CETA

TROUBLESHOOTING GUIDE ON

Laminar Flow Biological Safety Cabinets

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Laminar Flow Biological Safety Cabinets

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SECTION i

INTRODUCTION

Whether verbal or written, dissemination of information is the absolute foundation upon which the Controlled Environment Testing Association (CETA) was founded. The sharing of information is what CETA believes will enhance the overall integrity and quality of our testing and certification industry. To that end, the Association would request and encourage all that use this guide to please make comments, supply additional observations or even challenge the information contained herein.

From inception, the purpose of this guide has been to facilitate the troubleshooting of Class II biological safety cabinets. The information contained in this guide can also be applied to other types of laminar flow equipment.

This troubleshooting guide along with NSF *International* Standard #49 and the manufacturer's owners manuals will provide help to all technicians in the field insuring that the best possible information is always available. As the sophistication of the biological safety cabinet increases the importance of continuing education and the continual updating of this manual will become more apparent.

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ACKNOWLEDGMENTS

The Controlled Environment Testing Association (CETA) would like to thank Mr. Jim Wagner, President of Micro-Clean, Inc. of Bethlehem, Pennsylvania, for donating the entire manuscripts of his company's troubleshooting guide, which became the core of information for the text of this troubleshooting guide.

Mr. Michael Regits, the original author, provided a list of individuals responsible for the first manuscript and CETA would like to continue recognizing those individuals and companies and the information and materials they supplied.

- Advance Transformer Company; Rosemont, Illinois: "Pocket Guide to Fluorescent Lamp Ballasts."
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- Germfree Laboratories; Miami, Florida: Jeff Serle
- Harvard School of Public Health; Boston, Massachusetts: student manual "Certification of Class II Biological Safety Cabinets"
- Institute of Environmental Sciences; Mount Prospect, Illinois: "IES Recommended Practices"
- Merck & Co.; West Point, Pennsylvania: Jamie Walcroft
- NuAire, Inc.; Plymouth, Minnesota: Bill Peters and Walt Johnson

This Troubleshooting Guide is just one example of what industry professionals can successfully produce when working together for the good of the industry as a whole. Such an accomplishment is what the Controlled Environment Testing Association (CETA) represents and aspires to achieve.

SECTION 1

FILTER INTEGRITY

Filter integrity testing is the most important test in the certification of a biological safety cabinet (BSC). Should a High Efficiency Particulate Air (HEPA) filter leak, then the entire bio-containment is compromised. A small leak in a HEPA filter, sometimes called a pinhole leak, is a 0.01% bypass of the upstream concentration. To understand HEPA filter integrity better, a technician must understand some basic information in the construction of HEPA filters and testing done by the filter manufacturer at the factory.

Defining HEPA Filters

HEPA filters are manufactured according to the guidelines published in the latest version of the *Institute of Environmental Sciences Recommended Practice HEPA and ULPA Filters.* Two minimum criteria must be met for a filter to be classified as a HEPA:

- The filter must be 99.97% efficient at removing 0.3 micron-sized particulate. A filter meeting only this criterion would be considered industrial grade or type A.
- The filter must not exceed a pressure drop across the filter of 1 inch of water column (WC) when operated at rated airflow. Rated airflow represents the volume of air a filter is designed to successfully remove particulate, according to the manufacturer's disclosure.

Efficiency vs. Scan Testing

HEPA filters are tested by two very different methods: efficiency tests and scan tests.

Efficiency tests measure the percent penetration of monodispersed dioctylphthalate (hot DOP). In this test, the presence of pinholes or small leaks is not a concern if the overall efficiency of 99.97% is maintained, depending on the filter type. This test requires a penetrometer and is performed at the factory.

