



## **CAG-005-2007**

### **Servicing Hazardous Drug Compounding Primary Engineering Controls**

This document applies to hazardous drug (HD) compounding practice locations and is intended to provide guidance for service personnel such as certification technicians, facility service workers, equipment maintenance personnel, and drug compounding professionals regarding hazardous drug exposure when primary engineering controls are opened for service or repair work. This guide is based on best practice and stresses universal precautions by assuming materials are contaminated unless proven otherwise.

While this guide is designed specifically for hazardous drugs not involving radioactive or biological materials, it is likely that combination hazards may exist. In those cases, protection against multiple hazards must be undertaken.

Hazardous drugs (HDs) are considered those that have been associated with or suspected of causing adverse health effects due to workplace exposure.<sup>1</sup> Persons who work with or near HDs are at risk for potential hazard exposure and should take appropriate measures to protect their health. The extent of exposure and the resulting secondary biological effects are difficult to assess and may vary depending on the HD and the extent of exposure. Safe levels of exposure cannot be established but minimizing exposure to all HDs is considered the best course of action.<sup>2</sup> Common routes of exposure to HDs are inhalation, skin contact, skin absorption, ingestion, and injection.<sup>1 3</sup>

Ventilated equipment such as Class II Biological Safety Cabinets (BSC)<sup>4</sup> and Compounding Aseptic Containment Isolators (CACI)<sup>5</sup> are considered primary engineering controls. These are designed for appropriate containment and to provide a safe work environment for compounding both sterile and non-sterile HDs. By virtue of their design and use, the internal components of the BSC and CACI are considered contaminated with HDs because:

- these areas cannot be readily accessed and surface cleaned,
- HD particulates are captured in HEPA filters and within and upon the surfaces of other components within the BSC and CACI,
- multiple HDs may be present and no universal chemical deactivation method is available for the variety of HD used in compounding.

**NOTE:** Some deactivating agents that are appropriate for one HD, may cause other HDs to undergo a chemical change to an even more hazardous substance.<sup>6</sup>

The owner of the primary engineering control is ultimately responsible for providing and communicating all pertinent information and guidance about the hazardous drugs used within the device. This should include, but is not limited to, the hazardous drugs used, known and potential hazards of the drugs, the Permissible Exposure Limits (PEL), cleaning / deactivation methods for the drugs, providing recommended neutralizing or cleaning agents based on the HD used, hazard disposal, provision of applicable Material Safety Data Sheets (MSDS) if available, and provision of appropriate gowning attire. The owner is additionally responsible for taking appropriate steps to clean and deactivate the HD contaminants within the primary engineering control prior to repair or servicing, and for final cleaning and necessary disinfection after repairs are completed.

The Occupational Safety and Health Administration (OSHA) recommends that a qualified technician who is familiar with proper procedures should perform maintenance on primary engineering controls including calibration, certification and repair.<sup>2</sup> The American Society of Health-System Pharmacists (ASHP)<sup>7</sup> states that workers involved in repairs of primary engineering controls are at risk for contact with uncontained drugs. OSHA requires, *technicians servicing these cabinets or changing the HEPA filters should be aware of HD risks through hazard communication training from their employers and should use the same personal protective equipment as recommended for large spills.*<sup>2</sup>

Access to the immediate repair area of the HD-contaminated primary control should be limited only to authorized personnel with appropriate PPE. Presently there is no method to measure the extent of contamination of the interior components of the BSC or CACI. Best practice dictates that service personnel should presume that all internal components are contaminated. Therefore, the equipment's interior should not be accessed until the area surrounding the equipment is appropriately controlled, PPE has been employed, and the area secured from non-essential personnel. Planned maintenance and repair activities should be previewed or coordinated by an experienced occupational safety and health professional knowledgeable in hazardous drugs.

#### **Personnel Protection Equipment (PPE):**

Personal protective equipment is used to provide a barrier between the worker and the hazard. However, protective equipment should be evaluated to ensure effectiveness and performance. PPE use-training should be provided to all service personnel involved in service or repair of HD primary control equipment.

