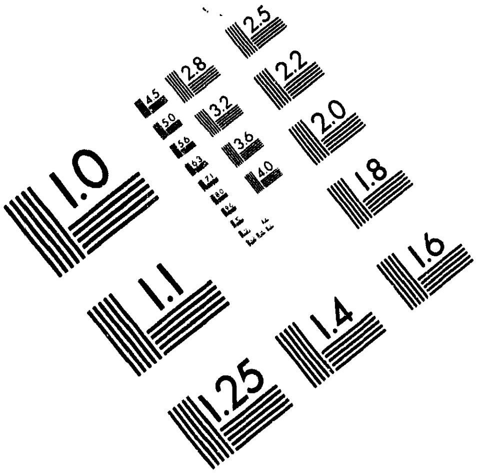
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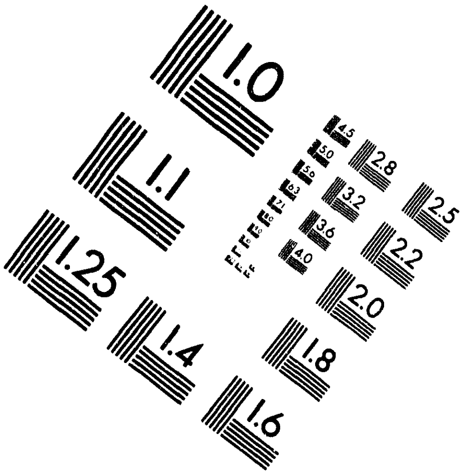
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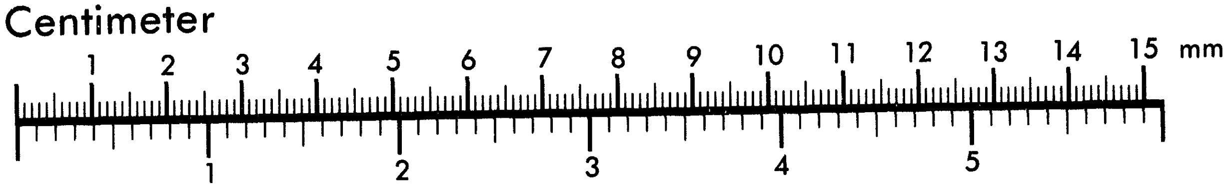
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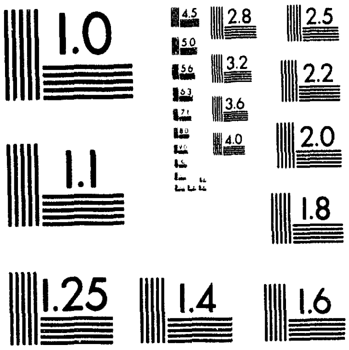
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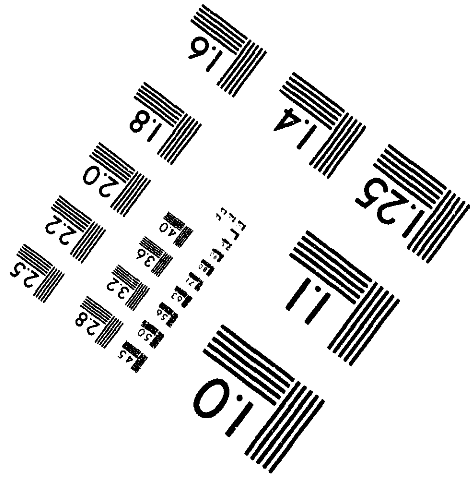
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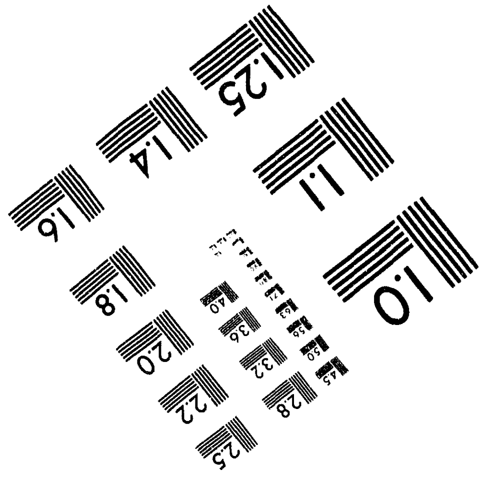
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WHC-SA-2077-FP