Factories also scan test some types of HEPA filters, such as a type C filter (sometimes called "probed" or "scanned"), which are tested with polydispersed dioctylphthalate (cold DOP or a recognized substitute) as a check for pinholes and small leaks. This test scans the entire face of the filter with a photometer at a rate not to exceed 2 inches per second. This grade of filter is then considered to be pinhole-free and is reported to have an overall efficiency sufficient test to be rated as 99.99% effective. Only the scanned (or sometimes called probed) Type C HEPA filters should be used in areas of biological containment such as biological safety cabinets.

HEPA Filter Types

HEPA filters are classified into six performance types: A, B, C, D, E, and F filters. All types come in a variety of sizes and configurations.

The following is a breakdown of the types of filters:

- Type A: Efficiency test only of equal to or greater than 99.97% efficiency on 0.3 micron particles at rated airflow.
- Type B: Efficiency test only of equal to or greater than 99.97% efficiency on 0.3 micron particles at both 20% and 100% of rated flow.
- Type C: Efficiency test and scan test equal to or greater than 99.99% on 0.3 micron particles and no pinhole leaks greater than 0.01%.
- Type D: Efficiency test equal to or greater than 99.999% on 0.3 micron particles and no filter area flaws or pinhole leaks greater than 0.01% with the scan tests.
- Type E: Tested according to MIL-F-51477 or MIL-F-51068 to meet Nuclear Regulatory Commission (NRC) guidelines.
- Type F: Efficiency test according to IES-RP-CC-007 and scan test using a particle counter, equal to or greater than 99.999% on 0.1 to 0.2 micron size particles and no filter flaws or pinhole leaks greater than 0.001%.

For HEPA filter types A, B, C, and E, pressure drop across the filter will be no greater than 1 inch WC at rated capacity. For type D and F filters, the pressure drop is usually determined by the buyer and seller.

HEPA Filter Construction

Filter media is arranged in filter frames in a variety of ways. The HEPA filters in a biological safety cabinet may have one of two different styles. Most common is the separator style filter pack where the filter medium is folded between corrugated aluminum separators (or paper separators in some very old filters). The separators support the medium and promote airflow by keeping the media separated. (see figure 1.1) Filters with separators are usually easy to repair when they leak.

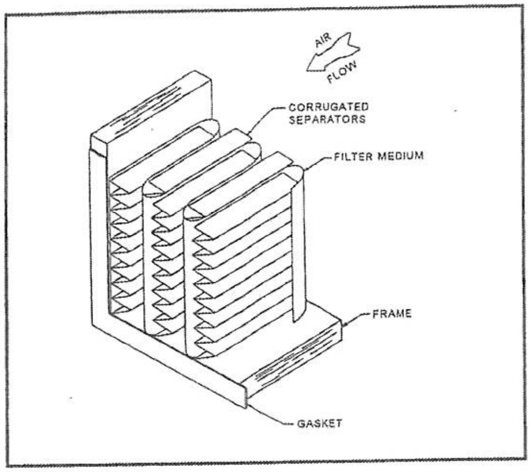


Figure 1.1 Separator

The second style, the minipleat, which is constructed without the aluminum separators, is the second style of filter pack. The minipleat filter is made with closely pleated folds of filter media with a center ribbon or glue-coated string used to support and separate the filter pleats. Filters that use glue-coated strings as separators are more difficult to repair because of the tightness between each pleat. (see figure 1.2)

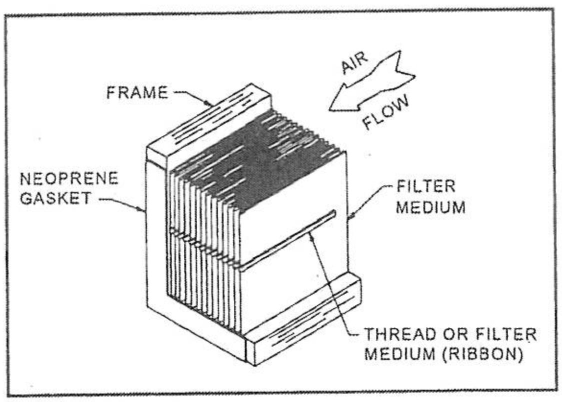


Figure 1.2 Minipleat w/o Separators

These figures are reprinted with permission from the Institute of Environmental Sciences' Recommended Practices document IES-CC-RP001.3 HEPA and ULPA Filters.

