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# Radioactive Contamination Control Practices

Prepared for the U.S. Department of Energy  
Assistant Secretary for Environmental Management

**Fluor Hanford**  
P.O. Box 1000  
Richland, Washington

Contractor for the U.S. Department of Energy  
Richland Operations Office under Contract DE-AC06-96RL13200

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**CONTAMINATION CONTROL**

**WORK PRACTICES**

**Fluor Hanford ALARA Center**

***<http://www.hanford.gov/alara/>***

# CONTAMINATION CONTROL WORK PRACTICES

At Hanford, loose radioactive material can be found in plant systems, rooms, ventilation ducts, fuel pools, and outside radiological work facilities. Work practices used to accomplish radiological work in nuclear facilities often concern keeping radioactive contamination from spreading.

This is not an easy task as the contamination activity levels can be very high and the material can be very unstable. Most of the time, the contamination is not visible, so we have to rely on surveys taken by Radiological Controls personnel to tell workers where the contamination is located and the activity levels present.

The work practices used by workers are critical in controlling contamination spread, but it is impossible to document all of the work practices a worker should use. Many times, something will happen during the job that could result in a contamination spread. We rely on the workers knowledge and experience to realize when a potential spread of contamination is occurring, and take the actions necessary to prevent it from happening. It is important that a worker understand the concepts of contamination control in order to make the right decisions when work is accomplished.

In facilities that work with “fissile” materials there is increased concern that nothing be done that increases the chance that a “criticality accident” might occur during work. Criticality safety personnel need to be consulted and approve contamination control practices that could increase the potential for a criticality accident.

## 1. CONFINEMENT (To enclose within bounds, limit, restrict)

Examples of the techniques used to confine the spread of contamination include the use of tape, sleeving, bags, glovebags, containment tents, catch basins, collection containers, protective clothing, ventilation, vacuum cleaners, fixatives, aerosol fixatives, polyurea coatings, and misting with water and other products that prevent the contamination from moving. The selection of tools used to work on contaminated systems can have a significant effect on whether contamination is spread.

The following is a list of these products with a brief explanation on how they're used. Any experienced worker or RCT that reads this can probably add more examples of products that can be used to confine contamination spread. So consider this as a living document.

- a. Tape: Tape is used to seal plastic bags, cover non-essential surfaces in the work area or on tools and equipment. It can also be used to decontaminate surfaces.
- b. Sleeving: Sleeving is used to cover radioactive material so the contamination isn't spread during handling. It can be made from transparent, translucent, or solid color materials. The advantage of using transparent sleeving is that workers can read serial numbers or other data

through the sleeving without completely unwrapping the item. The sleeving can be made from thicker, tougher material than normally found in plastic bags. This reduces the chance the sleeving will rip or tear if heavy objects or objects that have sharp edges are placed in the sleeving. It is often necessary to install sleeving over piping joints when hydrotesting radioactive systems. The sleeving provides spray protection, contains minor leakage, and this may prevent a spill. Sleeving is sometimes used to cover service lines passing into Contamination Areas to keep the hose or cable from becoming contaminated. We also remove a lot of equipment from contaminated systems by raising the piece into a sleeve, twisting the sleeve, taping, and then cutting through the tape. This is called making an “Umbilical Cut” or “horsetail”.

- c. Bags: Bags are similar to sleeving and are used to contain radioactive material. Most facilities have several sizes of bags to fit the most common items they handle. The bags can be fabricated to fit unusual shaped pieces and can be padded and contain absorbent. The bags can have Velcro closures, ties, windows, and pouches for Radioactive Material Control Tags. Items removed from rooms or containment tents can be bagged in each section of the tent as it's removed to ensure that contamination on the outside of a bag isn't transferred outside the tent.
- d. Glovebags: Glovebags confine contamination at the source. The area that can become contaminated is limited to the space inside the glovebag. Workers using glovebags may only have to wear an additional set of gloves instead of donning the protective clothing usually prescribed for work in a containment tent. Workers who have other work nearby don't have to wear protective clothing and respiratory protection that might be required if the job were worked without containment. Guidelines for using containments can be found in WHC-EP-0749, Radiological Containment Guide.

Glovebags are usually made from flexible 8-mil thick polyurethane or polyvinyl chloride (PVC). The advantage of polyurethane is that it remains flexible in freezing weather. The disadvantage is the polyurethane does not glue well so everything needs to be heat sealed to the glovebag during initial fabrication. The gloves in the glovebag allow personnel to perform repairs or operate components without directly touching the item. Pass sleeves and zippered or Velcro openings allow tools and material to be inserted or removed from the glovebag. The ALARA Center recommends that once everything is placed inside the glovebag the Velcro or Ziploc seals be covered with a strip of tape on the outside and inside the glovebag. If contamination levels will be high or aggressive tools will be used, the outer seal should be a glued strip to make sure nothing escapes. Guidelines for using glovebags are contained in WHC-EP-0749, Radiological Containment Guide. See Appendix A, Glovebag Design for assistance in designing a glovebag.

- e. Containment Tents: Containment tents enclose the work area and prevent contamination from spreading outside the tent. Workers have to wear protective clothing to keep contamination off their skin and clothing when working in the tent. Containments are obtained from off-site vendors, made at our Site plastic shop, or fabricated by specially trained workers. Lately, we have been inflating some containments to make them easier to install. Attachment (B) provides a checklist that can be used to design a containment.

Containments can be fitted with liners in the work area to simplify decontamination. When the floor becomes contaminated, the top liner can be removed and disposed as radioactive waste. The new liner underneath provides a new uncontaminated floor. Appendix C is a signoff sheet that can be used to get all parties that will be using a containment tent or glovebag to approve the design.

