

GLOVEBOX DISMANTLEMENT AND EQUIPMENT PROTECTION IN CONTAMINATED ENVIRONMENTS

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ABSTRACT

It has been revealed from the experiences of Decontamination and Decommissioning (D&D) activities that even a small improvement in performance can result in significant risk reduction and cost savings. For example, Race Scan Ear Mic System, which was originally developed for communications between racecar drivers and crews in loud environments, has been successfully applied to D&D work and proved to enhance worker safety and communications. Glovebox dismantlement is an important and costly process in D&D activities of nuclear facilities. Adequate decontamination and size reduction of the gloveboxes are especially important in this activity because they have the potential to reduce risks and costs significantly. This paper presents some simple approaches to support D&D tasks and discusses their potential advantages. Examples discussed include:

- Repeated shear wiping of large pipes and ducts
- Application of thin layers on radiological counters for uninterrupted use
- Partial use of robotics for glovebox dismantling

The paper also discusses schematics for protecting equipment interiors and/or glovebox inner surfaces from contamination, which may result in significant savings and waste minimization upon future dismantlement. Examples discussed include:

- Smart coating for contamination prevention
- Protecting equipment by geometrically simple cover

INTRODUCTION

The quality of Decontamination and Decommissioning of nuclear facilities depends heavily on budgets, resources, schedules, etc., and is influenced by external factors, such as regulations, strategies, and resource availability. Circumstances can be transitory and change with time. Therefore, it is important to develop a plan of action for D&D activities through optimization rather than evolution. Adopting methodologies and technologies in terms of practicality and applicability of existing practices, as well as taking advantage of opportunities to enhance efficiency and safety through adoption of new or alternative techniques, are both important to increase efficiencies.

Experience in the US and elsewhere has shown that it is a valuable exercise for an organization with substantial nuclear facilities to regularly review the potential for improving the efficiency of decommissioning planning activities at all levels. Even a very small improvement in planning

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efficiency can result in significant cost savings over the long term (1).

Here we consider small performance changes, such as application of existing methods to new aspects, extension of existing methods, design or creation of simple tools to enhance worker safety, etc., in dismantling of gloveboxes to enable work crews to save time, effort, and to enhance personal safety in D&D operations.

DECONTAMINATION

Enhancement in the efficiency and effectiveness of the decontamination of gloveboxes and equipment interiors is important because, if adequately applied, it will result in significant cost savings (For example, Rocky Flats decontaminated a number of gloveboxes by cerium spray decontamination, which allowed the boxes to be disposed as low level waste as opposed to disposal as TRU waste (2). This resulted in significant disposal costs savings). However, there are still a number of issues to be resolved regarding decontamination due to complicated geometries, crevice areas, congested areas, difficulties with fixed contamination, generation of secondary wastes, appropriate characterization of material before and after decontamination, etc. Here, we present option to circumvent the described difficulties.

Repeated shear wiping of large pipes and ducts

It is difficult to decontaminate inner surfaces of large pipes and ducts that are contaminated. Even if the decontamination agents are adequately applied, it is still difficult to remove them with the contaminants.

The following scheme indicates the process toward this difficult task.

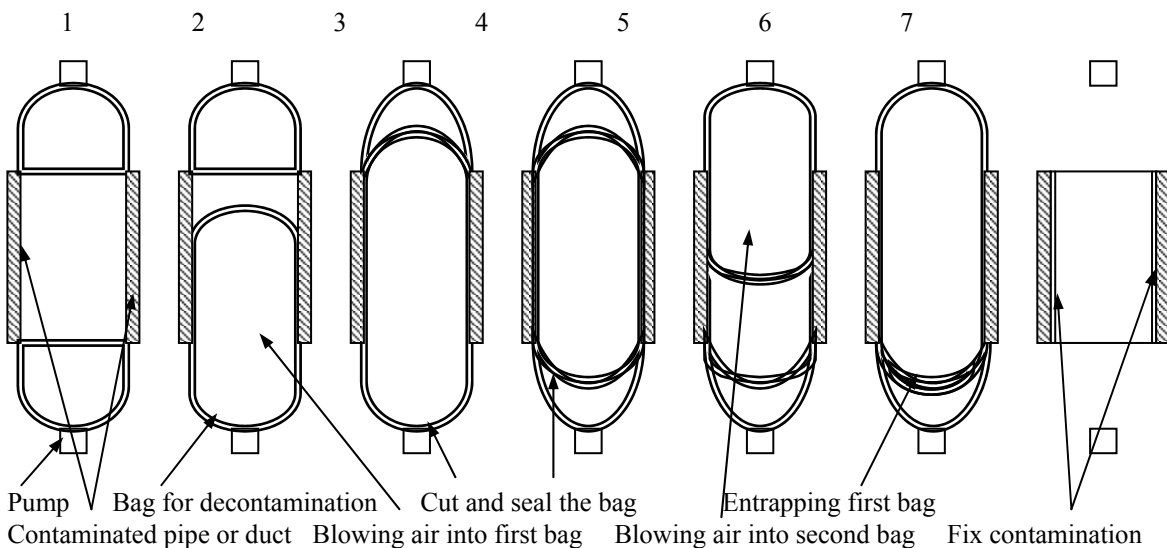


Figure1. The schematic procedure of repeated shear wiping method.

