USER MANUAL

RADIOSAFE BIOLOGICAL SAFETY CABINET

(Class II, Type A/B3)
**Introduction**

Read all the instructions in this manual before attempting to operate the RadioSafe Biological Safety Cabinet. The RadioSafe Biological Safety Cabinet is a minimal turbulence, unidirectional, vertical down flow re-circulating laminar flow cabinet, which provides a safe, lead shielded work area for handling particles and aerosols down to the sub-micron size. This chamber eliminates cross-contamination and accidental release of pathogenic microorganisms or carcinogenic aerosols to the outside atmosphere. The unit can be used wherever sterile air is required. Other applications include handling materials such as pollen, powders, allergens, dust, pathogen-free animals and plants— in any situation where both clean air and containment are required. All the air that bathes the work area and all the air that is exhausted passes through High Efficiency Particulate Air (HEPA) filters, which are parallel to each other and to the work surface. These filters remove particulates (organisms, aerosols, etc.) 0.3 micron in size with 99.99% efficiency, and are more efficient for both larger and smaller particulates. The laminar flow principle consists of moving individual streams of unidirectional ultra clean air along parallel lines with minimal turbulence. Perhaps the most valuable parameter is containment without the necessity of working through gloves. This is accomplished by discharging approximately 30% of the total filtered air each cycle through the exhaust HEPA filter in the top of the unit.

An equal amount of make-up air is pulled into the chamber through the bottom of the window under negative pressure from the blower and positive pressure from the air curtain. The viewing panel has a unique, recessed, contoured shape, which creates an aerodynamic flow pattern. It is this combination that produces the protective barrier for the operator by containing hazardous materials within the chamber.

The cabinet exceeds the requirements for a Class 100 chamber described in Federal Standard No. 209. This standard outlines air cleanliness classes and other environmental air conditions required for achieving and maintaining the levels of environmental cleanliness. Class 100, according to Federal Standards, is the class where particles 0.5 micron or larger must not exceed a total count of 100 particles per cubic foot. Biomedical engineering and technology have introduced safeguards into the design of laboratory equipment, but these safeguards do not prevent human error. Danger to personnel from carelessness or improperly used equipment cannot be overemphasized. There is no substitute for safe, proper technique.


**Safety, Operation and Additional Professional Training**

The RadioSafe Biological Safety Cabinet provides a sterile and shielded environment that allows for greater protection for both personnel and products than traditional open front laminar flow equipment. However, this protection can only be achieved through proper aseptic technique. The following is a list of topics that may apply to your operation. Many of these items may require additional professional study and practice beyond the information found in this manual.

1. Operation of the RadioSafe Biological Safety Cabinet
2. Understanding HEPA particulate filtration
3. Proper operator technique
4. Understanding chemical compatibilities for proper glove selection
5. Understanding chemical compatibilities for proper “cleaning” and “sterilization”
6. Understanding chemical compatibilities for proper “decontamination”
7. Understanding sterile product preparation and aseptic technique
8. Understanding hazards associated with the products handled in the safety cabinet
9. Understanding proper maintenance and initial / periodic certification
10. Understanding Federal, State and Local professional regulations.
11. Understanding Radiation Shielding

The RadioSafe Biological Safety Cabinet does not automatically provide a clean, sterile and safe working environment. In order for the unit to provide the required work environment, a professional understanding of the items above along with a complete understanding of the tasks to be performed is essential.

To obtain this information and understanding may require additional professional training. If you need assistance in finding Professional Pharmacy Organizations offering additional training for any of the above items please call Pharmacy Equipment Sales at GERMFREE, 800.888.5357

**GERMFREE, the RadioSafe Biological Safety Cabinet and USP <797>**

GERMFREE has strived to produce a primary engineering control that maintains a clean and microbe free environment through a combination of design elements and recommendations for good practice and technique.
GERMFREE’s policies will always err on the side of caution when making recommendations on the proper use of the RadioSafe Biological Safety Cabinet.

GERMFREE recommends the following general guidelines for the RadioSafe Biological Safety Cabinet.

1. The unit should be placed in a controlled environment. A room with a window which opens to the outdoors or a high traffic area is not appropriate for the compounding of sterile products. This is recommended to reduce the overall bioburden in the surrounding area. A classified environment or a room that conforms to a particular particle count is necessary.

2. Operators should wear a gown or coat to protect themselves from accidental dermal contact with elements being compounded. This is especially important when compounding potentially hazardous drugs.

3. Operators should always wear gloves when handling compounding elements. Studies have shown evidence of drug contamination on the outside of vials.

4. All compounding elements should be wiped down before placement in the airlock to reduce any surface contamination that may be present.

5. Operators should minimize fingernail length and jewelry because they increase the chances of glove puncture / tear.

6. Operators should don hair covers to decrease the chance of hair entering the work area.

7. Operators should be made aware that “first air” for the purposes of proper aseptic technique is located above the work area.

Particulates, Gases, and Vapors

The RadioSafe Biological Safety Cabinet provides personnel and product protection from particulates, dust, powders and aerosols. Microbiological particulates and aerosols are also removed. Personnel and product protection from gas and fumes are not provided by HEPA filtration, but limited protection from gas and fumes can be provided by venting or ducting.
Radioactive Materials Protection

The cabinet provides additional protection (shielding) for laboratorians by employing lead shielding in the walls and floors as well as the sliding lead shield.

The cabinet has ¼ inch lead in the sides, back, bottom, ante-chamber and sharps’ compartment. The large lead window has 2mm of lead equivalency.

Containment

The RadioSafe Biological Safety Cabinet maintains containment of the work area through a series of filters and its stainless steel construction. Joints are welded and polished for easy cleaning and all modular components are fully gasketed to ensure a gas tight seal. Adjustable compression hinges and positive-lock latches deliver consistent pressure at door openings.

All air entering and exiting the cabinet is HEPA filtered to ensure ambient particulates stay out of the work area and materials being compounded stay in.