- f. Catch Containments: Catch containments are installed beneath components or systems to catch radioactive contamination that might fall or drip. They are usually made from sheet plastic, but could also be made from metal or hard plastic. Drain connections can be added at the low point to drain off any liquids. Absorbent can be placed inside the catch containment if a drain is not installed to collect residual liquids that might drip. Flame-retardant material could be placed in the catch containment if “hot work” such as machining, grinding or welding was being accomplished. If a job is being worked in a glovebag and the introduction of liquids into the glovebag is part of the job, it might be wise to install a catch containment under the glovebag. Sometimes there is no room for a catch containment so “drop cloths” are laid under the components and workers can stand on the drop cloth to accomplish the work. Any contamination that falls straight down will be caught on the drop cloth, just as it would in a catch containment.
  
- g. Collection Containers: The most common collection container for liquids is the Radcon poly bottle in either the 5 or 15-gallon size. These have an adapter for connecting the hose that has a fitting for installing a 2-3 CFM HEPA filter. As the plastic bottle fills, the air that’s displaced passes through the HEPA filter. Waste drums can be used as collection containers when vacuuming contaminated debris. See section 1.j below. Drip pans or impermeable barriers placed under radioactive collection facilities collect liquids if there is a spill.
  
- h. Protective Clothing: There are different types of protective clothing that can be worn during radiological work and Radcon Managers are encouraged to select the type that is appropriate for the work being accomplished. Launderable protective clothing is available at each facility. Some facilities are purchasing higher quality breathable clothing to use when working near fuel pools or kneeling in highly contaminated areas. This clothing has reduced the chance of heat stress incidents at these facilities. Disposable clothing is also being considered for jobs that aren’t near radiological work facilities. New Polyvinyl Alcohol disposable clothing is going to be tested by CHG. This clothing dissolves when exposed to hot water or it can be laundered in cold water and worn a few times.

One of the ways of keeping contamination from spreading outside the work area is to remove the protective clothing in steps as the worker exits the work area. The most highly contaminated articles of clothing are removed first using a disciplined step-by-step process. The undressing sequence is posted and workers are taught to “Read the Step, then, Do-the-Step”. During work, workers can be required to change their gloves frequently to avoid a buildup of high contamination on the worker’s gloves. Gloves can also be wiped off with a damp rag if it isn’t convenient to change gloves often.

- i. Ventilation: The spread of contamination can be reduced if workers use HEPA filtered ventilation effectively. Applications include open-faced hoods and strategically placed exhaust hoses or ducts. The system used must have high enough flow rate to capture the airborne particle in the air stream and keep it in the air stream until it enters the ventilation ducting or hose. When using localized ventilation, workers are taught to position the hose within one duct-diameter and locate it so that contamination is drawn away from their breathing zone. Smoke testing can be used to ensure the incoming air has to pass through the area that is likely to have airborne particulate. This usually means that a scoop, hood, or collector has to be fabricated and attached to the end of the hose. This forces the incoming air to travel through the potentially contaminated atmosphere where the airborne contamination is being created. Work in open-face hoods can be accomplished with sufficient airflow into the hood opening. Workers are taught not to place their head inside the hood, keep everything at least six inches inside the opening, and keep the size of the opening as small as practical. At Hanford, the requirements and best industry practices for using HEPA filtered vacuum cleaners and portable ventilation systems are in HNF-SD-OPS-AR-001, which is available from document control, the RMIS database, or at the ALARA Center. Appendices D and E provide some guidelines on installing portable ventilation systems.
- j. Vacuum Cleaners: HEPA filtered vacuum cleaners are very effective at collecting contaminated debris. Rather than sucking the debris directly into the vacuum cleaner, workers often install a collection drum between the vacuum cleaner and the end of the suction hose. The collection drum has two sleeves that are sized to fit the vacuum cleaner hose. A hose is attached from the vacuum cleaner to one of the sleeves on the lid. A second hose is attached to the other sleeve. With the vacuum cleaner operating, debris and air are drawn into the suction hose and drop off in the collection drum. The air continues to the vacuum cleaner and passes through the HEPA filter as it's discharged. The collection container lid can be moved to additional containers as each one fills with debris. In this way, the waste is collected in waste containers, not the vacuum cleaner, and the job doesn't have to stop to empty the vacuum cleaner. Commercial lids are available (~\$500) that can be used to collect liquids in 30 or 55 gallon waste drums without sucking the liquids into the vacuum cleaner. See the Guide to using HEPA Filtered Vacuum Cleaners described in section 1.i above.
- k. Aerosol Fixatives: Aerosol fixatives can be applied to "fix" contamination in place without entering the space or room that is contaminated. A non-hazardous glycerin-based liquid is bombarded with sound waves and this shears the molecules off creating a dense aerosol. This appears similar to "fog" and is commonly referred to as "fogging". The aerosol fog passes through a hose into the enclosed area and completely coats all surfaces with a tacky residue. This keeps the contamination from moving and allows work to be accomplished in the area. The vendor refers to this product as "Capture Coating". Other fixatives, such as Polyurea, can then be applied over the fogged areas and later stripped up to decontaminate the surfaces.
- l. Polyurea Coatings: A product known as Polyurea can be sprayed over "fixed" contamination to add thickness and allow the material to be peeled up later to decontaminate

the surface. Some Polyurea coatings can be made so they become a permanent coating and provide a very tough, easily decontaminated surface that withstands high levels of radiation. This coating also has the advantage that it is a good shield for beta radiation.