1. Two sheets (bags) are placed at the both ends of pipe or duct with air pumps. Decontamination agents are either applied to the inner surface of the pipe or coated on the surface of the sheet.
2. Air is induced into one of the sheets. As the sheet moves, the resulting shear stress at the contact surface decontaminates and wipes out the contaminants.

3. The contaminated surface of the sheet is captured by the other sheet.
4. When the operation ends, the end of previous sheet is cut and depressurized. The other part of the same sheet is sealed for future usage.
5. Second sheet is blown by air as step 2, and resulting shear will again wipe and decontaminate the inner surface.
6. The contaminated surface of the sheet is captured again by the next sheet. At this point, the very first contaminated sheet is sandwiched between these two sheets.
7. Repeat the above process until contamination level of the surface is at the desired level. Finally, cut both ends of sheets and finish the procedure.

The important points of this method are:

- Operations could handled remotely
- Contaminated surfaces are always covered
- After the process, the inner surface of pipe is covered so that existing contamination is appropriately fixed

Use of spin coating to produce uniform thin layers for detector head protection

In the course of decontamination, it is key to survey for the level of surface contamination both before and after decontamination work takes place. In doing so, it is preferable to limit or exclude contamination of the detector while not impairing detection capability. Application of thin layers on the detector head has potential for meeting these requirements. If the layers could be easily peeled by hand, then the measurement could continue without interruption, even if the top layer were contaminated.

The method of spin coating is widely used to produce thin layers on materials with relatively ease. Spin coating is a technique to produce very thin and uniform films (with the final thickness ranging in between 10~100 μ m) by the centrifugal spinning of viscous liquids on a rotating disk (3). Because of its simple manipulation, it could easily be used to fulfill the above requirement as follows:

- First apply the strippable coating in liquid form to the surface of the detector head, and rotate to make a thin and uniform layer
- Make pull tabs so that the layer can remove easily
- Next, apply a second droplet and spin to form another layer
- Repeat above procedure as many times until the total thickness of layers affects detection

In this manner we could survey the surface of the contaminated material repeatedly by peeling off the upper layer whenever it became contaminated. Determining factors would be:

- Material to be used as strippable coating
- Adequate final thickness of the layer
- The number of the layers

SIZE REDUCTION

In the course of dismantling, size reduction operations comprise a large amount of the total work effort. Therefore, it is important to have systematic ways to operate size reduction activities. The ability to perform these cutting activities remotely is desired. We will discuss options to conduct size reduction operations to maximize efficiency.

Partial use of robotic for size reduction

Since some of the size reduction works face thick material cuttings, simple but time consuming activities, or constantly repeated works, the use of robotics plays important role in reducing worker exposure and hazard. Although these systematical approaches are recommended, it is still difficult to install robotics in full scale into the dismantlement field (For example, there are unknowns such as the amount of time to fix or repair equipment). There is also the uncertainty that the robotics will not operate as designed for their intended use. However, if we could combine the manual procedure with the robotics adequately, a rational scheme can be implemented. Japan Nuclear Cycle Development Institute (JNC) has been conducting glovebox strip-out operations in the glovebox dismantling facility successfully by using 80% manual and 20% robotics (4). Activities include:

- Unfastening bolts and removing panels from the gloveboxes
- Cutting the glovebox body and ceiling by plasma arc

Although this operation is currently conducted against standard sized gloveboxes (dimension of 3m × 3m × 1m), the success in the partial use of robotics highly recommends the use of similar methodologies in other facilities with various types gloveboxes.

Vacant rooms for decontamination and dismantlement

The Decontamination and Volume Reduction System (DVRS) was designed and deployed by a team, comprised of members from national laboratories and the private sector, at Los Alamos National Laboratory (LANL) to demonstrate decontamination and size reduction of the contaminated gloveboxes (5). DVRS is an integrated system for decontaminating TRU metallic waste to low level waste, and significantly reduces the total volume of waste for disposal.