Installation

The RadioSafe Biological Safety Cabinet is transported and moved in the upright position. The exhaust filter is located within the unit and the dimensions are such that it will fit through any opening 32” wide and 69” high. If narrower doors are encountered, the light housing can be taken off by removing four screws or the viewing panel with the attached light housing can be completely removed by sliding the split hinges to the right. This will reduce the width of the equipment to 28”. An additional 3/4” clearance is required for the two clamps located level with the bottom of the viewing panel.

It is strongly recommended a specialized moving company handle and place the equipment.

Electrical Requirements / Services

Electrical Requirements are as follows:

- 115 V, 10 amps
- 1 phase, 60 Hertz
• 3 prong safety power cord

During shipment, the power cord is coiled within the control panel. The plug of the power cord is a 3-pronged safety type and should be put into the appropriate 3-prong 115v receptacle. For convenience of operations and service, all circuitry is located within the control panel.

Standard services include the Motor ON/OFF switch, light switch, a Sensocon digital gauge at the front of the unit. The speed control is located in the control panel behind a plastic cap. Optional duplex electric outlets may be located in the rear of the work area and optional stopcocks may be placed installed in the unit according to your specifications.

Certification

The RadioSafe Biological Safety Cabinet is a complete unit whose performance was tested and documented before shipping. Certification is required prior to operation. This is especially important after transportation of the unit from GERMFREE to your facility. The purpose of this retesting is to verify that the HEPA filters, airflows and pressures are within limits and the unit is performing properly.

It is always a good idea to review basic operation of your new unit with the certification company personnel due to their knowledge of this type of equipment.

Certification may also be a Governmental and /or Professional requirement. Certification needs to be performed by a company that has the proper equipment and training needed to test and measure HEPA filter performance. Certification should be continued bi-annually or as regulations dictate.

The individual factory certification report is available and additional electronic copies can be provided by e-mail. Please call customer service at 800-888-5357.

Please contact GERMFREE at 800-888-5357 for a list of Certification Companies in your area if you do not already have this service.
Air Flow

*Unidirectional (Laminar) Air Flow*

The RadioSafe Biological Safety Cabinet offers the highest level of product protection by providing vertical laminar flow HEPA filtered air to the complete work environment. This is the same technology used in the Laminar Flow Workstations and Biological Safety Cabinets that “barrier isolators” are intended to replace. The cabinet utilizes a full width and depth supply HEPA filter above the work surface. Any particle-laden air is swept from the work area with a wash of HEPA filtered air. Filtered air washes over the work area into the front and rear grilles. Particles generated in the work area are immediately drawn into the returns and out of the work zone. Internal cross-contamination from compounding different products in the same work area is drastically reduced.

![Control of Airflow](image)
A qualitative indication of airflow can be monitored with the Sensocon digital gauge. It is a good practice to record the original pressure reading, or the reading immediately following certification. This will indicate the pressure that relates to airflows within the acceptable range to provide containment and product protection. Since the change of flow is related to the increased particulate load on the HEPA filters, which will be apparent by an increased pressure reading on the Sensocon digital gauge, the flow can be monitored. Particulate loading of HEPA filters happens slowly; therefore, a large change in gauge reading in a short period of time will indicate cause for concern. Any time a concern about the cabinet airflow is present you should call the GERMFREE’s customer service department or your local certifier for advice prior to resuming operation. The exact reading of the Sensocon digital gauge on each unit may vary depending on several factors unique to the individual unit such as resistance of a particular set of HEPA filters, electrical supply voltage, motor-blower characteristics, etc.

As filters become “loaded” with particulate matter, the motor blower will overcome a considerable increase in resistance while maintaining a constant airflow. This automatic compensation by the blower will cause only minimal changes in the reading of the Sensocon digital gauge. Eventually the resistance across the filters will increase to the point where, at a given setting of the variable speed control, the reading of the gauge increases. At this point it is necessary to turn the speed control counter-clockwise to increase the motor speed to reset the airflows (This operation should only be performed by a licensed certifier). This will again change the initial reading of the gauge for qualitative airflow monitoring. Depending on the cleanliness of the air in the room in which the cabinet is located, the initial change may not occur for a year or considerably longer. Thus, with new filters it is only necessary to examine the Sensocon digital gauge approximately once a month.

Over time as the HEPA filters continue to load with particulates, mostly from ambient air, changes of the variable speed control will be required at increasingly shorter intervals to provide adequate airflow.

To be sure your unit is functioning properly; the velocity should be measured by a third party certification professional. Readings of air velocity, measured in feet per minute, can be made with a velometer or thermoanemometer to determine if the unit is within specification and when filters should be changed. This certification should be performed at least annually, and many regulatory bodies recommend semi-annually. The following chart represents the acceptable range of air velocities that are measured in your unit.
Eventually the HEPA filters will be loaded with particulates to a point where the blower can no longer overcome the resistance to provide the proper air velocities. At this point new HEPA filters must be installed. Replacement HEPA filters can be ordered ahead of time so they are available in advance of changing. If any biological agents have been manipulated within the cabinet, the unit must be decontaminated before any HEPA filters are changed. This is because viable particles may be trapped and survive for a period of time in the filters.

Appendix A describes in detail how to accomplish this safety measure and Appendix B describes the method of changing filters. Please call the factory if you need assistance, or a combined service may be available from your certification company for decontamination, filter replacement, and recertification for a standard fee.

HEPA Filtration Theory

HEPA Filtration

The RadioSafe Biological Safety Cabinet is equipped with High Efficiency Particulate Air (HEPA) filters to provide the highest level of personnel and product protection. These filters are the laminar flow supply HEPA filter, which filters all air in the work area, and the exhaust HEPA filter which filters all air exhausting from the unit. All filters are rated to remove particulates and aerosols 0.3 micron (μm) in size with a minimum efficiency of 99.99%. These filters are even more effective at removing particulates both larger and smaller than 0.3 microns (μm) as the graph below depicts.
HEPA filters are recognized as one of the best forms of mechanical air filtration available for this application. HEPA filters improve or become more efficient as they load under use. There are a number of mechanisms involved in HEPA filtration, which are described below:

1. Impingement - Large particulates, e.g. dust, are captured by the filter fibers as the air stream flows around the fibers.