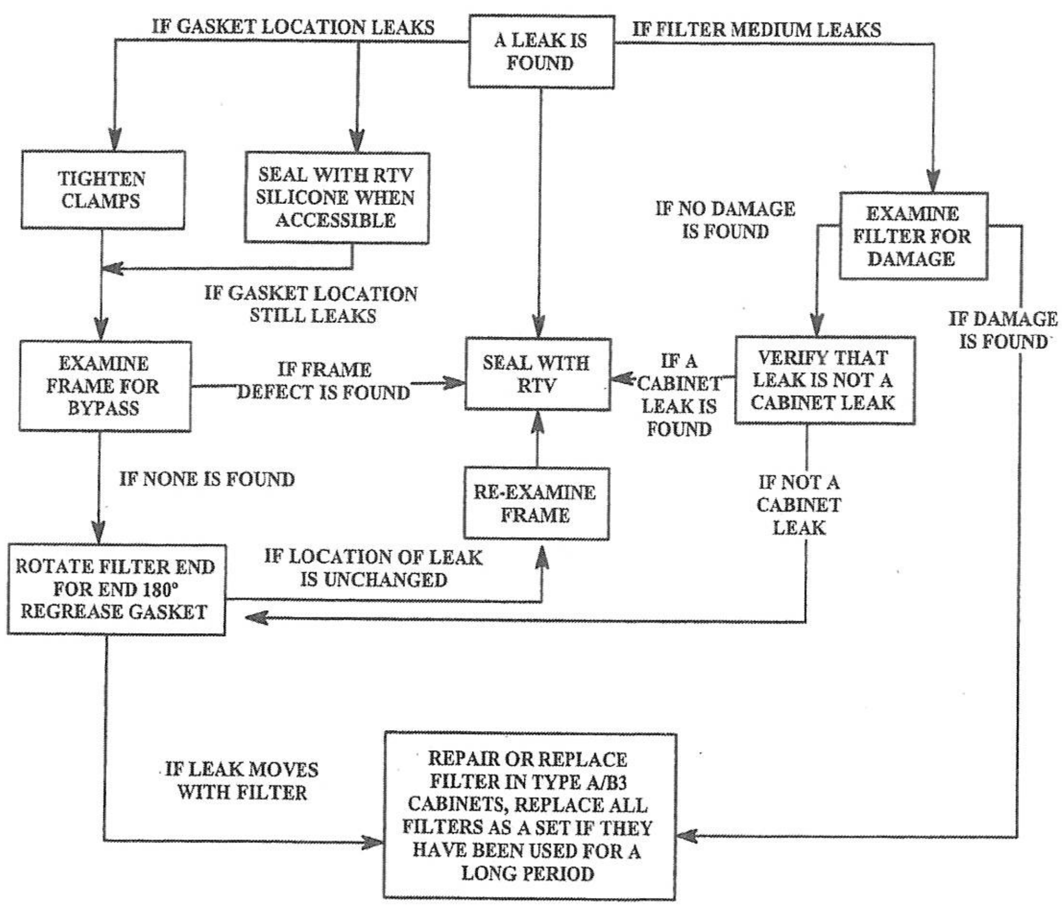
Troubleshooting

A HEPA filter leak in a BSC is usually attributed to holes or imperfections either in the filter medium or inadequate sealing between filter gasket and cabinet frame, or leaks in the cabinet housing that bypasses the HEPA filter. Depending on the nature and location, repairing a leak in a HEPA filter can be either simple and quick, or it can be a very difficult task.