- m. Misting: Misting the air and contaminated surfaces with water or other liquids is an effective way of keeping the contamination damp so that it won't become airborne easily. The liquid can be "spritzed" using a squirt bottle or applied through a misting system to cover larger areas. The source of liquid is connected to a small high-pressure pump and then a "fog" comes out each nozzle, which have many holes. These holes are sized so the water molecules are the correct size to capture any airborne particulate and take it to the surface.
- n. Expandable Foam: Piping systems and ventilation ducting can be removed without a gross spread of contamination by squirting expandable foam into the pipe or duct. Once the foam expands, any contamination present is trapped in the foam and the work can be accomplished with very little contamination spread. Typically, a hole is drilled in the top of the pipe or duct at the cut location and the foam squirted inside. It immediately expands and fills the internals within a few feet of the hole. The pipe or duct can then be removed. This works well on abandoned systems that are being removed rather than operating systems, as the foam will plug the system.
- o. Special Tools and Equipment: Some tools are specifically designed to reduce contamination spread. Shrouded tools have a connection to attach a hose from a HEPA filtered vacuum cleaner. Almost all debris, sparks, and contamination are collected in the vacuum cleaner instead of being dispersed in the work area. Shrouded tools include grinders, cutting tools, drills, scabblers, chipping guns and saws.

Clam-Shell cutting machines are easily mounted to the outside of piping and then the piping is cut leaving a beveled edge, for a butt weld, or piping that is cut off "square". This tool does not rotate fast and the metal chips are easy to control. The cutting machine can be removed just prior to break-thru to keep it from becoming contaminated. The final severance can be made with a hand-operated roller. This tool replaces a porta-band or saws-all which tend to spread contamination. In addition, since the bevel is already cut, there is no need to grind on the outside of the pipe. Burrs and rust on the inside of the pipe can be removed with a file or Emory paper instead of grinding with a "chicken-plucker". See DOE's Technology Website at <http://www.apps.em.doe.gov/ost/> under "Publications" and read report DOE/EM-0375, High-Speed Clamshell Pipe Cutter.

Nibblers are tools that are being used more and more in D&D work to cut up vent equipment and glove boxes. The nibbler has a reciprocating plunge cutter that bites off metal. The metal chips fall into a collection bag or inside whatever is being cut up. This makes them easy to control as compared to particles thrown off by a grinder.

Hot taps are often used to drain and/or depressurize piping. This eliminates the need to cut the piping and weld flanges or valves. There are different types of hot taps that attach to the outside of the pipe and allow you to drill or punch a hole in the pipe to drain the contents.

Hydraulic shears are used to cut up piping, concrete, steel, and wood. These shears are often referred to as the “jaws-of-life” due to their wide use by fire departments in extracting traffic accident victims from damaged vehicles. They can be hand-held, hung from cranes, or be used by manipulative arms. See DOE’s Technology Website at <http://www.em.doe.gov/ost/> under “Publications” and read reports “Blade Plunging Cutter”, “Self-Contained Pipe Cutting Shear” and “Size Reduction Machine”.

Robots and manipulative arms are being used more and more to accomplish work in highly contaminated or hostile environments. Robots have been used to take samples, surveys, and do work. Manipulative arms have been fitted with grippers to hold many kinds of hand tools. This allows work to be accomplished without sending workers into the area.

Several vendors sell “adhesive pads” that are normally used to remove dirt from workers feet. “Tack Cloth” is designed to be placed in the work area to reduce the tracking of contamination by workers. Both these products will collect contamination produced during work and prevent it from becoming airborne.

## **2. SOURCE REDUCTION**

Source Reduction methods are used to reduce the amount of contamination present before a job starts and periodically during work. This reduces the risk of contamination spread and may reduce radiation levels.

- a. **Decontamination**: Removing the contamination from surfaces in the work area significantly reduces the risk that workers will become contaminated or that the contamination will be spread. The decontamination is usually accomplished using mechanical methods, such as, wiping/scrubbing the surfaces with cloths dampened with water/decontamination agents or applying a strippable latex fixative and then stripping it off. These methods remove contamination from the surface. More aggressive methods can be used to remove the surface, such as, grinding or grit blasting. Chemical decontamination methods can be used in conjunction with mechanical decontamination to achieve better results. There are a lot of variables when using chemical decontamination products so the user needs to be certain what effect the chemicals will have on the surfaces, how they react with the contaminants and cost. It may be best to simply cover the contamination with sheet plastic, tape, or a strippable latex paint rather than attempting to decontaminate complex surfaces. By decontaminating the work area, it may be possible for RCTs to lower the protective clothing requirements. Sometimes we decontaminate highly contaminated items so they can be disposed as Low-Level Radioactive waste and this significantly reduces waste disposal costs. Strippable latex paint is used to cover contamination and then is peeled up later to decontaminate the surface. While the contamination is covered, the protective clothing requirements may be reduced. DOE’s Technology Website at <http://www.apps.em.doe.gov/ost/> has a report on strippable latex paint under “Publications”. Read report DOE/EM-0533, ALARA 1146 Strippable Coating

- b. Eliminate the source: If the contamination exists in a piping system, consider flushing so the high levels of contamination are no longer present in the area to be worked. The flushing causes the source to move out of the work area or be collected in a container. Hydro-blasting is a more aggressive form of flushing. High-pressure water is sprayed in the piping or component to break loose contamination imbedded in the walls or entrained in sludge. Dose rate reductions of 40-80% are common using this process.
- c. Good Housekeeping: Practicing good housekeeping will keep the work areas free of unnecessary materials that will make decontamination more complicated if a spill occurs during the work. It also promotes good work habits by the workers. Managers are encouraged to make frequent tours of their facility and observe work practices and housekeeping.