2. Interception - Particulates follow air stream around filter fibers and become captured (physical interference between particles and fibers).

3. Diffusion - Very small “particles” are bombarded by gas molecules causing them to move erratically (Brownian motion) and contact the filter fibers.
4. Straining - Occurs when the smallest dimension of the particulate is greater than the distance between adjoining filter media fibers.

5. Electrostatic attraction - Enhances mechanical capture through attraction of oppositely charged particles.

Filters

All RadioSafe Biological Safety Cabinets are provided with both a supply HEPA filter over the work area and an exhaust HEPA filter in the top of the unit. All filters were subjected to a particle challenge leak test at the time of manufacturing and again immediately before shipment and are certified to be 99.99% effective on a .3 micron particle, the hardest to capture. Loading time for HEPA filters will depend primarily on the number of particles in the ambient air and, to a lesser extent, on particles generated within the chamber. Under most laboratory conditions the life of the filters will be three to five years; rarely do they become obstructed in three years or less. The unit may be left on continuously or turned off and on as needed with a twenty-minute start up and cool down period prior to and after use.

Start-Up Procedure:

1) Turn on unit.
2) Wipe down all interior surfaces.
3) Allow 10 minutes for particles to wash into HEPA.
4) Begin use.

Shutdown Procedure:
1) Wipe down all interior surfaces.
2) Allow 10 minutes for particles to wash into HEPA.
3) Turn off unit.
The lead shielded window can be easily moved to access all areas within the cabinet. To move the viewing shield, loosen the silver window release knob and move into desired location. Tighten the knob to secure the sliding window in place.
Contoured Viewing Panel

The shape of the viewing panel is designed to put the operator above the work with a glare-free view of all parts of the work area. Mechanically, this allows for a one-piece straight up and down construction with the filters parallel to each other and to the work surface. The standard viewing panel is acrylic and can be cleaned with a soft cloth and a mild detergent. **Do not use abrasive cleansers or organic solvents on this viewing panel!** Acrylic should not be cleaned with anything stronger than 50% Ethyl or 70% isopropyl alcohol solution. **Do not use glass cleaner with ammonia or RadicWash on the viewing windows.**

The viewing panel is hinged and can be raised to more than a 90-degree angle to provide easy access for larger items (chains are provided to support the window in the open position). Before the window can be fully opened, the sliding lead shield must be lowered.

The procedure to lower the sliding lead shield is as follows:

1. Pull the knob on the gas shock and place the pin clip in order to keep the gas shock released.
2. Release the knob on opposing gas shock and use the handle to pull the sliding lead shield away from the work area. This must be done to allow room for the viewing panel to open.
3. Once the sliding lead shield is lowered, the viewing panel may now be opened. If the window needs to remain open for an extended period of time, a chain is provided to support the window.

Work Tray

With the viewing panel removed (or raised and supported by the lifting chain), the work tray and its support can be easily separated and removed. If the cabinet has been used with potential pathogens, the cabinet should first be decontaminated with paraformaldehyde before disassembling. The work platform and its perforated support can be decontaminated by using a sponge or squeeze bottle containing a biocide specific to the organisms being worked with. If materials are spilled within the chamber, they should be made safe by the addition of an appropriate germicide. For initial cleaning and daily maintenance, the interior of the chamber should be completely wiped with 70% alcohol, using a lint-free cloth. The exterior may be similarly maintained periodically.
Dose Calibrators

GERMFREE’s RadioSafe cabinet is constructed to accommodate a dose calibrator. The dose calibrator is shielded to protect users and the integrity of the reading. The control panel for the dose calibrator is external to containment and connects to the internal components via gas-tight connection.

The containment area for the Dose Calibrator chamber is shielded with ½ inch of lead. Spacers can be used under the chamber to raise the height of the top of the Dose Calibrator Ionization chamber so it is level with the stainless work surface.

Several Dose Calibrator models are compatible with this cabinet.

The Dose Calibrator power should be left ON at all times.

*Please contact the manufacturer of your particular model for any questions pertaining to the use and service of the calibrator.*

Dose Calibrator Housing

To install the dose calibrator, open the viewing panel and raise or remove the work tray to expose the chamber housing.
Data cords and cables required for the calibrator can be run through the back side of the housing.

Motor Blower

The motors and blowers in this unit they have the following characteristics: low noise levels, low vibration levels, compatibility with the variable speed control and most important, efficiency in delivering air through clean HEPA filters as well as those loaded with a considerable amount of particulate material.

Motors are 1/3 or 1/2 h.p., 115 V single-phase and 60 Hertz.

Before servicing the motor, the power cord must be disconnected. The access to the motor-blower is through the top of the unit. If potentially contagious material has been handled, the cabinet should first be decontaminated. If the unit is used to contain non-biological chemical hazards, the workers and surrounding area should be isolated and protected. The motor is located in the center of the blower and can be disconnected by removing three motor mounting screws.

Lights

Two fluorescent lights are mounted in a housing along the top of the viewing panel exterior to the work area. This location gives the best glare-free view to the operator and
also prevents heat build-up within the cabinet. The lamps are wired independent of the
motor-blower and provide good visibility within the work area at all times.

Ultraviolet lights are provided in the work area only if ordered. Most authorities do not
recommend use of UV light in this type of safety cabinet for a number of reasons:

1) A considerable volume of HEPA filtered air passes through the work area; the unit
tends to be self-cleansing.

2) The tubes and electric components can affect the laminar airflow pattern.

3) There is a danger to personnel; approximately 12% of UV light penetrates the viewing
panel, and UV rays reflect off the stainless steel work area. Thus, damage may occur to the
retina of unsuspecting personnel.