During the technician's initial certification of the BSC, any of the above three leaks can be present as a direct result of shipping and/or installation of the BSC. When recertifying BSCs that are in use, typically the types of leaks found are gasket leakage as a result of the filter age or physical damage to the media of the HEPA, sometimes obvious to the naked eye, caused by personnel using the BSC.

See figure 1.3 for a flow diagram for troubleshooting and repairing filter leaks in uncontaminated filters.

Figure 1.3: Filter Leak Isolation Procedure



Note: Patches shall not exceed 5% of the face area. The maximum width of any one patch shall not exceed 1.5 inches.

NOTE: If the cabinet has been in service with hazardous materials, the BSC should be decontaminated, appropriate precautions should be taken, and/or proper personal protective equipment should be donned before performing any step that requires removing access panels to the internal plenums or filter compartments.

Seal leaks in the filter media or filter gaskets with RTV silicon compound. RTV can be applied using a caulking gun, a squeeze tube, or even a syringe and is forced into the filter structure to seal the bypass area. This method is particularly good to use when the leaking area is visible. Self-leveling RTV (sometimes called filter glue) is used when the leak is believed to be out of the technician's view of the filter pack (not near either face), and is "poured in" to reach the suspected area. The importance of sufficient curing time when using self-leveling RTV cannot be overstated. This is a time-consuming procedure typically performed by the filter manufacturer. Generally, the smallest dimension of a patch should be no more than 1.5 inches and the total aggregate area patched should not exceed 5% of the filter face area as per NSF Standard 49 paragraph 4.19.6.

Beware of background or induction leakage giving a false reading when testing the exhaust HEPA filters. If the background slowly increases, then consider possible test equipment leakage, such as the generator delivery hose falling out of the BSC while testing, or the safety cabinet's integrity.

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SECTION 2

AIRFLOW RATES AND PROPER BALANCE

As a biological safety cabinet (BSC) is used, the cabinet HEPA filters may slowly build up with particulate, resulting in an increase in resistance across the filter and a decrease in airflow. As a result, a BSC may require an airflow adjustment in order to bring downflow (supply) velocities and inflow (face) velocities within the manufacturers specified airflow range.

Additionally, if BSC's are connected to building exhaust systems, balancing a cabinet is always challenging because of the unpredictable nature of the house exhaust systems. Type B1, B2, and B3 cabinets will have separate exhaust blowers that must also be adjusted periodically so that each BSC will again provide the proper exhaust airflow.

Testing personnel will encounter many varying situations that they must be prepared to handle. For example:

- There are four different types of BSC's (A, B1, B2, and B3).
- Each manufacturer will build their cabinet a little differently.
- There are several different ways to connect a cabinet to building exhaust (canopy, thimble, or hard duct connections).

Preparation

NOTE: If the cabinet has been used for pathogenic materials and the damper is upstream of the exhaust filter, then the BSC should be decontaminated according to NSF *International* Standard #49 *(Appendix G) before the damper access port is removed and the damper adjustment made.*

Before beginning, make sure that all test equipment is functioning properly; otherwise invalid airflow readings may result.

If there is no factory issued test report for the BSC being tested, then the manufacturer should be called and given the cabinet's model and serial number. All manufacturers will provide the exhaust volume static requirements for the cabinet either by fax or phone .

New Installations

The most common problem in new installations with ducted biological safety cabinets is inadequate exhaust volumes, which commonly result from improperly-sized fans. When sizing an exhaust fan, it is important to remember that the volume of air to be removed must take into account all of the static pressure of the entire exhaust system. Not only must the blower be rated for the design volume and static, but consider ation must also be given to static losses in the ductwork and the biological safety cabinet itself.

Type A/B3 BSCs Connected to Building Exhaust

A/B3 cabinets differ from B1 and B2 in that their internal blower pushes air out of the cabinet. The auxiliary exhaust blower in the building exhaust system helps by pulling the exhaust air from the BSC through the system, and therefore must be carefully balanced with the cabinet blower.