308 Building Zone I Stabilization and Confinement

I. L. Metcalf
K. E. Schwartz
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M. W. Benecke
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308 BUILDING ZONE I STABILIZATION AND CONFINEMENT

I. L. Metcalf
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1.0 ABSTRACT

The 308 Building (Fast Flux Test Facility [FFTF] fuel supply) at the Hanford Site, located in Richland, Washington, is currently in transition to shutdown status. After shutdown, the facility will be maintained/surveilled and turned over to the U.S. Department of Energy (DOE) Office of Facility Transition and Management (EM-60) for utilization, remedial action, or decontamination and decommissioning (D&D). This may require that the facility be maintained in the shutdown mode for up to 30 years. To date, all of the special nuclear material (SNM) has been removed from the facility, potential fuel supply equipment has been preserved, surplus materials and equipment have been excessed, and enclosure cleanup and stabilization has begun. Shutdown planning has been completed, which outlines the major tasks, scope, methodology, and timing for the shutdown activities. A major activity in support of the 308 Building shutdown is the cleanup and stabilization of the enclosures and surface contamination areas.

This document identifies the specific designs, processes, and methods to stabilize and confine the radiological material within the enclosures and exhaust ducts to allow shutdown of the active support systems. The designs and steps planned will be effective, are simple, and make maximum use of current technologies and commercial items.

2.0 INTRODUCTION AND OBJECTIVES

The 308 Laboratory contains 56 radiological enclosures, which are contaminated with radioisotopes resulting from their use in reactor fuels research and/or fabrication.

Essentially all of the gloveboxes contain residual plutonium oxide contamination. These enclosures and internal large equipment items will remain in place in the facility and be removed at remediation or D&D.

The facility shutdown plan outlines the following workscope related to the contaminated equipment and stabilization task.

- Removal of small loose equipment items.

- Draining all process fluids from equipment that will not be removed.

- Removal of glovebox waste materials.
- Coating the internal surfaces with a fixative coating.
- Replacement of the associated in-glovebox high-efficiency particular air (HEPA) filter.
- Installing seals/port covers over glovebox ports.
- Isolating the glovebox primary confinement exhaust system from the exhaust stack and a passive vent provided within the building.
- Termination of all nonessential energy sources.

This document describes the specific designs, processes, and methods used for stabilization of the radiological material within the enclosures, compartmentization, and confinement to allow shutdown of the active support systems. Also presented are the post-process evaluation and lessons learned.

3.0 STABILIZATION -- CONFINEMENT PROCESS

A combination of steps was taken to stabilize/compartmentize the remaining radiological materials within the Zone I (enclosure exhaust) system and provide appropriate confinement to allow for the shutdown of the active exhaust system. A phased and systematic approach was taken to enhance the safety posture and effectiveness during the transition from previous operations to complete system shutdown.

3.1 REDUCTION OF RADIOLOGICAL MATERIAL TO MINIMUM LEVELS

Efforts were in progress for a number of years to reduce the inventory of SNM, waste, and hazardous material from the facility. Category I, II, and III SNM have been removed. Based on a recent nondestructive assay of the gloveboxes and exhaust ducts, only ~21 g of plutonium are held up in the ducts and ~374 g of plutonium in the gloveboxes. Cleanup of the enclosures and waste disposal further reduced the radiological inventories to a minimum level within the facility and enclosures.

3.2 STABILIZATION OF RESIDUAL MATERIALS TO MAXIMUM EXTENT POSSIBLE

After the enclosures (gloveboxes and hoods) were cleaned to the maximum extent possible, the residual materials were fixed by coating the inside surfaces as necessary. At the connection between the enclosures and ducts, new HEPA filters were installed (if necessary) to further reduce residual materials and compartmentize the radiological materials in their present locations. The interior of the enclosures was coated with Polymeric Barrier System[1] (PBS) to fix any remaining loose material. (The HEPA filters were protected during the application process.)