4) The tops of the UV tubes will be kept clean by the laminar flow air; however, the
bottoms of the tubes will have to be wiped with a cloth soaked in alcohol as a light
coating of dust will interfere with their effectiveness. This, of course, will have to be
performed at less frequent intervals inside the cabinet than in the ordinary room.

5) If left on for long periods of time, such as overnight or over the weekend, the UV will
crack and/or yellow the viewing panel unless it is shielded.

6) UV tubes often lose their germicidal potential even though they glow with a blue light.
They must be tested periodically for effectiveness.

7) In the proper utilization it may be necessary to rotate or turn over objects in the work
area so that all surfaces are exposed to the direct or reflected ultraviolet rays, since there is
no bactericidal effect in the shadows.

Traditional use of UV would ordinarily be limited to initial sterilizing of the work area and
decontaminating of material spilled within it. GERMFREE recommends decontaminating
a spill with the appropriate germicide. For serious accidents, complete decontamination
of the entire RADIOSAFE BIOLOGICAL SAFETY CABINET with paraformaldehyde
should be considered, see Appendix B.

Units that have UV lights are wired with a safety switch, which automatically shuts off
these lights when the fluorescent lights are turned on. Since most bacteria for which UV is
effective are killed in seconds, and spores in minutes, it is recommended that the
ultraviolet light be used for a predetermined interval (e.g. 10 to 20 minutes). Preferably,
the user should set an alarm type clock and stay out of the immediate vicinity of the
chamber when the UV lights are operative. Standard precautions must be taken, of course, to protect personnel whenever ultraviolet lights are utilized.

Performance Testing

The RadioSafe Biological Safety Cabinet features a one-piece welded construction. No access panels are required and it has no jointed segments that might loosen during shipment. This is a distinct advantage because many potential sources of the leaks through gaskets are avoided. Your RADIOSAFE BIOLOGICAL SAFETY CABINET has been thoroughly tested at the factory. To ensure supply and exhaust HEPA filters are free of defects; Poly-Alpha Olefin (PAO) mineral oil was aerosolized into the unit on the upstream side of the HEPA filters. Integrity of the HEPA filters was determined by scanning with a photometer to detect PAO aerosol particles on the downstream side of the HEPA filters. If there was any penetration greater than .01% through the filter medium or perimeter filter seal, the leaks were located and repaired. Air velocity was measured with a thermoanemometer to ensure that it was uniform and unidirectional. The probe was placed six inches away from the interior walls and readings were taken at 6"-spaced intervals in both axes at window height. Other tests for temperature rise, noise level, vibration level and light intensity were performed; the RadioSafe Biological Safety Cabinet meets or exceeds recommended standards. A simple test of the air balance which you can perform after the unit is set up is carried out with cigarette smoke or a chemical smoke (i.e. titanium tetroxide). The smoke source is held near the access port of the work area. If the unit is working properly and is unobstructed, the air curtain will direct the smoke downward. No smoke should enter the work area or flow over the work platform, all air should flow downward within the unit and no air should exit the interior.

The cabinet has also been tested from a microbiological standpoint. This testing was two-fold. Challenges were designed to prove the integrity of the unit in containing potentially hazardous materials and to demonstrate that work within the chamber would be protected from outside contamination.

Use of the RadioSafe Cabinet

The successful use of the RadioSafe Biological Safety Cabinet as a safety tool depends upon two factors: advance planning and good technique. Even the most sophisticated and elaborate systems would be useless if proper technique were not employed. It is the responsibility of the senior investigator or head of a particular facility to train personnel
who will use the unit and to see that good technique is maintained. If this is not done, a false sense of security may prevail.

**Advance Planning:**
To achieve maximum safety and utilization of your RADIOSAFE BIOLOGICAL SAFETY CABINET you must take into account the equipment and materials necessary for the proposed operation and must outline the procedural details of your particular operation or experiment. The best way to accomplish this is through the use of a checklist and/or protocol that would include the equipment, apparatus, media, supplies, biological samples, specimens and any other items necessary for the anticipated procedure. The procedural checklist should include the order of events and other details necessary for the successful completion of the proposed operation or experiment.

Your advance planning should include a layout for the arrangement of items in the work area. This should be planned so that contaminated items and clean items are segregated and the movement of contaminated items over clean items is minimized. Arrive at a logical progression for a particular operation and arrange your layout accordingly. In a complex situation, an ideal arrangement of equipment may not be achieved easily so it may be necessary to compromise.

**Good Technique:**
When the planning phase is completed, the start-up procedure can begin. Turn on the fluorescent lights. Clean the entire stainless steel surface in the work area thoroughly using a soft, lint-free cloth and 70% alcohol. Using your checklist, collect all items for the procedure, which are to be placed in the chamber. Clean all of these items thoroughly before introducing large items of equipment. Do not overload the work area. It is important, however, that everything needed for the complete procedure be placed in the chamber before starting so nothing passes in or out through the air curtain until the procedure is completed. Items should be positioned within the work area so they do not block the air intake or the return air openings. Perform work far enough away from the access opening (i.e. over the work tray), to ensure containment.

Now that all the items on the checklist have been arranged in the work area, turn the power switch to ON. Many operators choose to leave the unit on constantly. Wait approximately five minutes before starting test procedures. This allows sufficient time for the ultra clean air circulating within the chamber to remove any airborne contamination from the work area and any particulate matter from the newly introduced items.
The operator is a critical factor in the successful and safe operation of any biological safety cabinet. It is dangerous to have the idea that the chamber is going to do all of the work. A properly balanced and properly utilized cabinet will do an excellent job of controlling airborne contamination. Before starting to work in the chamber, the hands and arms of the operator should be washed thoroughly with a germicidal soap. It is also recommended that technicians working in the cabinet wear long-sleeved gowns with knit cuffs and rubber gloves. This minimizes the shedding of skin flora into the work area and protects the hands and arms from contamination with viable agents. Conventional laboratory coats with open cuffs allow the entrapment of contaminated air around the technician’s arms inside the sleeves. The hands and arms should be inserted into and withdrawn from the work area slowly to prevent “dragging” of contaminants from the room into the work area or from the work area into the room. Abrupt movements of the arms and hands should be avoided. Excessive activity in the room may also create disruptive air currents. This should be held to a minimum or eliminated when work is being performed in the unit. The viewing panel should never be opened while work is in progress. When work has been completed, cover the tray for the discarded supplies with a towel or paper towels soaked in an appropriate germicide. The outside of the tray and other equipment (glassware, etc.) can be wiped or sprayed with the appropriate solution. Wait approximately five minutes before removing any item from the chamber.