Preliminary Airflow Test: For ducted Type A/B3 cabinets, balancing airflow may be helped by monitoring the negative static pressure in the exhaust duct or at the thimble or canopy openings. The static pressure within these zones is ideally around negative (suction) 0.03 inches WC. This low negative pressure can be considered an elementary and initial indication that the exhaust volume leaving through the ductwork is not adversely affected by the building exhaust. Excessive positive or negative pressures are also possible indicators of improper airflow volumes.

Type A/B3 cabinets with only one blower available for adjustment, may also require adjustment of internal dampers to achieve proper air balance. Typically, this internal damper is located upstream of the exhaust filter (inside the cabinet) and must be either opened or closed to properly balance supply and exhaust volumes (velocities).

Type A/B3 units without adjustable exhaust dampers may require a matched set of filters to maintain proper air balance. Matched could mean that both filters are new (equal pressure drop), or possibly that one of the filters is a "super flow" HEPA (rated with a higher airflow/lower pressure drop than normal) or some equivalent design. Proper selection of replacement HEPA filters in this situation can be determined from the air flow resistance figures on the filter housing or by a specific request to the manufacturer of the BSC. It is generally necessary to change both supply and exhaust filters in a type A/B3 cabinet at the same time if the cabinet has been in service for some time and the cabinet has only one blower with a common plenum to both exhaust and supply filters.

Type B1 and B2

Preliminary Airflow Test: Type B1 and B2 cabinets are always ducted to the outside atmosphere and their exhaust duct static is typically around negative one inch WC with clean HEPA filters. The negative one inch is a nominal number. It may be lower or higher, depending on the size of the filter and the volume of air through the exhaust HEPA. The filter's age can influence the duct static as a result of loading.

If there is insufficient exhaust, then the static pressure in the duct should be checked first. If the static pressure is adequate, then check the cabinet balance to be sure the internal blowers are operating correctly. If the BSC air balance is correct, then check the filters for loading. If the filters are loaded, they will need to be changed. If the static pressure is not acceptable, then find the problem with the building exhaust and correct it, which is sometimes as simple as an adjustment of a damper.

Type B cabinets require exhaust volume adjustments via external exhaust fan speeds, exhaust fan sheave adjustments, or exhaust damper adjustments. It cannot be emphasized enough that certifying technicians must have a thorough understanding of how the building exhaust operates and how it can affect the BSC prior to set up, balance, and final adjustment to airflow volumes and velocities. Testing personnel must understand in-line pneumatic, mechanical, and/or electronic exhaust dampering devices and how they work to properly balance exhaust air. Understanding compatibility, set up calibration procedures, and other adjustments may be a joint effort between the testing personnel and equipment supplier to reach successful certification. Self education and communication is a must to eliminate downtime to the end user.

Older Models

Some older cabinet models have perforated grills on either the exhaust or supply filters in order to obtain a sufficient air balance. These perforated grills may require periodic cleaning to permit proper airflow for achieving proper air balance.

Additional Information

Table 2.1 on this page and on page 14 lists a number of problem areas and corrective actions and is broken down by type of cabinet.

Table 2.1: Corrective Action for Improper Airflow and Balance
(continued on next page)

Class II Type A

Observation		*Corrective Action*
Inflow velocity low	Downflow velocity okay	6, 11
Inflow velocity low	Downflow velocity low	1, 2, 9, 11
Inflow velocity low	Downflow velocity high	5, 7, 8, 11
Inflow velocity okay	Downflow velocity low	1, 2, 6, 9
Inflow velocity okay	Downflow velocity high	7, 8
Inflow velocity high	Downflow velocity okay	7, 10
Inflow velocity high	Downflow velocity low	7, 9, 10
Inflow velocity high	Downflow velocity high	3, 4, 8, 10