3.3 PROVIDE ADDITIONAL CONFINEMENT FEATURES TO ALLOW CHANGES FROM ACTIVE SYSTEMS TO PASSIVE SYSTEMS

Reliance on active systems has a greater risk potential because of a higher probability of component failure. They also require additional resources and operating cost. The subject radiological materials were first minimized and stabilized and then the enclosure openings (glove ports, bag ports, etc.) covered with rigid covers and the exhaust blanked off between the last stage of HEPA filters and the exhaust fan. This allowed shutdown of the active ventilation systems and corresponding monitoring systems. The contaminated ducting and enclosure system will be able to equalize pressure with the building via a HEPA-filtered passive vent. The equalization HEPA filter was connected to the existing exhaust duct. Based on historical and process knowledge, this section of duct, including its corresponding first stage testable HEPA filter located in the filter tunnel, is very clean. This will allow the enclosure-duct system to adjust to temperature-related pressure changes, but, at the same time, provide confinement and allow the active heating, ventilation, and air conditioning (HVAC) system to be eliminated.

The principle confinement barriers are the metal enclosures and ducting system, which provide adequate confinement as-is. Potential leak paths such as glove ports, bag ports, window gaskets, service penetrations, gaskets, etc., required additional barriers to ensure confinement over the extended surveillance period. A combination of methods was used to form barriers to prevent migration of materials from inside the enclosures and ducting to the exterior. Migration will be prevented with the use of room temperature vulcanizing (RTV) caulking, heat shrink materials, PBS, tape, bags, and physical protection. The different barriers were used by themselves or in combination with others.

After all the loose equipment was removed and the interior wiped down for the final time, the stabilization process was initiated. The stabilization process will actually start on the exterior prior to interior coating to take advantage of the vacuum produced by the exhaust system. The vacuum may possibly assist by pulling the RTV caulking, PBS, and/or other sealants into any leak paths. The overall process flow is shown in Figure 1. Specific confinement features are as follows:

<u>Flanges, bolts, gaskets on gloveboxes, and exhaust ducts</u>

For flanges with a gasket and bolts, the exposed gasket, bolt head, and nut were treated. With respect to the exhaust ducting where internal stabilizing is not possible, the contamination is believed to adhere to the duct surfaces, the flanged areas were coated with PBS or other sealants (such as latex paint). Select locations did not receive any

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[1] Polymeric Barrier System is a trademark of Bartlett Services.