Exposure to airborne microorganisms is one of the most common sources of laboratory infections. Through biomedical engineering and advance technology, we have provided the RADIOSAFE BIOLOGICAL SAFETY CABINET as one of the key elements to safe handling of viable biological materials and other materials that must be contained. By utilizing good sterile technique and following the outlined procedures you can protect yourself, the environment and the integrity of your research. YOU ARE THE KEY.

Cleaning

**NEVER CLEAN LEAD ACRYLIC VIEWSCREEN WITH RADIAcwASH**

Outside
The outside of the cabinet can be cleaned at any time while the unit is closed and the procedure does not require Personal Protective Equipment (PPE) additional to that normally used when operation. The stainless steel should be cleaned using a 70% alcohol solution or a solution specifically designated for the cleaning of stainless
steel. The acrylic front and sliding viewing window screen should be cleaned with a soft cloth and a mild detergent, alcohol, or a solution specifically designated for the cleaning of acrylic surfaces.

It is important to NEVER use abrasive cleaners or organic solvents on the lead acrylic view screen. Additionally, the lead acrylic should NOT be cleaned with any solution stronger than 50% ethyl or 70% isopropyl alcohol. DO NOT use glass cleaner with ammonia. DO NOT use Radiacwash or other decontaminating solutions on the lead acrylic.

**Inside**

A water-based, high pH, disinfectant cleaner should be used, followed by 70% alcohol. This cleaning method, when properly performed, prevents dripping of dirty solution onto cleaned surfaces and does not carry contaminants from surfaces near the open front of the work area to the rear.
This list is by no means comprehensive nor does it constitute endorsement by GERMFREE. Read the labels on the products you are currently using to categorize them. Rotate cleaning agents to avoid developing any resistant strains. Contact your current disinfectant supplier or search the internet for purchasing information.

<table>
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<th>Class</th>
<th>Recommended Use</th>
<th>Examples</th>
<th>Name Brand Products</th>
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<tbody>
<tr>
<td>Phenolic Compounds</td>
<td>Bactericide, Fungicide, Tuberculocide, Viricide</td>
<td>H1L-Phene, LpH, Metar, Vespheine Brand</td>
<td>Decon-Cycle by Veltek Lysol® L-Stat Ulta Phene Medaphene® Amphy®</td>
</tr>
<tr>
<td>70% Isopropyl Alcohol Solution</td>
<td>Cleaning certain instruments, cleaning skin</td>
<td></td>
<td>TexShield™ by Texwipe, Decon-Ahol® By Veltek</td>
</tr>
<tr>
<td>Chlorine Compounds</td>
<td>Spills of human bodily fluids, bactericide, fungicide, sporicide at &gt;1000ppm Sodium Hypochlorite</td>
<td>Bleach Solutions (Sodium Hypochlorite),</td>
<td>Clorox, Cyosan, Purex</td>
</tr>
<tr>
<td>Quaternary Ammonium Compounds (QUATS)</td>
<td>Ordinary housekeeping of floors, furniture, walls, bactericide, fungicide, viricide (not as effective as phenols)</td>
<td>Quatsyl Coverage 258, End-Bac, Hi Tor</td>
<td>Decon-QUAT 100® By Veltek Lysol®-IC Alpha-Lemon QUAT by Alphasource</td>
</tr>
</tbody>
</table>
**Cleaning Terms**

**Clean**  
Free from disease or infectious agents <a pullorum-clean flock> <keep installations clean of TB infection>

**Deactivate**  
1: to make inactive or ineffective  
2: to deprive of chemical activity

**Decontamination**  
A process that reduces contaminating substances to a defined acceptance level.  
To make safe by eliminating poisonous or otherwise harmful substances, such as noxious chemicals or radioactive material. To rid of contamination (as radioactive material)

**Disinfect**  
To destroy pathogenic microorganisms in or on any substance or to inhibit their growth and vital activity.  
To cleanse something so as to destroy or prevent the growth of disease-carrying microorganisms. To free from infection especially by destroying harmful microorganisms

**Sanitization**  
That part of decontamination that reduces viable microorganisms to a defined acceptance level, normally achieved by using a chemical agent or heat.  
To make sanitary (as by cleaning or sterilizing) <if the apparatus is not properly sanitized, pathogens may be disseminated to subsequent patients —Journal of the American Medical Association>

**Sterilize**  
To make free from live bacteria or other microorganisms.

 References provided by:  
Merriam-Webster Medical Dictionary, © 2002 Merriam-Webster, Inc.  
Some Biological Safety Cabinet Operation
“Don’ts”

1) DON’T ever cover the air intake area in front of the Chamber with papers, notebooks, equipment, etc. Movement of air into the negative pressure section must not be impeded!

2) DON’T “turn up the air” under the impression that the faster the air flow the better the unit is operating. A flow of about 80 linear feet a minute is the recommended velocity for most conditions (at this speed smoke introduced into the chamber should gently and evenly float down without breaking up into turbulent patterns). Also do not reduce the airflow rate below safe levels.

3) DON’T ever cover the exhaust filter.

4) DON’T ever attempt any maintenance of the motor or any component outside the work area without decontaminating the unit as described in Appendix B.

5) DON’T overload the work area.

6) DON’T carry out procedures in front of the work tray (i.e. too near the air curtain).