#### **Gloves:**

Neoprene, natural rubber latex, and nitrile gloves have been found to have the highest resistance to permeation by certain HDs studied.<sup>8</sup> The glove material and/or finishing process can affect permeation since all materials are permeable to some HDs.<sup>7 9</sup> The American Society for Testing and Materials (ASTM) has developed a testing standard to assess the resistance of gloves to permeation by certain HDs and has developed the designation of "Chemotherapy Gloves".<sup>10</sup> Gloves rated as "Chemotherapy Gloves" should be used when available.

Factors, such as the duration of exposure, glove material, and drug composition, and concurrent exposure to other solvents or cleaning agents also affect permeability.<sup>8</sup> Two pairs

of powder free disposable chemotherapy gloves (or other gloves approved for chemotherapy use) should be used. <sup>1</sup> Powder free gloves are recommended since powder can absorb the HD and prolong skin contact and contaminated powder could become an airborne hazard. <sup>11</sup> Long gloves are recommended and the outer glove should cover the gown cuff to reduce the opportunity for skin exposure at the wrist. <sup>2</sup>

Because gloves are permeable, ASHP recommends glove changes at least every 30 minutes by pharmacists working with HDs. <sup>7</sup> OSHA recommends hourly glove changes as a minimum for service personnel. To reduce potential contact exposure, gloves should be changed immediately when damaged, showing wear, or are visibly contaminated. Regular visual inspection of the gloves should be performed and regardless of obvious damage, regular changing of gloves should be performed throughout the repair process.

Service personnel should avoid contact with all non-contaminated surfaces with contaminated gloves to reduce the spread of HDs within the work area. Gloves exposed to HD must not be worn outside the HD area and shall be handled and disposed as hazardous or chemotherapy waste through the facility waste management process. When removing gloves, it is critical to avoid touching contaminated surfaces with non-contaminated glove surfaces or with ungloved fingers. The outer glove is more contaminated than the inner glove. Remove the outer glove slowly by pulling from the cuff to invert the outer surface to help seal contamination inside the glove. Inner gloves should be used to remove the rest of the PPE first, and then carefully removed inside out and contained for proper disposal. In all cases, hand washing should be performed before gloves are donned and immediately after they are removed.

### **Gowning:**

A disposable protective gown made of lint-free, non-permeability fabric with a closed front, long sleeves, and elastic or knit closed cuffs should be worn to protect clothing and skin. Coated polypropylene or other materials are strongly recommended to reduce or prevent the penetration of liquid chemotherapy agents. <sup>7 12</sup> When donning the gown, all fastening devices should be fully used to reduce skin or clothing exposure. The inner glove should be tucked under the gown cuff and the outer glove should be worn over the gown sleeve cuff. Shoe covers must be worn to limit spread of HDs outside the immediate repair containment area and hair covers worn to limit hair and scalp exposure. Hair and shoe covers should be donned first, followed by the gown and then the two pairs of gloves.

When the gown is removed, it should be inverted to aid in containing surface contamination and the inner glove should be removed last. Attire removal should be performed in a manner that reduces shedding or creation of airborne HD particles. The outer gloves should be used to remove the shoe covers and then the outer gloves should be carefully removed. The inner gloves should be used to remove the hair cover and the gown. Attire used in the HD area must not be worn outside the area <sup>7</sup> and should be changed when damaged, contaminated, or visibly soiled. All used attire must be contained in sealed bags and disposed of properly as hazardous waste.

**Respiratory Protection:**

A NIOSH-certified respirator equipped at a minimum with High Efficiency Particulate Air (HEPA) filter cartridges or powered HEPA air purifying respirators must be used. Other filters or vapor protective cartridges as appropriate for the hazard(s) should be evaluated and worn as required. The use of respirators must comply with OSHA's Respiratory Protection Standard<sup>13</sup> which outlines the aspects of a respirator program including selection, fit testing, and worker training. Documented fit testing and worker training should be established and made available for inspection by the customer, safety personnel or regulatory authorities. Dust masks, surgical masks, or face shields without HEPA filtered respiratory protection are not appropriate.

**Eye and Face Protection:**

Chemical-barrier face and eye protection must be used.<sup>14</sup> Eyeglasses with temporary side shields are not considered adequate protection.<sup>2</sup> Unless a full face respirator is worn, a half-mask respirator must be used with appropriate eye protection. A face shield is recommended to reduce skin contact where splashes, sprays, or aerosols are possible. In all cases, minimum eye protection using approved goggles or safety glasses should be used.