### **3. RADIOLOGICAL SURVEYS**

Workers rely on Radcon personnel to tell them where contamination is present. Routine and job surveys need to be in enough detail to be representative of the work area. Inaccurate or incomplete surveys set the workers up for an incident that may result in a skin/clothing contamination or a spread of contamination.

Surveys need to be taken while jobs are in progress to ensure the radiological controls and work practices are adequate. If high contamination levels are found, the work area needs to be decontaminated to keep the levels low.

The amount and extent of contamination surveys should be based on the work being accomplished. It is insufficient to just take the required surveys listed in the Radcon Manual. Use a graded approach and take surveys when they are necessary to control the work.

## ***WORKSHEET FOR DESIGNING GLOVE BAGS AND CONTAINMENT TENTS***

This worksheet should be used in conjunction with WHC-EP-0749, Rev 1, Radiological Containment Guide. Copies can be obtained by contacting Document Control at 376-5421/376-9654 or the ALARA Center at 376-0818.

The use of glove bags and containment tents will limit the spread of contamination during radiological work. Glove bags confine the contamination spread to a small area and the workers do not have to wear multiple sets of protective clothing and respiratory equipment. Containment tents limit contamination spread, but still require the workers to wear protective clothing.

If your job requires a glove bag or containment you have several choices. You can design it and fabricate it yourself, you can have the PFP Plastic Shop fabricate it from your design, you can purchase one from Tank Farms Spare Parts, or you can purchase it from a commercial vendor.

Design and Fabricate Yourself - Fabricating a special sleeve or catch basin is commonly done by individual contractors. When the job requires a glove bag or containment, most contractors do not try and fabricate it themselves as it is difficult to construct something that will contain contamination and be acceptable to the Radiological Controls Organization who may have to inspect and certify the device before it is used. Fluor Federal Services has their own shop and has been very successful in fabricating unique containments for use on complex work. This shop is staffed by specially trained workers who design the containment, fabricate it, and then install it.

Have the PFP Plastic Shop fabricate - The PFP Plastic Shop can be reached at 373-2220. There are operators at this shop that can fabricate a glove bag or containment tent based on your design. Fax your design to 373-3190 and they can provide a cost estimate as well as an estimated completion date. They also manufacture special sleeves, bags, and other materials made from plastic products.

Purchase it from Tank Farms Spare Parts – Tank Farms have several designs of glove bags and containment tents in their spare parts inventory at Building 2101M, Door 106, in the 200East Area. These devices are used for work in Tank Farms but will also work for other applications. These are purchased from commercial vendors and stocked along with all accessories commonly used with the glove bags or containments. The warehouse will require you to contact Robert L. Brown at 372-2932 for permission to release the material from spare parts. Contact the ALARA Center or contact Bob Brown for sketches showing each design.

Procure it from a Commercial Vendor - There are several vendors that will either take your design and fabricate it or will sell you one of their standard designs that fit most of your needs. Buying a containment or glove bag is similar to buying an automobile. You tell them which basic design will work and then add/remove accessories or change dimensions to meet your needs. If you purchase a standard design, they usually have several on the shelf and can ship it to you

overnight. Contact the ALARA Center at 376-0818 for telephone numbers or your facility/area ALARA Chairperson.

The use of the following Worksheets should help you as you design your glove bag or containment.

# GLOVE BAG DESIGN WORKSHEET

JOB TITLE: \_\_\_\_\_

FACILITY: \_\_\_\_\_ WORK PACKAGE # \_\_\_\_\_ RWP# \_\_\_\_\_

LOCATION OF GLOVE BAG: \_\_\_\_\_

SKETCH IS/IS NOT ATTACHED. NUMBER REQUIRED: \_\_\_\_\_ DATE REQUIRED \_\_\_\_\_

DESCRIBE WHAT IS GOING TO BE DONE IN THE GLOVE BAG: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

HOW WILL THE GLOVE BAG BE SUPPORTED? \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

HOW WILL GLOVE BAG BE ATTACHED TO COMPONENT? \_\_\_\_\_

WILL TEMPERATURES EXCEED 150 DEGREES FAHRENHEIT ON COMPONENTS? \_\_\_\_\_

WILL THE GLOVE BAG HAVE NEGATIVE VENTILATION AND/OR VACUUM CLEANER? \_\_\_\_\_

MINIMUM SIZE HEPA FILTER REQUIRED IS \_\_\_\_\_ CFM.

SIZE & LOCATION FOR FILTER SLEEVE IS \_\_\_\_\_

OVERALL DIMENSIONS: \_\_\_\_\_ COLOR \_\_\_\_\_

DOES THE SKETCH SHOW THE NUMBER OF GLOVE SLEEVES, LOCATION & SIZE GLOVES? \_\_\_\_\_

DOES THE SKETCH SHOW THE NUMBER OF PASS SLEEVES, SIZE & LOCATION? \_\_\_\_\_

SHOULD THE PASS SLEEVES BE MADE FROM TRANSPARENT, TRANSLUCENT (frosted), OR SOLID COLOR MATERIAL? \_\_\_\_\_

NOTE: Sometimes you need to inspect components after they're removed from a glove bag and having them in transparent sleeving usually means the inspection can be accomplished without completely unwrapping the material.