7) DON’T place items in a position that would interrupt the laminar flow pattern.

8) DON’T introduce or remove your hands rapidly from the unit.

9) DON’T allow spilled viable material to remain in your equipment.

10) DON’T move contaminated items over clean items.

11) DON’T work with open cuffs or other loose garments that might entrap viable agents.
# Troubleshooting

This section is to be used as a general guideline. An independent certification agency or a qualified technician specializing in repairs and testing of this type of equipment must do any maintenance or repairs that need to be made.

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<th>Possible Causes</th>
<th>Remedy</th>
</tr>
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<tbody>
<tr>
<td>Air supply inoperative</td>
<td>Main switch off</td>
<td>Check main switch. See that plug is in the electrical outlet. Green light switch should be on.</td>
</tr>
<tr>
<td>No air circulation</td>
<td>Blower off</td>
<td>Check motor blower control.</td>
</tr>
<tr>
<td></td>
<td>Blown circuit breaker</td>
<td>Check circuit breaker on control panel.</td>
</tr>
<tr>
<td></td>
<td>Break in electrical wiring</td>
<td>Use electrical diagram and check wiring connections.</td>
</tr>
<tr>
<td>Excessive blower vibration</td>
<td>Foreign matter in blower squirrel cage</td>
<td>Remove paper, paper clip, etc.</td>
</tr>
<tr>
<td>Exhaust air imbalance</td>
<td>Obstruction over exhaust filter</td>
<td>Remove obstruction.</td>
</tr>
<tr>
<td></td>
<td>Improper adjustment of blower motor control</td>
<td>Adjust to proper reading on Sensocon digital gauge.</td>
</tr>
<tr>
<td></td>
<td>Obstruction of plenum</td>
<td>Remove obstruction.</td>
</tr>
<tr>
<td></td>
<td>Leak between blower and plenum</td>
<td>Repair leak – Contact certification company.</td>
</tr>
<tr>
<td></td>
<td>Filter loaded</td>
<td>Replace Filters – Contact certification company.</td>
</tr>
<tr>
<td>Condition</td>
<td>Cause/Description</td>
<td>Solution/Action</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>--------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Low velocity air</td>
<td>Low voltage on house current</td>
<td>Measure voltage – contact certification company.</td>
</tr>
<tr>
<td></td>
<td>Filter loaded</td>
<td>Replace filters – contact certification company.</td>
</tr>
<tr>
<td></td>
<td>Improper adjustment of blower motor</td>
<td>Adjust to proper reading on Sensocon digital gauge – contact certification company.</td>
</tr>
<tr>
<td></td>
<td>Obstruction in plenum</td>
<td>Remove obstruction.</td>
</tr>
<tr>
<td></td>
<td>Leak between blower and plenum</td>
<td>Repair leak – contact certification company.</td>
</tr>
<tr>
<td>High velocity air</td>
<td>Exhaust filter rupture</td>
<td>Replace Filters – Contact certification company.</td>
</tr>
<tr>
<td></td>
<td>Supply filter rupture</td>
<td>Repair (App. B) – contact certification company.</td>
</tr>
<tr>
<td></td>
<td>Supply filter gasket leak</td>
<td>Find and repair leak – contact certification company.</td>
</tr>
<tr>
<td></td>
<td>Exhaust air outlet obstruction</td>
<td>Remove obstruction.</td>
</tr>
<tr>
<td></td>
<td>Improper adjustment of blower motor speed control</td>
<td>Adjust to proper reading on Sensocon digital gauge.</td>
</tr>
<tr>
<td>Non-laminar airflow</td>
<td>Large object obstructing airflow</td>
<td>Remove item.</td>
</tr>
<tr>
<td></td>
<td>Large leak in supply filter</td>
<td>Replace Filters – Contact certification company.</td>
</tr>
</tbody>
</table>
Appendix A

PARAFORMALDEHYDE DECONTAMINATION

Successful decontamination with paraformaldehyde consists of exposing all internal parts of the chamber to the generated formaldehyde gas under the proper conditions, which will kill all microorganisms that are harbored anywhere within the cabinet. Although the details are for the RADIOSAFE BIOLOGICAL SAFETY CABINET, the general method will apply to other types of biological safety cabinets. Specifically, it is necessary to (a) close off the cabinet and any extension (ductwork), (b) volatilize and disseminate the proper amount of paraformaldehyde, (c) assure proper conditions of temperature and humidity, (d) contain the gas for an adequate period of time and (e) terminally remove the gas from the cabinet.

Details for the procedure are numbered more or less in the order in which they should be performed:

1) If the unit is ducted, this duct must be sealed at some appropriate point. This may be at the termination of the duct or closer to the unit if a damper or similar mechanism is utilized. If the exposed duct is long, additional paraformaldehyde may be needed to compensate for the increased volume.

2) If the unit is not ducted, tape a plastic cover over the exhaust filter on top of the RADIOSAFE BIOLOGICAL SAFETY CABINET. This cover should be fabricated with a sleeve on the top and flexible hose taped to the sleeve. (We find that permanent taping of the flexible hose to the plastic cover is advantageous because it can be used with other RADIOSAFE BIOLOGICAL SAFETY CABINETS that have to be decontaminated without having to tape a flexible hose in place each time). The flexible hose is placed in a window to exhaust fumes to the outside. (However, this hose can be placed or taped into the room exhaust system providing it does not connect to other areas in the building).

3) In a situation where the formaldehyde gas can’t be exhausted through a duct or window it can be passed into a charcoal or appropriate chemical filter.

4) The temperature ranges found in laboratories where the RADIOSAFE BIOLOGICAL SAFETY CABINET would be employed are quite satisfactory for using formaldehyde. Relative humidity is more critical; it is desirable to have a relative humidity
of 60% or higher (short of saturation) for optimum decontamination. Experience has shown, however, that decontamination with paraformaldehyde will occur at a relative humidity as low as 50% and a temperature as high as 30°C. If the relative humidity is too low it can be increased by boiling water on a hot plate within the work area.