**PPE Disposal and Decontamination:**

All contaminated gowns, gloves, and disposable materials must be disposed of according to the facility's hazardous drug waste procedures and state and federal laws. Materials such as respirator, goggles or safety glasses, and face shields can be cleaned with mild detergent and water.<sup>2</sup> Service personnel should also consider properly disposing of respirator HEPA cartridges after use to reduce potential spread of HD.

**Medical Surveillance:**

An effective medical surveillance program should be established to augment safe practices and PPE. Service personnel at risk of exposure to HDs should be included in a systematic medical surveillance program which includes procedures to identify and/or prevent injury and disease.<sup>2 15</sup> This program should be designed to provide early warning of the potential biological effects of HD exposure, but must not replace preventive measures such as appropriate work practice, use of PPE, hazard communication, and training.

Personnel should receive medical evaluations before job placement and medical surveillance performed periodically during employment, following acute exposure, and at job termination or transfer. Medical evaluation and surveillance information should be used to aid in the early detection of disease and to identify health conditions or risk factors that could adversely affect the individual.<sup>16</sup> Other considerations such as personal health history, past exposures to HD, duration of HD exposure, type(s) of HD, and the potential reproductive effects should be evaluated on a case by case basis for each service person.

## General Repair Process

### Appropriate Materials:

When considering materials for performing repairs, service personnel should expose only those tools and materials necessary to complete the intended task. After completing the repair, all contaminated durable materials must be cleaned using appropriate cleaning agents as dictate by facility policy. All contaminated disposable materials must be handled and disposed of as hazardous waste.

### Recommended materials:

- $\geq 4$  mil disposable plastic bags.
- Adhesive labels to identify Chemotherapy Waste or Hazardous Waste as required by federal, state and local regulation.
- $\geq 4$  mil plastic sheet film
- Duct tape
- Hand tools and other equipment necessary for the repair. Power tools should be avoided as they cannot be easily decontaminated.

### Preparing the primary engineering control:

The exhaust fan or blower on the BSC or CACI should be left on at all times, except when the hood is being mechanically repaired or moved. Where the exhaust blower is not operating or when relocated, the BSC or CACI should be sealed in  $\geq 4$  mil plastic to reduce potential external contamination by drug material that may remain on the surfaces within the device.

Appropriate surface cleaning and decontamination shall be performed prior to the repair to remove contaminants and provide a safe service environment. Cleaning should be performed by personnel trained in using appropriate cleaning agents for the HD of concern. Service personnel should obtain a written verification of the cleaning procedure performed before starting the repair. Detailed procedures for cleaning a Class II BSC can be found in the 1990 ASHP Technical Assistance Bulletin *Guidelines on Handling Cytotoxic and Hazardous Drugs*.<sup>11</sup> A variation of this procedure would be effective in cleaning a CACI.

Service personnel and others present must don appropriate PPE before starting work and always assume enclosed areas remain contaminated until proven safe by analytical methods. Surfaces must be visually inspected for cleanliness and, where necessary, analyzed for HD contamination. Facility personnel should remove all extraneous items from the BSC or CACI. Removable work trays should be carefully lifted within the primary engineering control for visual inspection of cleanliness and caution applied where broken glass or other sharps may be present as these can damage PPE or cause injury.

### Repair procedure:

Once the above steps are in place, if the primary engineering control is located in an open area, it should be isolated from the rest of the area where possible. Work areas should be adequately sized to prevent unauthorized entry. Generally it is recommended that non-service personnel leave the area during time of repair where risk of HD exposure exists.

**NOTE:** Some repair providers have fabricated an isolation chamber using polyethylene (4 mil) plastic film with a double door entrance and floor cover. Certified portable HEPA filtered negative air units are used to exhaust filtered air from the enclosure which makes this space negative relative to the room. Proper post repair handling, cleaning and disposal of all materials including the HEPA filter in the negative air unit should be considered.

During the repair, damp wiping the interior of the contaminated plenum and its component parts may aid in reducing gross surface contamination or contaminated debris that can become airborne. Contaminated wipes should be handled and disposed of as hazardous waste.