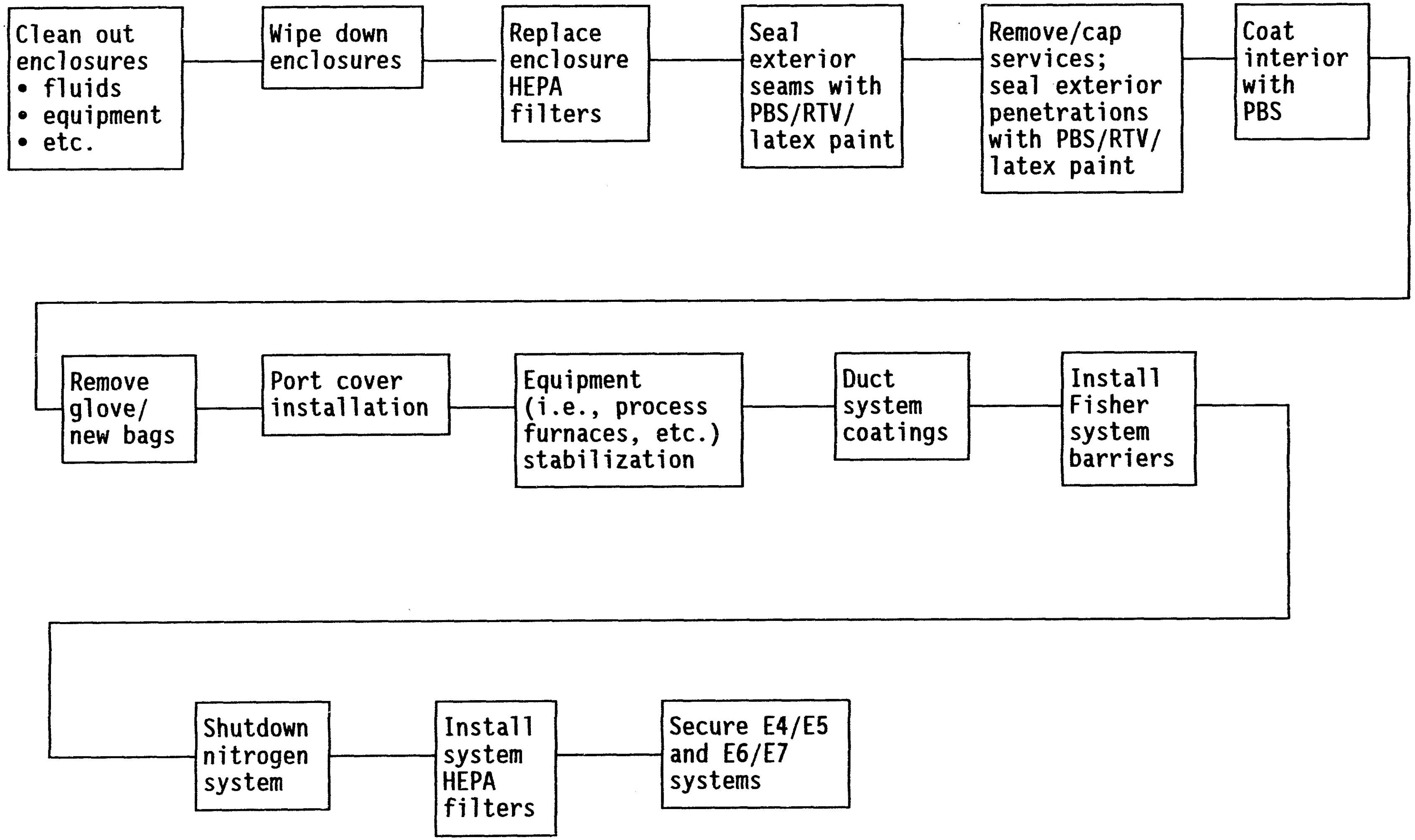


Figure 1. Stabilization/Confinement Process Flow.

external or internal stabilization because of limited access, equipment complexity, etc., but these areas were so noted in the stabilization documentation. This will allow for special attention, as appropriate, when periodic radiological surveys are performed.

Windows

For windows that use a combination of bolts (studs), washers, nuts, frames, and gaskets, the treatment consisted of using RTV to caulk the interface between the window face and the glovebox, and the window/gasket/window frame area. The above interfaces and the nuts that fasten the window frame to the glovebox wall were coated with high-particle content latex paint to seal the interface between the nuts and the frame. The specific areas include the following:

- The interface between the window frame and glovebox.
- The area around and including the bolts, washers, nuts, and frame.
- The miter joints on the window frames.
- The area between the window, gasket, and frame.

Electrical penetrations

- Interior junction boxes and electrical connectors were coated with PBS.
- Connector interior surfaces were similarly coated. Electrical wires were cut on the exterior side.
- Exterior connector surfaces were coated with RTV. RTV was also used to fill gaps in junction box seams.

Gas penetrations

- Inlet penetrations were plugged or capped where applicable. Sections of N_2 supply piping up to the first manually controlled valve were allowed to breathe with the glovebox.
- Exhaust penetrations were left open.