NUMBER OF OTHER SLEEVES, SIZE & LOCATION \_\_\_\_\_

DOES GLOVE BAG NEED A SWIPE BOX? \_\_\_\_\_

ARE THERE ANY COMPONENTS, I.E. PIPING, THAT PENETRATE THE GLOVE BAG THAT WILL REQUIRE SPECIAL SLEEVES OR SEALING METHODS? \_\_\_\_\_

ARE HEAVY TOOLS OR COMPONENTS GOING TO BE PLACED ON THE BOTTOM OF THE GLOVE BAG? \_\_\_\_\_ WILL SCAFFOLDING UNDERNEATH THE GLOVE BAG BE REQUIRED TO SUPPORT THE WEIGHT OF COMPONENTS/TOOLS DURING WORK? \_\_\_\_\_ IF SCAFFOLDING CAN'T BE USED, CAN THE WEIGHT BE SUPPORTED BY RIGGING THROUGH A GLOVE BAG SLEEVE? \_\_\_\_\_

IS TEMPORARY SHIELDING GOING TO BE INSTALLED INSIDE THE GLOVE BAG? \_\_\_\_\_ HOW WILL THE TEMPORARY SHIELDING BE PROTECTED FROM CONTAMINATION? \_\_\_\_\_

DOES GLOVE BAG REQUIRE A CONVERTIBLE TOP THAT CAN BE OPENED? \_\_\_\_\_

ARE LIQUIDS OR CHEMICALS EXPECTED? \_\_\_\_\_ HOW MUCH? \_\_\_\_\_ WHAT CHEMICALS WILL BE DRAINED OR USED IN THE GLOVE BAG? \_\_\_\_\_ ARE ANY OF THESE CHEMICALS DETRIMENTAL TO THE GLOVE BAG MATERIALS? \_\_\_\_\_

SHOULD GLOVE BAG BE WATER TIGHT? \_\_\_\_\_ SHOULD A DRAIN BE INSTALLED? \_\_\_\_\_

WILL GLOVE BAG BE TESTED WITH WATER PRIOR TO CERTIFICATION? \_\_\_\_\_

ARE THE GLOVE BAG INTERNALS REQUIRED TO MEET GRADE "A" CLEANLINESS REQUIREMENTS? \_\_\_\_\_

SHOULD THE GLOVE BAG CONTAIN INTERNAL POCKETS FOR TOOLS? \_\_\_\_\_ IF SO, WHERE? \_\_\_\_\_

SHOULD LINERS BE INCLUDED TO COVER THE BOTTOM OF THE GLOVE BAG SO THEY CAN BE REMOVED IF THE BAG BECOMES HIGHLY CONTAMINATED? \_\_\_\_\_

IS A CATCH PAN OR DRAPE REQUIRED BELOW THE GLOVE BAG TO CONTAIN ANY SPILLAGE? \_\_\_\_\_

WHAT TOOLS WILL BE USED IN THE GLOVE BAG? \_\_\_\_\_

IS THE GLOVE BAG BIG ENOUGH FOR THESE TOOLS OR WILL THEY BE MOUNTED THROUGH A SLEEVE? \_\_\_\_\_

WILL LONG TOOLS SUCH AS TORQUE WRENCHES BE USED IN THE GLOVE BAG? \_\_\_\_\_

NAME: \_\_\_\_\_ PHONE: \_\_\_\_\_

# CONTAINMENT TENT DESIGN WORKSHEET

JOB TITLE: \_\_\_\_\_  
 FACILITY: \_\_\_\_\_ WORK PACKAGE # \_\_\_\_\_ RWP# \_\_\_\_\_  
 LOCATION OF CONTAINMENT TENT: \_\_\_\_\_  
 SKETCH IS/IS NOT ATTACHED. NUMBER REQ'D: \_\_\_\_\_ DATE REQ'D: \_\_\_\_\_ COLOR: \_\_\_\_\_

DESCRIBE WHAT IS GOING TO BE DONE IN THE CONTAINMENT: \_\_\_\_\_  
 \_\_\_\_\_

## **THINGS TO CONSIDER:**

Sharp objects present in the work area can damage the containment once it's installed. Delicate components, such as gauges, that are covered by the containment can be damaged during work. Interference's that prevent access to the work area may have to be removed before the containment is installed. Insulation may have to be removed and on older plants, it may contain asbestos. Temporary shielding may have to be installed on components before the containment is installed. Scaffolding may have to be installed in the location where the containment is going to be placed if the floor is uneven. If there is a good chance the containment may fail during service and contamination will be spread outside, cover the area underneath with plastic to reduce the chance the floor will become contaminated.

ARE THERE OBJECTS WITH SHARP EDGES THAT REQUIRE PADDING? \_\_\_\_\_

ARE THERE COMPONENTS THAT NEED TO BE PROTECTED? \_\_\_\_\_

ARE THERE INTERFERANCES THAT NEED TO BE REMOVED? \_\_\_\_\_

DOES INSULATION HAVE TO BE REMOVED? \_\_\_\_\_ IS IT ASBESTOS? \_\_\_\_\_

DOES TEMPORARY SHIELDING HAVE TO BE INSTALLED? \_\_\_\_\_

SHOULD SURROUNDING AREAS BE WRAPPED OR COVERED IN PLASTIC BEFORE TENT IS INSTALLED? \_\_\_\_\_

NOTE: Sometimes we cover the floor and surrounding areas with plastic to keep it from getting contaminated. Other times we cover these areas so that it's easier for the Radiological Controls Organization to survey and release the area when the work is complete and the containment has been removed.