Removal of filters, motors, or other components shall be performed in a safe manner. Particular attention should be paid to sharp edges and or protrusions that could damage PPE. There should be an appropriate number of service personnel to ensure the safe removal of large or heavy contaminated objects.

After removal, all contaminated parts and filters staged shall be properly bagged or temporarily staged prior to bagging, transferred to a plastic sheet floor liner until properly bagged, sealed, and labeled as hazardous waste. Placement should be in non-traffic areas. Doorways and other spaces where the contaminated material may be disturbed should be avoided.

**NOTE:** Some service personnel have attempted to contain hazards on the HEPA filter or other surfaces using canned aerosols such as shellac, hair spray, or adhesives. This practice is NOT recommended as the action of spraying may dislodge or aerosolize contaminants.

#### **HEPA Filter Bag In / Bag Out (BIBO) Systems:**

Bag In / Bag Out (BIBO) systems are designed to provide a method to safely remove certain contaminated installed HEPA filters. These systems utilize a dedicated housing designed with a pre-installed barrier (change-out bag) which separates the contaminated HEPA filter from the non-contaminated exterior during removal.

Prior to the filter change, seal ducts or close dampers and shut down the appropriate exhaust fan to filter housing to equalize to near-ambient air pressure. Remove the filter access panel, ensure that the safety strap is correctly installed on the change-out bag, and roll out the installed change-out bag and unclamp the filter.

**NOTE:** A safety strap wraps around change-out bag housing collar to prevent the bag from slipping off the housing during change-out.

Remove the contaminated filter by pulling it into the change-out bag using bag arm sleeves (if provided). Manipulate the filter to the innermost section of the bag to maximize slack at the housing collar. Create a pinch off point at two locations between the bagged filter and

the collar. Seal the pinch off points. Cut between the pinch-off points leaving two leak-proof bag stumps. Seal the stump ends.

Place the new replacement filter into the new change-out bag. Remove the safety strap from the filter housing, place new bag onto filter housing collar over old bag stump. Replace safety strap and tighten. While manipulating through the new bag arm sleeves, remove the old bag stump from the filter housing and slip it into the new change-out bags arm sleeve. Push the new filter into position within the housing, tighten the filter clamps, and roll the new bag up into the storage position. Re-install the access panel.

Restore exhaust system to operational mode and proceed with appropriate certification. Dispose of the contaminated materials as Chemotherapy Waste or Hazardous Waste as appropriate under federal, state, or local laws.

### **Post-repair procedure:**

Tools shall be cleaned after use with an appropriate decontamination solution and then dried using cleaning cloths. Contaminated cloths, cleaning solution, HEPA filters, replaced parts and other materials shall be treated as hazardous waste and disposed of appropriately.<sup>17</sup> All contaminated materials shall be handled in a manner that minimizes the spread of contamination.

To reduce the risk of airborne hazards, caution should be used when gathering the floor liner or other material that has come in contact with contaminated parts or filters and when bagging contaminated materials. For example, voiding air out of bag containing hazards could release hazardous particles into the air. Tightly seal hazardous waste bags with an appropriate closure device or adhesive tape. Use double bags where necessary. Apply tape or other materials to blunt any sharp-edged waste before bagging to reduce potential for tearing the plastic containment bag. Properly identify all contaminated waste as Hazardous Waste according to federal, state or local laws.

After the primary engineering control has been re-assembled, and waste bags placed in proper locations, all protective clothing, plastic film, and cleaning materials/containers considered hazardous shall be appropriately disposed of using hazard marked sealed bags. It may be necessary to don additional PPE if further handling of the hazardous containers is required.

The facility is responsible for the recording and disposal of all contaminated materials including filters, parts, cleaning materials, and protective clothing. Notify appropriate facility personnel of the location and source of the contaminated waste.

### **Disposal or reuse of hazardous drug primary engineering controls:**

Presently there is no national guidance for the disposal of derelict or out of service contaminated primary engineering control equipment. Best practice dictates that where BSC and CACI equipment has been identified for disposal, the following steps should be taken:

1. Consult with appropriate occupational health and safety professionals to evaluate the decommissioning process and areas.