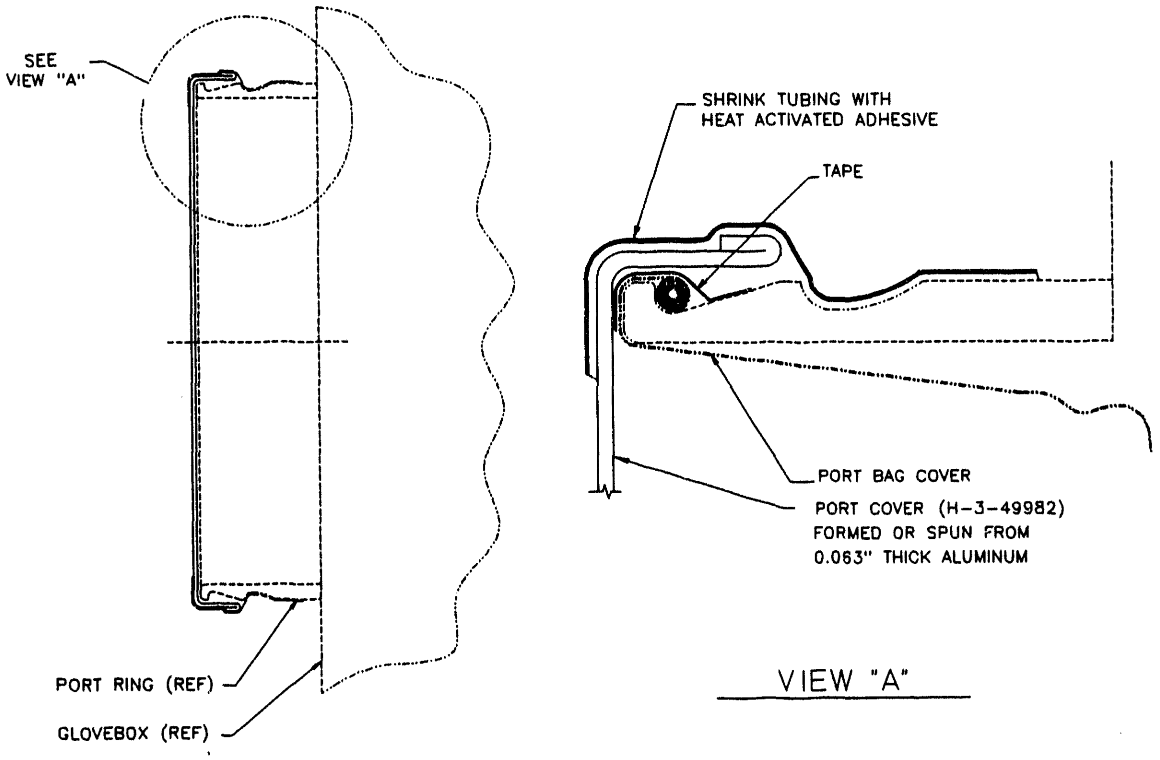
Sphincter seals

The entire exterior of each sphincter seal was coated with latex paint. The gasket region was coated with RTV or latex paint, depending on the configuration of the gasket.

Ports

After the interiors of the gloveboxes were stabilized, the existing gloves or bags were removed and port bags installed using standard techniques. To provide physical protection, port covers as shown in Figure 2 were installed. Next, the covers were secured with shrink material having a heat-activated adhesive lining. This material provided a tight fit and an additional barrier. This composite of barriers is shown in Figure 2.

Figure 2. Candidate Glovebox Port Seal Arrangement.



Airlocks

Each airlock door gasket area will be caulked with RTV.

Valves

The gasket, nut/bolt, and flange regions were coated with latex paint. Gasket configurations that are concave were first sealed with RTV.

Fire extinguisher connections (quick disconnect connecters)

With the supply disconnected, the connectors were filled with RTV.

Hydraulic presses

Internal hydraulic supplies to the presses were disconnected, drained, and capped, as appropriate.

Sinter furnaces

Water-cooled power conductors and jacket cooling lines for the sinter furnaces were disconnected at the enclosure interface, drained and reconnected (or capped).

Vacuum pumps

On gloveboxes with vacuum pump systems, all rubber hoses were removed and the connections capped.

Open-faced hoods

Following wipedown, the interior surfaces of the hood were coated with PBS. The face panels were then closed and the cracks caulked with RTV.

Fisher vacuum regulators and air bleed HEPA filter

Each glovebox and air lock is provided with a vacuum regulator whose purpose is to control pressure in the glovebox or air lock by modulating the exhaust flow. A 1 in. (nominal) sense line is routed from the bottom of the valve operator diaphragm to the glovebox, and there is a slight potential for some radiological material to have accumulated inside the lower chamber of the valve operator. The upper chamber of the valve operator has an open air reference port with a small weather cap, which allows it to equalize pressure with the room. In order to ensure that the vacuum regulator is maintained in the open position during the layup of the gloveboxes (to allow the gloveboxes to breath), the actuator air reference port was maintained functional (open to the room).

A small HEPA filter with an isolation valve was provided on the bottom of each vacuum regulator to allow room air to enter upstream of the regulator seat to improve the pressure control stability of the regulator at low glovebox pure flow rates. Because the vacuum regulator is immediately downstream of the glovebox HEPA filter, some radiological material that passed through the first stage nontestable glovebox HEPA filter over the years could still be located in the bottom of the regulator valve where the air bleed HEPA filter is installed.

To stabilize this portion of the glovebox installation, the following actions were performed.

- The small air bleed HEPA filter isolation valves were closed and the HEPA filter with its housing was removed for disposal. A plug was installed in the open port of the isolation valve.
- The weather cap was removed from the top of the vacuum regulator room air reference port and replaced with a small respirator HEPA filter using a fabricated adapter.
- All bolted connections on both the vacuum regulator valve and its actuator were coated with latex paint.

