the sample in the container, closing and locking the doors, and removing the container (Figure H). The whole operation can be accomplished within one minute in a completely contained manner without requiring the use of full PPE. ALARA improvements realized with the use of the DPTE™ are summarized in Table I.

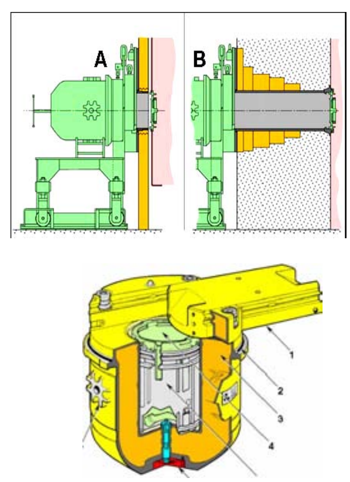
Fig. H



Inside Glovebox
Fig. I



Outside Glovebox
Fig. J



γ / α / β Transfer
Fig. K

Table I. ALARA Improvements Realized with the Use of Double Door Transfer Systems for Sample and Material Transfers.

Material Type	Bag Out/In	Open Hood with Double Door Airlock	DPTE™
Contamination Areas	When a new bag is placed over the old remnant on a bag ring, contamination can be exposed when the remnant is pulled to the outside of the ring. When the horsetail is cut, the cutting tool and the cut ends of the horsetail are contaminated.	Items passed from containment through an airlock including the airlock are all exposed to contamination and much care must be taken to not contaminate the external layers of confinement	The tip of both seals on the DPTE™ (0.3mm wide) is the only surface exposed to both the inside and outside of containment. Periodic lubrication during periodic swabbing of the external seals helps affix any possible powder that may escape during high volume loose powder transfer.
	Bag Out/In	**Open Hood with Double Door Airlock**	**DPTE™**
Oxide (Powder) Samples/ Materials	Much preparation, care, and PPE are required for powder transfers using bags.	Not normally used for Powder Transfer.	Certain powders require some care and PPE dependant on the possible transferred external activity based on the CR calculation.
Oxide (Powder) Contamination Areas	Usually powder is placed in a container inside a bag in the bagout bag. The integrity of the bagout bag horsetail (bag tie), the cut, the cutting tool, and tape over can all contribute to external transfer of powder.	NA	Powder is placed into an internal container then placed directly into the DPTE™ container. If extreme amounts of powder are airborne during transfer, a simple wipe prior to closing the doors, limits contamination to the external surfaces. External transferred mass can be calculated as in Figure C.
Solid/Liquids Sample/Materials	Bagging normally will contain solids/liquids but surface oxidation/dehydration can cause active particulate shedding posing an inhalation risk in a breach. Active gamma isotopic materials cannot be effectively shielded with bags. Metal containers can provide necessary shielding.	Solid/liquid samples, when well controlled can be transferred out and in using an airlock and open hood. Multiple bag layers help contain particulate shedding. Metal containers as a confinement layer provide necessary shielding.	DPTE™ containment is not an issue with solid or liquid samples. Shielding can be handled by using a thicker or metallic DPTE™ container or using a special lead cask (Figure K). The DPTE™ container can be easily inerted to prevent material oxidation during transfer.

WASTE TRANSFER

Bag Out / Drum-Bagout

Bagging out TRU waste (Figure L) from a glovebox is normally performed by passing the waste through a bagport using bag techniques. In some cases waste removal is performed through a large bagport directly into a 55-gallon drum. To avoid tearing the bag or breach of containment, sharps are normally padded or tapped and some items are pre-bagged before bagging out. Both methods expose multiple operators to dose and possible contamination.

Fig. L

DPTE™ Waste Handling

The entire process of placing the DPTE™ container in the DOT drum (Figure M), inserting the Centering Ring (Figure N), aligning the drum (Figure O) and raising into position (Figure P), locking the drum in place and opening the doors (Figures Q & R), and installing the funnel (Figure S), takes less than two (2) minutes to accomplish. The entire process is monitored and interlocked to prevent breach of containment. Disconnecting the drum is as safe, fast, and easy as connecting the drum. Conventional and DPTE™ waste transfers are compared in Table II.