5) A commercially available electric frying pan, containing a specified amount of paraformaldehyde (see table) is placed on the work tray. The thermostat of the frying pan is set at 450°F and the paraformaldehyde spread evenly over the surface of the pan. The electric cord should hang free from the cabinet.

6) Cover the viewing panel with a plastic film and tape the top, sides and bottom so there are no leaks. To ensure that disseminated formaldehyde gas will not escape into the room, use one of the following methods around the electric cords:
   a) Tape the cord(s) resting on the edge of the unit using sufficient tape, or...
   b) Make a small slit in the plastic film. Insert the cord(s) through the film and tape. (We find method (a) to be the better of the two, for the slit has to be made large enough for the plug to pass through. There is a tendency for the film to tear when the tape is removed from the plastic; film can only be used a few times).

7) Plug the frying pan cord into the electrical outlet on the control panel.

8) After one-fourth of the paraformaldehyde has depolymerized turn on the blower-motor for 10-15 seconds. Repeat when one-half, three-fourths, and the total amount of the paraformaldehyde has depolymerized.

9) Disconnect electrical cord(s).

10) Let the unit stand for at least one hour.

11) Evacuate gas from hood.

12) Remove plastic film from the front of cabinet and from over the exhaust filter and then turn on the blower.

13) Addendum:
   a) Experience from established laboratories has shown that the amount of paraformaldehyde can range from as low as 0.15 grams per cubic foot of cabinet volume to 0.3 grams/ft³. This concentration may be used for most work with safety; however, the investigator should consider what organisms have been used in the RADIOSAFE BIOLOGICAL SAFETY CABINET. One can employ a lower concentration to decontaminate the cabinet after using S. marcescens than after using Mycobacterium tuberculosis or some other highly resistant organism.
   b) In a series of experiments using M tuberculosis and the saprophytic phase of Histoplasma capsulatum we found that 0.25 grams/ft³ paraformaldehyde polymerized into the cabinet killed all micro-organisms on the surfaces and in the filter. However, during this study, the exhaust blower was turned on four times because the previous
experience of others as well as ourselves, proved the importance of disseminating the formaldehyde gas during this decontamination.

c) If, for convenience, the RADIOSAFE BIOLOGICAL SAFETY CABINET containing formaldehyde gas is left overnight or over a weekend, this will have no deteriorative effect on the unit. All that is required is to completely purge the unit to eliminate all the formaldehyde gas before use.

**TABLE 1**

<table>
<thead>
<tr>
<th>BIOFLOW CHAMBER NUMBER</th>
<th>TOTAL CUBIC FEET</th>
<th>0.20 gm/ft³</th>
<th>0.25 gm/ft³</th>
<th>0.30 gm/ft³</th>
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</thead>
<tbody>
<tr>
<td>BBF 3</td>
<td>32.7</td>
<td>6.6</td>
<td>8.2</td>
<td>9.8</td>
</tr>
<tr>
<td>BBF 4</td>
<td>43.4</td>
<td>8.7</td>
<td>10.9</td>
<td>13.0</td>
</tr>
<tr>
<td>BBF 6</td>
<td>64.8</td>
<td>13.0</td>
<td>16.2</td>
<td>19.4</td>
</tr>
</tbody>
</table>

**Appendix B**

**FILTERS**

An independent certification agency or a qualified technician specializing in the repair and testing of this type of equipment must perform all maintenance to the RADIOSAFE BIOLOGICAL SAFETY CABINET, especially the filters.

**I. Certification and Repair**

All models of RADIOSAFE BIOLOGICAL SAFETY CABINETS have a large supply and a smaller, exhaust HEPA filter. These are sized to provide the entire work area with ultra clean air and to filter particulate matter. Approximately 30% of the circulated air is exhausted during each cycle. HEPA filters are placed and sealed within the cabinet to prevent any bypass of air. Filters are certified to be 99.99% effective against 0.3 micron sized particles and free of any leaks discernible by this method. Those that are not are repaired and retested. Testing also includes making sure that the junctions of the filter
medium and framework must be completely free of leaks. This testing also includes checking the seal around the filter itself. Should damage occur to the filters or if after replacement, defects are found in new filters, these defects can be repaired. This requires sealing with such materials as RTV (Room Temperature Vulcanizing) silicone or preferably Elmer’s glue (commercial white glue).

Commercial organizations with proper equipment and personnel are available in most areas of the world for testing and servicing. If you need GERMFREE to refer one of these agencies, please contact the factory.

II. Changing Filter on RadioSafe Biological Safety Cabinets
A. Removal
1) Remove the screws around the cover located on the top.
2) Remove top.
3) Remove exterior collar on top of exhaust (smaller) filter.
4) Remove exhaust filter and place in large bag for incineration.
5) Unplug or disconnect wires from the motor.
6) Remove all four nuts and hold-down bars from top of aluminum plenum housing.
7) Lift out motor and plenum together.
8) Lift out supply filter and bag for incineration.

B. Installation Supply Filter
1) Remove from shipping carton and examine for possible damage.
2) Fill grooves of multigrooved bottom gasket with silicone grease (can or jar supplied).
3) Lower into cabinet making sure that the arrow and the silicone filled gasket is facing down.
4) Reassemble using reverse procedures to Section A above.