Fisher vacuum breakers

A second "Fisher" valve (vacuum breaker) is also provided on the nitrogen gas/air supply to each glovebox. Because the direction of flow has always been maintained toward the gloveboxes, and because there has always been a HEPA filter at the interface between the ventilation supply and the gloveboxes, the potential for radiological material to have migrated into the valve body is small. These regulators, however, are also provided with a sense line to the valve actuator that is common to the vacuum regulators. There is a potential that some radiological material could have migrated into the actuator. Unlike the vacuum regulators, there is no need that the actuator reference port be maintained open. The following actions were performed to stabilize the vacuum breaker valves.

- The weather cap was removed from the top of the vacuum breaker room air reference port and replaced with a pipe plug.
- All bolted connections on both the vacuum breaker valve and its actuator were coated with PBS or latex paint.

Fisher regulator sense lines and ventilation supply piping

The majority of the piping on the sense lines and the ventilation supply to the gloveboxes is threaded carbon steel pipe, which has been painted numerous times. Paint previously applied to these joints is adequate to ensure that they are stabilized. Any joints that have been disturbed or are not adequately sealed (based on a visual inspection) were coated with latex paint.

First stage testable glovebox HEPA filters

Exhaust fans EF-4 and EF-5 exhaust air from the gloveboxes and confinement hoods located in the Main Process Building through exhaust stack 308-GL-EX. The exhaust streams from the gloveboxes and hoods are routed through two stages of testable HEPA filters (in addition to the nontestable HEPA filter located at each of the gloveboxes) before being exhausted to the atmosphere. The gloveboxes utilize small 8 in. x 8 in. standard HEPA filters installed in a nontestable configuration directly in the wall of the glovebox to limit material deposition in the ducts. For those gloveboxes and smaller hoods located on the first floor of the process building, the first stage of testable HEPA filtration is located in the filter tunnel in fabricated housings, which contain standard 24 in. x 24 in. HEPA filters. The gloveboxes located on the second floor are also provided with the same type of HEPA filter and housing installed in the room with the gloveboxes rather than remotely. The second and final stage of testable HEPA filtration is located on the second floor.

Essentially all radiological material that was able to penetrate the nontestable HEPA filter at each glovebox has been distributed in the ducts between the glovebox and the first stage testable HEPA filter, or is located in the first stage testable HEPA filter. Stabilization of the ducts and the gloveboxes has been discussed previously in this document. To stabilize the first stage testable HEPA filter, the following activities will be completed.

- Open differential pressure sense lines and duct sample lines were capped
- All mechanical joints in the first stage testable HEPA filter housing (including fasteners) were coated with latex paint.

Seal traps

Both the glovebox exhaust system and the building Zone II ventilation (operating area ventilation) system have been provided with seal traps to allow for draining of accumulated fire protection water upstream of the HEPA filters. In the case of the building Zone II room ventilation system, three seal traps are located upstream of the first stage of testable HEPA filter located in the filter tunnel. Because the return ducts for each room are located in the floor, the seal traps are intended to drain any water that enters the ducts as a result of fire system discharge in the rooms and drains the water to the main ventilation plenum below the tunnel. The second seal trap is located in the glovebox exhaust system downstream of the first stage testable HEPA filters in the filter tunnel. From the filter tunnel, the glovebox ventilation duct is routed vertically up to the second floor. At the top of the vertical duct section, a spray nozzle was provided to ensure that the final stage HEPA filters could not be exposed to high temperature exhaust gases. Excess water would drain down the vertical duct section, and the seal trap would drain the water to the main ventilation plenum below the tunnel.

Because the fire protection system in the main process building will remain active (although modified to a dry system), the seal traps that serve the Zone II ventilation system must remain in service with periodic surveillance of the liquid level (ethylene glycol) throughout the time period the building is laid up. The spray nozzle associated with the glovebox exhaust system will be permanently removed from service at the time the ventilation system is shut down. The seal trap will be drained and a pipe plug installed to isolate the glovebox ventilation ducts from the building ventilation system.

4.0 DISCUSSION

4.1 CRITERIA/FUNCTIONAL REQUIREMENTS

Described below are the major functions and requirements that were used for the stabilization/confinement effort.

- Minimize, stabilize, and confine radiological material within the enclosures to allow for termination of active confinement systems.
- Provide physical protection to normal and upset conditions.
- 30-year stabilization/confinement system life.
- Planned, periodic retrofitting permissible during system life.
- Minimum surveillance during surveillance period before remediation or D&D.