IF THE CONTAINMENT IS LOCATED OUTSIDE, HOW WILL IT BE SECURED SO IT ISN'T DAMAGED BY WIND AND WEATHER? \_\_\_\_\_

SIZE OF WORK SECTION: Average length \_\_\_\_\_ ft X width \_\_\_\_\_ ft X height \_\_\_\_\_ ft = \_\_\_\_\_ ft<sup>3</sup>

IS NEGATIVE VENTILATION GOING TO BE INSTALLED? \_\_\_\_\_ IF SO, THE FLOW RATE OF THE

VENTILATION SHOULD GIVE 7-12\* AIR CHANGES PER HOUR. THIS IS CALCULATED AS FOLLOWS:

$$\frac{\text{Vent system flow rate in CFM}}{\text{Containment Volume in ft}^3} \times \frac{60 \text{ min}}{1 \text{ hour}} = \text{Air Changes per Hour}$$

\*Note Some facilities at Hanford specify up to 20 air changes per hour. The industry standard is 7-12. Based on the calculations, does it appear that the ventilation system will be adequate for the containment?

SIZE OF ANTE ROOM \_\_\_\_\_ IS IT BIG ENOUGH FOR UNDRESSING? \_\_\_\_\_  
IF NOT, SHOULD SLEEVES BE INSTALLED SO WASTE AND PROTECTIVE CLOTHING CAN BE  
DISPOSED DOWN A SLEEVE RATHER THAN IN BAGS IN ANTEROOM? \_\_\_\_\_

The shape of the containment may vary from job to job. The work section is normally designed to provide sufficient space to accomplish the work, but not a lot of extra space. Larger work sections reduce the airflow through the tent. Containments around valve transfer pits in Tank Farms are often made larger than necessary. The radiation coming from the pits makes it necessary to have larger containments so personnel can move to a lower radiation area during periods where they're not performing work and can't leave the tent. If the potential for heat stress is a consideration, include Industrial Hygiene in the work planning and containment design.

IS THERE A POTENTIAL FOR HEAT STRESS? \_\_\_\_\_ SHOULD INDUSTRIAL HYGIENE BE  
INCLUDED IN THE CONTAINMENT DESIGN? \_\_\_\_\_

IF SCAFFOLDING IS USED TO SUPPORT THE TENT, WILL IT BE INSIDE OR OUTSIDE THE  
CONTAINMENT? \_\_\_\_\_

LOCATION/SIZE OF WINDOWS IN WORK SECTION: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

NOTE: Keep windows small or include window covers if tent is installed outside during summer. This reduces temperature in tent.

DOES THE SKETCH SHOW LOCATION/SIZE OF WINDOWS IN ANTE ROOM: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

LOCATION/SIZE OF PASS OUT SLEEVES : \_\_\_\_\_  
\_\_\_\_\_

LOCATION/SIZE OF SERVICE SLEEVES IN ALL SECTIONS: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

LOCATION/SIZE OF NEGATIVE VENT SLEEVE IN WORK SECTION: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

LOCATION/NUMBER/SIZE OF SLEEVES OR OPENINGS FOR HEPA FILTERS, DAMPERS OR FILTER MEDIA: \_\_\_\_\_

NOTE: Airflow through containment should be in general downward direction. Recommend entering at head level in anteroom and exiting work section near the floor. The ventilation exhaust is normally positioned on the opposite wall from where workers enter the work section.

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**CONTAINMENT FLOORS:**

SHOULD THE WORK SECTION HAVE A REPLACEABLE FLOOR THAT CAN BE CHANGED PERIODICALLY? \_\_\_\_\_ IF SO, HOW MANY EXTRA FLOORS ARE REQUIRED? \_\_\_\_\_

SHOULD THE FLOOR OF THE CONTAINMENT HAVE SEVERAL LINERS THAT CAN BE DISPOSED WHEN THEY BECOME CONTAMINATED? \_\_\_\_\_ IF SO, HOW MANY? \_\_\_\_\_

SHOULD THE WORK SECTION FLOOR BE MADE FROM A DOUBLE THICKNESS OF MATERIAL?  
\_\_\_\_\_

SHOULD THE WORK SECTION FLOOR BE "WATER TIGHT"? \_\_\_\_\_

WILL THE CONTAINMENT FLOOR BE FLAT? \_\_\_\_\_ IF NOT, SHOULD ACTIONS BE TAKEN TO MAKE IT FLAT?

WHAT MATERIAL IS THE CONTAINMENT SETTING ON? \_\_\_\_\_

IS PLYWOOD AND/OR PADDING REQUIRED? \_\_\_\_\_

**CONTAINMENT ROOF:**

DOES THE ROOF NEED TO HAVE WINDOWS TO ALLOW LIGHT TO ENTER? \_\_\_\_\_  
HOW MANY: \_\_\_\_\_ SIZE: \_\_\_\_\_

NOTE: Poorly lit work areas can result in the job taking up to 40% longer. Position windows to take advantage of existing lighting or install portable fluorescent lighting outside the tent.

DOES ROOF OF THE WORK SECTION NEED TO HAVE THE CAPABILITY OF BEING OPENED TO ALLOW MATERIALS OR COMPONENTS TO BE REMOVED/INSTALLED? \_\_\_\_\_

HOW BIG SHOULD THIS OPENING BE? \_\_\_\_\_

SHOULD THIS OPENING BE LOCKABLE? \_\_\_\_\_

NOTE: If the containment could become a High Radiation Area, all entrances are required to be locked or guarded.

IF THE CONTAINMENT IS LOCATED OUTSIDE, HOW WILL RAIN WATER BE DEFLECTED?  
\_\_\_\_\_

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NOTE: The containment can be designed with a slanted roof or a tarp can be installed in a slanted position over the top of the containment. Designing a containment with a flat roof is easier and cheaper to fabricate. In addition, the air space between the tarp and the tent makes the tent cooler on days when the sun is out.