C. Installation Exhaust Filter
1) Examine for possible damage.
2) Fill both multigrooved gaskets (on both top and bottom for exhaust filter) with silicone grease and replace making sure the arrow on the side is pointing upward.
3) Replace the connecting collar on top of the filter.
4) Reconnect motor and speed control.
5) Replace all top screws and tighten securely.
GERMFREE

- 20mm lead shielding
- Sliding lead shield
- Optional Dose Calibrator
- Optional lead-lined Generator and storage cabinet, 1” lead lined.
Line Drawings (With optional Dose Calibrator)

BBF4 - Pb

Line Drawings (Standard Configuration Models)
HEPA Filters

<table>
<thead>
<tr>
<th></th>
<th>Supply</th>
<th>Exhaust</th>
</tr>
</thead>
<tbody>
<tr>
<td>BBF 2-RX</td>
<td>20&quot; x 20&quot; x 3&quot;</td>
<td>18&quot; x 8&quot; x 6&quot;</td>
</tr>
<tr>
<td>BBF 3, BBF 3-RX</td>
<td>20&quot; x 34&quot; x 6&quot;</td>
<td>18&quot; x 12&quot; x 6&quot;</td>
</tr>
<tr>
<td>BBF 4, BBF 4-RX</td>
<td>20&quot; x 46&quot; x 6&quot;</td>
<td>18&quot; x 16&quot; x 6&quot;</td>
</tr>
<tr>
<td>BBF 6, BBF 6-RX</td>
<td>20&quot; x 70&quot; x 6&quot;</td>
<td>2 @ 18&quot; x 16&quot; x 6&quot;</td>
</tr>
</tbody>
</table>

Blowers

9.7 DD All BBF 2-RX, BBF 3, BBF 4, BBF 6,

Viewing Panel

- BBF-2VPC For all 2’ Chemo 24 models, Acrylic plastic
- BBF-2VP For all 2’ benchtop models, Acrylic plastic
- BBF-3VP For all 3’ benchtop models, Acrylic plastic
- BBF-4VP For all 4’ benchtop models, Acrylic plastic
- BBF-6VP For all 6’ benchtop models, Acrylic plastic

Motor

For BBF 2, BBF 3, BBF 4 1/3 hp, 1625 rpm, 5.7 amps Fasco # 7124-1126-1/2;

For All BBF 6 1/2 hp, 1625 rpm, 4.6 amps Fasco # 7124-1125-1/3

Capacitor 7.5 □ F, 370 VAC UL Approved AERVOX PART # P50G3707YJ6

Switches 10A-250 vac. 12A-125 vac. UL Approved CARLING SWITCH PART # T1GA21-6S-BL-NBL

Motor Speed Control 15 AMP 115V UL Approved KB ELECTRONICS PART # KBMC 115NS
**Circuit Breaker**
UL & CSA Approved
POTTER & BROOMFIELD PART # W58-XB1A4A-XX
XX = RATED AMPS

**Duplex Electrical Outlet**
15A-15V UL APPROVED
LEVINGTON PART # 5320-I

**Fluorescent Ballast**
Advance Transformer Ballast #1CN-2P32-SC35M

**Fluorescent Tubes**
- 2 Ft: F-17T8/841
- 3 Ft: F-25T8/741
- 4,6 & 8 Ft: 32T8/741

**Fluorescent Lamp Holders**
660W 600V UL Approved
LEVINGTON PART # 13057 UN

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**BBF SERIES 220V**

<table>
<thead>
<tr>
<th>HEPA FILTERS:</th>
<th>SUPPLY</th>
<th>EXHAUST</th>
</tr>
</thead>
<tbody>
<tr>
<td>BBF 2SS</td>
<td>20” x 20” x 3”</td>
<td>8” x 18” x 6”</td>
</tr>
<tr>
<td>BBF 3 SS</td>
<td>20” x 34” x 6”</td>
<td>12” x 18” x 6”</td>
</tr>
<tr>
<td>BBF 4SS</td>
<td>20” x 46” x 6”</td>
<td>16” x 18” x 6”</td>
</tr>
<tr>
<td>BBF 6 SS</td>
<td>20” x 70” x 6”</td>
<td>2@16” x 18” x 6”</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ULPA FILTERS:</th>
<th>SUPPLY</th>
<th>EXHAUST</th>
</tr>
</thead>
<tbody>
<tr>
<td>BBF 4 SS</td>
<td>20” x 46” x 6”</td>
<td>16” x 18” x 6”</td>
</tr>
<tr>
<td>BBF 5 SS</td>
<td>20” x 58” x 6”</td>
<td>18” x 24” x 6”</td>
</tr>
<tr>
<td>BBF 6 SS</td>
<td>20” x 70” x 6”</td>
<td>2@16” x 18” x 6”</td>
</tr>
</tbody>
</table>

**MOTOR:**
½ H.P., 1425 RPM., 50 Hz, 2.4 AMPS
FASCO # 7124-1177

**CAPACITOR:**
5 F, 370 VAC UL Approved
GE # 6X653D

**BLOWER:**
Direct Drive, forward curved
LAU Industries # DD97 AT

**SPEED CONTROL:**
15 AMP, 220 VOLT, 240 VAC (UL approved)
KB Electronics # KBWC 215NS

**ELECTRICAL CONNECTORS:**
Camlock — male — 4 pole
Empire products # 5000110-10
Camlock — female — 4 pole
Empire products # 5000110-628

**SWITCHES:**
Carling Switch # LRGSEK221-C-G-B-E/125N
UV Switch — Marquadt #
Rocker — Series 1839-1407 Double pole center OFF

**CIRCUIT BREAKERS:**
5 AMP, 250 VAC max. 50 Vdc max
AMF Potter & Brumfield # W58-XB1A4A-5

**SOUND ALARM:**
30-250V Projects Unlimited # AI-384K

**SENSOCON DIGITAL GAUGE:**
0-2” water gauge
Dwyer Instruments # 2002

**LIGHTING:**
Fluorescent Bulbs
GE # FF20T12-CW, GE # F40CW-RS-WM or
Phillips # F30TP/CW/RS

Ultrasound Bulbs
Bulb Direct # G15T8 Code 11078

Ballast-Fluorescent
Magnetek # 673-L, 544-L-TC or 437-L-TC-P

Ballast-Ultraviolet, 220 volt, rapid start
Advance Transformer # XM-2SP20-TP

Lamp Holder
Leviton # 13357-N
Jones Plug (UL approved)
Male — Beau # P-3302-CCT
Female — Beau # P-3302-CCT

POWER CORD:
10 foot grounded
SJT Cable # 14/3