- Maximum confinement, minimum contamination spread during remediation or D&D phase.
- Minimize safety and environmental impacts.
- Minimize application costs and resources.

The process and elements described previously meet the functions and requirements described above. The following discusses how these functions and requirements are satisfied.

Minimize and stabilize radiological material with the enclosure system to maximum extent possible

Of the total 374 g of plutonium held up in the gloveboxes and other enclosures, 161 g is in the form of a very hard, rock-like compound caused by the gradual combination of hydraulic oil residue and oxide material (with organic binder) over the approximately 20-year operating life of the facility. This rock-like material is strongly adhered to the hydraulic presses in the three hydraulic press gloveboxes. In the past, some of this material has been removed using a chisel to chip the material off the presses. Because of the nature of the material adhered to the presses, it is considered to be nondispersible and, therefore, would not contribute to the dose that would result from a postulated accident.

The remaining 213 g plutonium (374 g - 161 g) in the gloveboxes are in the form of small particles of plutonium oxide, which have adhered to surface imperfections and irregularities in the walls of the gloveboxes and ducting. The gloveboxes were cleaned out and wiped down with damp rags to complete material recovery and accountability. The cleaning was very effective, because the glovebox interior surfaces are in good condition and free of rust or scale. The remaining glovebox residual material is embedded and bonded to the surface inside the glovebox. After wipedown, the interior of the enclosures was coated with PBS. For the most part, this will fix most residual materials within the enclosure (only inaccessible locations will be spared).

Following cleanout of the gloveboxes, the HEPA filters at the exit of each glovebox and the HEPA filters in the process area ventilation system were replaced, if required.

The 21 g of plutonium in the exhaust ducting are also assumed to be in the form of small particles, because it has passed through one stage of HEPA filtration at the glovebox exit. It is also assumed that material is also fairly well adhered to the walls of the ducting given the continuous airflow through the ducting has not caused the material to migrate. In any event, the HEPA filters at the enclosure exhaust will help confine the residual plutonium in the ducts. Sealing the duct flanges with paint will provide adequate protection.

In summary, the planned process and elements used will stabilize or confine any remaining radiological materials to the maximum extent possible.

Provide physical protection to normal and upset conditions

The enclosure systems (enclosure and ductwork) are constructed of substantial material and are capable of providing adequate physical protection consistent with any normal conditions and any upset conditions identified by the facility Safety Analysis Report (SAR). The only significant weakness is the glove and bagports. The protective covers outlined previously will provide the appropriate protection. Other enclosure system penetrations will also receive appropriate protection as outlined.

Thirty-year stabilization/confinement life

The protective measures outlined previously are believed to be capable of providing the degree of confinement, stabilization, etc., required for the desired lifetime based on material data available, experience, number of barriers, and the following:

- No active operations are planned that would alter initial protective measures
- No adverse environmental changes
- No exposure to outside weather conditions
- No significant exposure to ultraviolet radiation
- Maximum stabilization confinement of radiological material
- Low radiation dose rate (< 2 mrem/hr)
- Routine surveillances.

Planned, periodic retrofitting permissible during system life

It is not possible to predict the full extent of degradation of the less substantial materials used to stabilize and confine the radiological material within the enclosure system. Appropriate, long-term, material data is just not available for materials such as shrink material, silicone rubber, PBS, and paint. Although evaluation of these subject materials concluded that they will most likely meet the projected lifetime, a process will need to be in place to perform appropriate surveillance to verify the integrity of the protective feature. As discussed in the previous section, the protective features incorporated will not prevent recovery in the event of a failure. If a failure should occur, simply retrofit using the original techniques to provide a permanent recovery or an interim solution until a new technique is implemented.

Minimum surveillances during surveillance period prior to remediation or D&D

Surveillance during the period prior to remediation or D&D is essential from a good practice standpoint. At the same time, excessive surveillances result in increased costs, especially over the projected time period. Accordingly, it was appropriate to provide sufficient barriers and means of inspection to reduce the extent of surveillances required. As described earlier, in most cases, there are several different barriers used that should be adequate. Although not currently defined, appropriate radiological surveys will need to be performed.