2. A decommissioning area should be identified where the equipment can be serviced safely and which can be sealed to contain hazardous drug debris during decommissioning. This area may be within the original site if necessary or elsewhere if determined appropriate by facility safety or other qualified personnel. Post decommissioning cleaning should be included in the assessment of this area.
3. The primary engineering control should be wrapped in  $\geq 4$  mil plastic and sealed for transportation to a decommissioning area (if used) to reduce the incidental spread of HD during the transfer.
4. Access to the decommissioning area should be limited to authorized personnel wearing appropriate PPE.
5. Removable parts or materials that were in the contaminated air stream and cannot be cleaned adequately should be identified and safely removed. These would include, but are not limited to, filters, motors, impellers, wiring, etc. Those parts which can be cleaned by a validated procedure (according to the work station owner, HD manufacturer or other criteria such as MSDS) should be treated, then recycled or disposed of as non-hazardous waste.
6. The remaining surfaces, including the unit's plenum, should be thoroughly washed with cleaning agents appropriate for the hazardous drug. Avoid spraying with liquid cleaning solutions as this process may aerosolize hazards. Waste water, cloths, and other material used for cleaning are considered to be contaminated.
7. Unless all surface areas can be positively identified as being free of any contamination by hazardous drugs, dispose of the body of the primary engineering control as hazardous waste. A worst-case evaluation should include difficult to clean areas such as under the work tray, in the plenum, and other surfaces that may be hard to access for cleaning.
8. A certificate or letter stating previous usage and containing a warning of contamination or potential exposure to hazardous drugs must accompany any previously contaminated primary engineering control that is transferred or sold for any reuse, stored, or disposed of in any manner other than as hazardous waste.

**NOTE:** Depending on the extent of contamination and the difficulty in effectively cleaning and evaluating all areas of the engineering control shell, disposal as a hazardous waste may be the safest approach. Consultation with qualified hazardous waste professionals trained in hazardous drug disposal is recommended prior to any disposal.

## References:

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- <sup>2</sup> OSHA Technical Manual TED (training and education directive) 1-0.15A, section VI, Chapter 2 “Controlling Occupational Exposure to Hazardous Drugs”. [http://www.osha.gov/dts/osta/otm/otm\\_toc.html](http://www.osha.gov/dts/osta/otm/otm_toc.html)
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- <sup>5</sup> Controlled Environment Testing Association. CAG-001-2005 CETA applications guide for the use of barrier isolators in compounding sterile preparations in healthcare facilities, Controlled Environment Testing Association, 1500 Sunday Drive, Suite 102, Raleigh, NC 27607, [www.cetainternational.org/reference/ApplicationsGuideBarrierIsolator110805.pdf](http://www.cetainternational.org/reference/ApplicationsGuideBarrierIsolator110805.pdf)
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- <sup>7</sup> American Society of Health-System Pharmacists. 2006. ASHP Guidelines on Handling Hazardous Drugs" *Am J Health-Syst Pharm*; 63:1172-93
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- <sup>10</sup> American Society for Testing and Materials (ASTM) D 6978-05 Standard Practice for Assessment of Resistance of Medical Gloves to Permeation by Chemotherapy Drugs. West Conshohocken, PA: ASTM; 2005.
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- <sup>12</sup> Connor TH. An evaluation of the permeability of disposable poly-propylene-based protective gowns to a battery of cancer chemotherapy drugs. *Appl Occup Environ Hyg.* 1993; 8:785-9.
- <sup>13</sup> U.S. Department of Labor, Occupational Safety and Health Administration. 1984. Respiratory Protection Standard. 29 CFR 1910.134.
- <sup>14</sup> OSHA 29 CFR 1910.133 “Eye and face protection” U.S. Department of Labor Occupational Safety & Health Administration, 200 Constitution Avenue, NW Washington, DC 20210
- <sup>15</sup> Medical Surveillance for Health Care Workers Exposed to Hazardous Drug DHHS (NIOSH) Publication No. 2007–117
- <sup>16</sup> Polovich M, Belcher C, Glynn-Tucker EM et al. Safe handling of hazardous drugs. Pittsburgh: Oncology Nursing Society; 2003.
- <sup>17</sup> Environmental Protection Agency. 1991. Discarded commercial chemical products, off specification species, container residues, and spilled residues thereof. 40 CFR 261.33(f)