10" Glovebox Port

5-G Waste Shuttle Container

Transfer Safety Cover

DPTE™ Waste Handling continued…

DPTE™ 55-G Container Placed in DOT Drum
Fig. M

Centering Ring
Fig. N

Drum Under Glovebox
Fig. O

Raised Drum
Fig. P

PLC controls Interlocks and Drum and Doors opening
Fig. Q

Removing Doors
Fig. R

Funnel in place in Open Drum
Fig. S

Table II. Operational Comparison of the DPTE™ Bagless Drumout System with the Conventional Bagout Process [3]

Conventional Drumout/Bagout	DPTE™ Bagless Transfer System
Drumout/Bagout is 2 or more person job.	DPTE™ ™ Drumout can be performed by one person.
10 Step procedure to replace Bagout Bag.	3 Step Procedure for connecting DPTE™ container.
22 Step Procedure for Bagging out waste many of which are very operator intensive to ensure containment.	6 Step Procedure for drumming out waste, most of which are protected by DPTE™ interlocks to preserve containment integrity.
Work performed under the glovebox in awkward positions.	Work performed by operator in upright position.
Respirators required for all activities involving bagout bags.	Respirators may not be required.
Radiation exposure of 20 – 30 minutes per bagout in close proximity to waste.	Radiation exposure reduced to 3-5 minutes per drumout.

Table II. continued…

Conventional Drumout/Bagout	DPTE™ Bagless Transfer System
Twisting and taping of bag requires repetitive motion.	Repetitive motion is reduced or eliminated.
Plastic bags, tape, and ties, become part of the waste stream.	Plastic bags are not used.
Waste accumulates in gloveboxes awaiting sufficient personnel and time to perform bagout process.	Waste can be removed as they are generated.
Bagout port is sealed with a bagout bag	Glovebox is sealed with a DPTE™™ door.
Bagout port can be used for introducing items into the glovebox through a bagin.	Multiple size DPTE™ containers are available for introduction of items through the DPTE™ Drum port.
Sharps have to be taped before loading into the bag to prevent puncture.	Sharps can be directly loaded without possibility of puncture.

Table III. ALARA Improvement with the Use of DPTE™ Waste Systems Over Bag Operations.

Bag Out to Drum Operation	DPTE™ Drum Out Operation
Two or more operators are in close proximity to the waste as they twist, tie, tape, cut, and tape over the cut bag ends.	Single operator can perform the entire connect and disconnect of the drum and is always contained from the waste throughout the installation and removal of the drum.
Bag on / Bag off process takes two or more operators an average of 20 minutes per drum.	DPTE™ Drum connect / disconnect takes an average of 3 minutes per drum.
Multiple bag, tape, and tie procedures in the glovebox, add to the operator's exposure time and increase the chance of a glove breach.	Waste contact requires only dropping the item into the DPTE™ drum container. Less motion, and less time in the gloves in contact with the waste improves ALARA.
Well-trained careful operators can perform multiple step bag procedures safely. Multiple step procedures tend at times to cause an operator to rush possibly causing an inadvertent exposure.	The DPTE™ Drum connection and disconnection process, although quick, is completely interlocked to ensure containment throughout operations. Even a fatigued rushed operator would have little chance of being exposed by the DPTE™.
Sharps present the highest risk to bag operations and are the cause of at least 50% of bag containment breaches. Many times sharps must be taped and padded before being placed into the bag.	The 125mil polyethylene DPTE™ container is puncture resistant, drastically reducing if not eliminating a containment breach due to sharps.
Bags can pull off the ring, tear, or be punctured during bag out operation, potentially exposing the operator and room to α/β contamination.	DPTE™ interlocks prevent containment breach and the DPTE™ container is very difficult to puncture; thus greatly reducing or eliminating operator or room exposure.

Table III. continued…

Bag Out to Drum Operation	DPTE™ Drum Out Operation
In case of γ active TRU waste, the bag is all that shields the operator during parts of the transfer operation. Two or more operators are near or in contact with the drum for the entire bag off process.	The operator is nearly one meter from the drum throughout the operation. Since the operator never needs to touch the drum during the operation, shielding can be used on the lift as well between the drum and the operator for higher activity transfers.

ALARA controls during TRU waste transfer activities are clearly improved with the use of the DPTE™ Drum System. As shown in Table III, not only is less time spent dealing with the waste, but also containment breach is essentially eliminated.

SUMMARY

To control variability of contamination and/or dose during contained transfer operations, engineering controls provide the most consistent results. The DPTE™ double door transfer port is a very well engineered, consistent, contained transfer device. Consistency provides the ability to use the known contamination ratio of the DPTE™ to provide better ALARA control. With the use of the DPTE™ in place of bag operations and open hood/airlocks, ALARA can be greatly improved and much more easily controlled. Not only will operators be lowering their dose and chance of exposure, but also the transfer operation efficiency will improve and RAD waste will be greatly minimized further reducing the possible spread of contamination.

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REFERENCES

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