Maximum confinement, minimum contamination spread during D&D phase

The first objective is to confine the radiological material for the system life. At the same time, the features used must be compatible with the eventual removal of the enclosure and ducting system. One person's solution should not be the next person's nightmare. The approach taken is compatible with both. As discussed earlier, adequate confinement was provided consistent with appropriate surveillances and retrofitting (if necessary). As envisioned, appropriate radiological surveys would be taken prior to the removal process. Although unlikely, it should be assumed that barriers may have failed. In any event, appropriate actions would be expected to further confine (i.e., additional shrink material, greenhouse, etc.) to allow removal and disposition. The approach taken should allow for the appropriate actions to be taken without undue remedial or D&D activities or resources.

Minimize safety and environmental impacts

Most of the previous discussion has focused on the confinement and stabilization of the radiological materials. At the same time, the constituents must be applied, removed, or disposed of. Based on the material data sheets for each of the constituents, there is little safety or environmental concerns if applied as recommended. Application and disposal practices and procedures were consistent with these data sheets. Further, the planned environment is within the allowable as defined in the data sheets. The application of the shrink material required an energy (heat) source. However, the material was applied in areas that have full fire protection and appropriate job safety analyses in place.

Minimize application costs and resources

Safety is first, but total cost must be commensurate with the safety consideration. Fortunately, the process provides both. With respect to cost, the basic materials are commercially available, or in the case of the metal port covers, are economical to be fabricated. Installation and application of the planned components were also common and reasonable. Accordingly, the total cost was reasonable and did not require any special resources.

4.2 EVALUATION PROCESS/LESSONS LEARNED

A process was undertaken to determine an appropriate solution. This included team selection, a survey of existing materials and resources, identification and evaluation of existing techniques and practices and database searches. With respect to the team, team members were selected from management, process engineering, process operations, and operating technicians. This provided a diverse resource with a broad spectrum of experience related to decision making, management, radiological experiences and practices, safety considerations, past failures, and extensive hands-on experience.

Naturally, existing components and designs were evaluated. With regard to port covers, various types are in use at the Hanford Site. However, all of these were intended for use with active ventilation systems. It was the consensus of the working group that a less expensive, more lightweight, cost-effective design could be developed, which would exceed the performance characteristics of the existing port covers for this particular application. The port covers shown in Figure 2 are easily spun, stamped, or hydro-formed from sheet aluminum at a lower total cost (~$6.00 each) and provide a better fit than the existing cover.

Also, from an existing practice standpoint internal spray painting was, and still is, a common practice. However, use of spray-paint with volatiles is less accepted today. A survey of commercial radiological decontamination vendors identified a product which has been shown to be effective for applications of interest. The PBS was developed at the University of Cincinnati and has been used at other DOE sites for dispersion control of contaminated materials. Because of its demonstrated abilities, ease of application, and nontoxic, water-based characteristics, it was selected for use in the 308 Building to stabilize the remaining radiological materials within the enclosures and provide a barrier to migration. However, although most internal enclosure components are constructed of stainless steel, some of the commercial products (i.e., connectors, receptacles) are constructed of carbon steel. The water-based product used promoted rusting of these components. The subject components should be pretreated with an antirust inhibitor before coating with water-based sealants.

New techniques were also evaluated. In particular, shrink wrap coverings were considered early in the process. It was envisioned that after initial internal preparation with PBS, the enclosures would be sealed with shrink wrap. The idea was to cocoon the enclosures with an additional barrier to further confine and minimize surveillance requirements. However, after discussions with D&D personnel, it was concluded that routine surveillance would be performed for assurance purposes, and that the shrink wrapping would be unnecessary and possibly hinder the surveillances. This, however, is a viable concept and may have applications for short-term (such as handling and disposal of contaminated equipment during the D&D phase) or even long-term confinement applications. A comparable product, shrink tubing, was selected for use in the 308 Building. Heat-activated, adhesive-lined shrink tubing was used to hold the port covers to the port ring and confine the radiological materials at these vulnerable locations. These materials are considerably thicker and much more durable than the shrink tubing used in the product packaging industry.

5.0 SUMMARY

A process was undertaken to utilize personnel with extensive experience for selection of designs, concepts, etc., which made use of existing commercial products, processes, and practices to provide an approach that meets functional requirements in a cost-effective manner. Implementation of the elements described will stabilize and confine the residual radiological material within the 308 Building enclosures and exhaust ducts and allow shutdown of the active support systems for up to 30 years.

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