DVRS has two rooms for decontamination and size reduction. The concept of these vacant rooms may serve to optimize the operation. In the past, there has been a tendency to install full-sized equipment in tight conditions in the glovebox for decontamination or dismantling equipment. It was, therefore, very difficult to maintain or replace the equipment. Also there is a danger that if the equipment, once install, was found to be useless, it would require a large expenditure of time and money to exchange the equipment. The vacant rooms concept enables us to treat such difficulty easier by simply replacing equipment by hand. The improved rooms might be obtained by considering the following design options:

- Curved construction at the floor and wall corner
- Two layer (plastic + painting) protection of the room
- Drainage system
- Valid containment design for doors

CONTAMINATION PREVENTION

Decontamination and size reduction works are difficult and time-consuming activities. If we could prevent contamination for equipment those of which we anticipate to be dismantled in the future, it would greatly increase the efficiencies for the dismantling work. Here we present some options to prevent contamination by coating equipment and surfaces before installation into the contaminated environment.

Smart coating for contamination prevention and waste minimization

Smart coating is a nontoxic water-based polymeric coating which provides vivid color change in

the regions of contamination (6). The material is composed of polyvinyl alcohol (PVA), poly vinyl pyrrolidone (PVP) and 2-(5-bromo-2-pyridylazo)-5-diethylaminophenol (BrPADAP). Addition of PVP and BrPADAP are, respectively, for improvement of adherence and colorimetric indicator. PVP acts as a solubilizer for the BrPADAP in PVA as well. Smart coating exhibits different color changes for different contaminant (orange to purple for uranium and orange to red for plutonium) and is effective at removing varying levels of both contaminants from different types of surfaces. Since the areas of contamination are indicated by a color change, it is intended to be used as an efficient and effective decontamination and segregation method, because contaminated portions of the coating can be separated from uncontaminated areas and treated accordingly.

Although still expensive for commercial use, this method may also be used to prevent contamination. If applied to D&D work areas, newly generated contamination areas or spots can be determined quite certainly and easily, which could avoid extensive decontamination work since contamination in large suspected areas can not usually be determined and in most situations it is necessary to decontaminate the whole suspected area. It will therefore eliminate the possibilities of unnecessary decontamination work and schedule delay.

Protecting equipment by geometrically simple cover

Equipment dismantling is one of the most difficult activities in D&D operation, because its complexity in geometry resists many types of decontamination and its thickness makes size reduction work difficult. If we could appropriately coat the equipment before installation in the gloveboxes, we may treat equipment dismantling much easier and costless at the time of decommissioning. Here is one scheme that resolves this difficulty:

- Cover the equipment by thin plastic type material that has a simple form (such as cylindrical geometry) except for the parts necessary for direct contact and/or maintenance
- Strip coat on this plastic cover
- At the time of dismantling use Fogging (air stream containing a glycerin/saccharide fog) (7) to reduce airborne contamination and then apply strip coat again (Fog & Strip) to sandwich the contamination
- Strip plastic cover along with strip coat in another (relatively clean) controlled area

In this way we can have, not to say clean waste but, very low level radioactive waste for TRU assumed waste, and significant cost and workforce reductions are expected.

APPLICATION OF LANL TECHNOLOGIES

LANL's Large Scale Demonstration and Deployment Project (LSDDP) is identifying and demonstrating technologies to reduce the cost and risk for management of transuranic element contaminated objects (including gloveboxes). Some of these technologies have already been demonstrated to be useful. However, they have the potential to be used in another area as well.

Application of NTvision in another circumstances

NTvision was developed as a security camera system with features that are particularly interesting to DVRS operations (8). The system may be applied as a support of safeguards activities, those of which some of countries (including Japan) are obligated to ensure no unreported work has been done (for example, the system can be made as remote monitoring system in unattended mode). Also, it may be used for making decisions such as which one (of the waste boxes) should be treated first, as well as to enhance the review process of the waste management work, and improve quality assurance that waste has been properly characterized and disposed.

AeroGo air pallet system

The AeroGo air pallet system includes air casters, air hose, and pressure manifold distribution control box to “float” loads on a virtually frictionless film of air. The reduced friction and omni-directional movement allow the operator to precisely place and align the load in a limited workspace (8). The AeroGo air pallet demonstration proved air pallets are a superior method of placement of the waste crates in the Large Item Neutron Counter (LINC) for initial radionuclide surveys. This technology facilitated easy movement placement of very large crates in precise locations in the LINC. This system may be applied to settle the gloveboxes in the size reduction area for robotic manipulation. Also it is it may be applicable for adequately setting and placing the container for the waste treatment. The use of the system in every possible situation will eventually enhance overall worker safety.

CONCLUSION

We have shown some simple but effective methods to assist glovebox decontamination and dismantling work. Enhancements like these kinds of small improvements are definitely important for increasing efficiencies and reducing costs and risks. Even if they fail, we have the opportunity to collect lessons learned, determine what went wrong, and improve future D&D work.

ACKNOWLEDGEMENT

A. K. acknowledges the hospitality of the Science Technology/Science Application Group, Risk Reduction and Environmental Stewardship (RRES) Division of Los Alamos National Laboratory, where this work was conducted.

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