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**CONTAINMENT WALLS:**

DOES A WALL OF THE WORK SECTION NEED TO HAVE THE CAPABILITY OF BEING OPENED TO ALLOW MATERIALS OR COMPONENTS TO BE REMOVED/INSTALLED? \_\_\_\_\_  
WHICH WALL? \_\_\_\_\_ SIZE OF OPENING: \_\_\_\_\_ LOCKABLE? \_\_\_\_\_

IS SWIPE OR PASS BOX NEEDED IN WORK SECTION? \_\_\_ LOCATION/SIZE \_\_\_\_\_

IS A DOSIMETER DROP BOX OR SLEEVE NEEDED ON THE ANTEROOM WALL? \_\_\_\_\_  
LOCATION: \_\_\_\_\_

DOES THE DESIGN SHOW THE LOCATION FOR CLEAR POCKETS IN THE ANTEROOM FOR POSTING THE UNDRESSING SEQUENCE? \_\_\_ ARE THESE LOCATED WHERE WORKERS CAN EASILY READ THE UNDRESSING SEQUENCE? \_\_\_\_\_

**CONTAINMENT DOORS/OPENINGS:**

DOORS NORMALLY HAVE A ZIPPER AND VELCRO CLOSURE. IS THAT WHAT'S NEEDED: \_\_\_\_\_  
IF NOT, WHAT'S DIFFERENT? \_\_\_\_\_

SHOULD DOORS HAVE WINDOWS? \_\_\_\_\_ APPROXIMATE SIZE? \_\_\_\_\_

ARE CLEAR POCKETS FOR POSTING WARNING SIGNS INCLUDED ON THE ENTRANCE DOOR? \_\_\_

SHOULD INNER DOORS HAVE THE CAPABILITY OF BEING ROLLED UP AND SECURED? \_\_\_\_\_

SHOULD THE OUTER DOORS AND OPENINGS BE LOCKABLE FOR HIGH RAD CONTROL? \_\_\_\_\_

**ACCESSORIES:**

IF DESIRED, SPECIFY THE NUMBER OF VELCRO STRAPS FOR HOLDING AIR LINES/OTHER HOSES  
\_\_\_\_\_

IF DESIRED, SPECIFY THE NUMBER AND SIZES OF TOOL POCKETS TO BE ATTACHED TO INTERNAL WALLS OF THE TENT: \_\_\_\_\_

ARE TIEOFFS OR OTHER SLEEVES NEEDED ON THE INSIDE OF THE TENT?  
\_\_\_\_\_

NAME: \_\_\_\_\_ PHONE \_\_\_\_\_

## CONTAINMENT/GLOVE BAG DESIGN SHEET

JOB TITLE: \_\_\_\_\_ WORK PROCEDURE: \_\_\_\_\_ RWP: \_\_\_\_\_  
LOCATION: \_\_\_\_\_

THIS SKETCH INCORPORATES THE REQUIREMENTS FOR THE FOLLOWING CRAFTS:

SHOP \_\_\_\_\_ SIGNATURE \_\_\_\_\_ DATE \_\_\_\_\_ PHONE \_\_\_\_\_  
SHOP \_\_\_\_\_ SIGNATURE \_\_\_\_\_ DATE \_\_\_\_\_ PHONE \_\_\_\_\_  
SHOP \_\_\_\_\_ SIGNATURE \_\_\_\_\_ DATE \_\_\_\_\_ PHONE \_\_\_\_\_

THIS CONTAINMENT/GLOVE BAG DESIGN IS ADEQUATE TO PERFORM THE WORK DESCRIBED ABOVE BY THE LEAD CRAFT AND ASSIST CRAFTS WITH THE EXCEPTION: \_\_\_\_\_  
\_\_\_\_\_

LEAD CRAFT SIGNATURE \_\_\_\_\_ DATE \_\_\_\_\_ PHONE \_\_\_\_\_

THIS CONTAINMENT/GLOVE BAG DESIGN IS REQUIRED TO ACCOMPLISH THE WORK OUTLINED ABOVE, IS RADIOLOGICALLY ADEQUATE AND IS APPROVED FOR FABRICATION.

HPT SIGNATURE \_\_\_\_\_ DATE \_\_\_\_\_ PHONE \_\_\_\_\_  
HP ENGR SIGNATURE \_\_\_\_\_ DATE \_\_\_\_\_ PHONE \_\_\_\_\_

THE REQUIRED COMPLETION DATE IS: \_\_\_\_\_  
OPERATIONS OR MAINTENANCE DEPT SIGNATURE \_\_\_\_\_ DATE \_\_\_\_\_

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SKETCH (OR ATTACH OTHER DRAWINGS)

## USE OF PORTABLE HEPA FILTERED VENTILATION

An ideal portable ventilation system has the following characteristics:

1. The ALARA Center recommends that facilities purchase high-quality "Nuclear Grade" ventilation blowers equipped with a HEPA filter if it is going to be used for radiological work. There are several companies that sell cheap imitation units that might be all right for asbestos, but don't work well for radiological work. The fan should have flow characteristics that allow it to operate over a large pressure range to account for inherent losses in the system and increased pressure drop as the filters collect dirt and debris.
2. The length of hose or duct from the blower/fan to the work area should be as short as possible and contain a minimum number of bends.
3. The ducting should be routed through low traffic areas where it is protected to avoid damage.
4. The ducting should have no sharp bends. Usually, bends have a minimum radius of 2-2.5 times the duct/hose diameter. A straight duct section of at least six equivalent duct diameters should be used where the hose connects to the fan. NOTE: as a rule, a 90-degree bend is the equivalent of adding extra hose equal to 6-8 times the hose diameter.
5. The hose/duct has a smooth bore and is free of obstructions, especially at joints.
6. The hose/duct should be round whenever possible to reduce system losses.
7. Use of blast gates or other types of dampers should be avoided. If a blast gate must be used to adjust the flow, place it in a vertical section near the midway point. Install a tamper proof device.
8. The flow rate at the point where airborne contamination is captured is sufficient to cause the particulate to follow the air stream into the ventilation. This capture velocity is recommended to be a minimum of 125-200 feet/min for the type of work to be performed. If the airborne activity is released into quiet air, a capture velocity of 50-100 feet/min is all that's necessary. If grinding is performed, the particles will have a high initial velocity so the capture velocity of the ventilation needs to be in the 500-2000 feet/min range.
9. Use of a funnel, scoop, or hood attached to the hose/duct to collect airborne contamination will increase the amount of contamination collected over a "hose only" application. The design of the funnel or scoop forces incoming air to be drawn through the area where contamination is being created. Any particulate that is present is more likely to be captured in the air stream and carried into the vent system.

10. Position localized ventilation so that any airborne particles are drawn away from the worker's breathing zone. Normally the ventilation sucker is placed 90 to 180 degrees from the worker on the opposite side of the source at a distance of one duct diameter, or less. If the suction end of the hose is greater than one duct diameter away from the source, very little contamination will be captured in the air stream.
11. System fittings should be designed so there is a gradual taper on the HEPA filter inlet and outlet and a long straight inlet to the fan. Transition pieces that change from one dimension to another should also be tapered. Since have tapered connections on each side of the HEPA filter would require more space, you often find there is little or no taper.
12. Joints in the system should be securely sealed to avoid leaks.
13. If the system is going to draw moist or damp air, install a demister filter to remove the moisture before it reaches the HEPA filter. Damp HEPA filters lose their tensile strength and could fail if they become stressed later, i.e., during a fire.
14. Locate the ventilation system components in well-lighted areas that allow easy access for maintenance.
15. Air discharged from the blower flows in a straight line. Ensure the air being discharged does not disturb contamination or asbestos that might be present in the work area. This may require installing a vent hose on the discharge side of the blower and either pointing it up or routing it outside the work area.
16. If the system is going to be used for hot work, a metal hose with a spark arrester is required to avoid causing a fire in the flex ducting and/or prefilter/HEPA filter.
17. After a ventilation system is installed, contact Vent & Balance at 373-1857 or 373-4866 to accomplish an aerosol leak test. This will ensure the HEPA filter is installed correctly.
18. The industry standard for air changes in a containment tent is 7-12 air changes per hour. In the nuclear industry, air changes up to 20 per hour are common. The important thing to consider is the amount and direction of flow at the source of the contamination. So if you're removing a flange from a contaminated system inside a containment, look at what the ventilation is doing at the flange. Powdered material can be blown near the flange and you can determine the direction and make an estimate whether it's adequate. The ALARA Center recommends that facilities purchase "Flowchecker Silica Powder, Item 7904C from Lab Safety & Supply @ (800) 356-0783. BHI uses "baby powder" because it's cheaper, but it makes the work area slippery.
19. Recommend obtaining a copy of HNF-SD-OPS-AR-001, Guide for Using HEPA Filtered Vacuum Cleaners and Portable Ventilation Systems from the ALARA Center or on the RMIS Database. Note: drop the "HNF" from the title during your database search.

## ***Ventilation Calculations***

Capture Velocity: Air velocity at any point in front of a hood or at a hood/hose opening necessary to overcome opposing air currents and to capture the contaminated air at that point by causing it to flow into the hood/hose. Capture velocity varies depending on the size of the particles and the rate at which they are released into the air. For most applications, 125-200 feet per minute (fpm) capture velocity is satisfactory. Vent & Balance normally adjusts the velocity at the face of a fume hood to be 125 fpm.

Flow Rates: Approximate flow rates and velocity are determined using the following formula:

V = Velocity in linear feet per minute  
 A = Area of opening in square feet  
 F = Flow rate in cubic feet per minute

$$V = \frac{F}{A} \qquad F = V \times A$$

Example: What is the velocity at the face of an 8" diameter hose whose system is rated at 1000 CFM?

$$V = \frac{F}{A} \qquad V = \frac{1000 \text{ CFM}}{3.14 \times 4'' \times 4'' / 144} \qquad V = \frac{1000 \text{ CFM}}{0.349 \text{ ft}^2} \qquad V = \mathbf{2865 \text{ fpm}}$$

## ***Calculating Duct Velocity***

Duct velocity is the air velocity required to keep contamination suspended in the air stream as it moves through the duct. For most applications, 1500-3000 fpm is sufficient.

Find: the largest duct size that will give a velocity in the 1500-3000 fpm range. For 8" diameter duct the face velocity was 2865 fpm. For 10" diameter ducting the face velocity is about 1850 fpm, which falls into the 1500-3000 fpm range. A 12" diameter duct has a face velocity of about 1275 fpm, which is outside the range.

## ***Calculating Velocity***

Fume hood has an opening of 2' x 3' and flow rate of system is 1000 CFM.

Area of opening is 2' x 3' = 6 ft<sup>2</sup>

Velocity into the hood is 1000 CFM / 6 ft<sup>2</sup> = **167 fpm**