Class II Type B1

Observation		*Corrective Action*
Inflow velocity low	Downflow velocity okay	13
Inflow velocity low	Downflow velocity low	1, 2, 13
Inflow velocity low	Downflow velocity high	3, 13
Inflow velocity okay	Downflow velocity low	1, 2
Inflow velocity okay	Downflow velocity high	3
Inflow velocity high	Downflow velocity okay	12
Inflow velocity high	Downflow velocity low	1, 2, 12
Inflow velocity high	Downflow velocity high	3, 12

Table 2.1: Corrective Action for Improper Airflow and Balance (continued from page 13)

Class II Type B2

Observation		Corrective Action
Inflow velocity low	Downflow velocity okay	13
Inflow velocity low	Downflow velocity low	1, 2, 13
Inflow velocity low	Downflow velocity high	3, 13
Inflow velocity okay	Downflow velocity low	1, 2
Inflow velocity okay	Downflow velocity high	3
Inflow velocity high	Downflow velocity okay	12
Inflow velocity high	Downflow velocity low	1, 2, 12
Inflow velocity high	Downflow velocity high	3, 12

Class II Type B3

Observation		Corrective Action
Inflow velocity low	Downflow velocity okay	1, 6, 13
Inflow velocity low	Downflow velocity low	1, 2, 9, 13
Inflow velocity low	Downflow velocity high	8, 13
Inflow velocity okay	Downflow velocity low	1, 2, 6, 9
Inflow velocity okay	Downflow velocity high	3, 7, 8
Inflow velocity high	Downflow velocity okay	12
Inflow velocity high	Downflow velocity low	1, 2, 9, 12
Inflow velocity high	Downflow velocity high	3, 4, 8, 12

Corrective Actions

1. Increase cabinet blower speed—if at maximum and filter differential pressure is high, then replace filter(s).
2. Increase cabinet blower speed—if at maximum and filter differential pressure is low, then:
   - replace filter(s) (if applicable)
   - check blower boot (loose or defective)
   - check impeller for obstruction/debris
   - check motor voltage
   - check internal plenum bag

- check internal panel(s)
- If a two internal cabinet blower system—one blower/motor is bad
- If a two internal cabinet blower system—one blower is running

3. Decrease cabinet blower speed
   - if still high, then adjust speed control trim potentiometer
   - if speed control is unadjustable, see electrical troubleshoot section
4. Reset cabinet alarm.
5. Adjust internal damper.
6. Increase cabinet blower speed and/or adjust internal damper.
7. Decrease cabinet blower speed and/or adjust internal damper.
8. If a two blower system, then decrease downflow (supply) blower.
9. If a two blower system, then increase downflow (supply) blower.
10. If a two blower system, then decrease inflow (exhaust) blower.
11. If a two blower system, then increase inflow (exhaust) blower.
12. Decrease (in-house) facilities exhaust volume, i.e., fan speed, exhaust damper.
13. Increase (in-house) facilities exhaust volume, i.e., fan speed, exhaust damper. If a maximum capacity (100% damper position, 100% fan speed), check duct's negative static pressure if
    - static pressure is high, then replace filter(s)
    - static pressure is low, then there is inadequate exhaust capability

See *Section 8: Differential Pressure Gauges* starting on page 41 and *Section 10: Unique Troubleshooting Problems with Cabinets* starting on page 49 for possible scenarios and hints to troubleshooting while air balancing.

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SECTION 3

CABINET INTEGRITY

Soap bubble leak testing (SBLT) of biological safety cabinets can be a formidable task for a technician in the field. Not only are there the inherent difficulties of physically performing the test in a laboratory, but there are the compounding problems of user-friendly options on new model BSCs. These options include labor-free sliding sashes, large exhaust filter areas, and finally the customized designs (e.g., animal change units with disposal applications). This section discusses a few ideas that may alleviate some problems associated with SBLT.

The first problem often encountered relates to the location of the BSC within the facility. Most of the time, the BSC can not be moved easily to gain equal access to all sides. When such a situation occurs it may be necessary to do the leak test, according to NSF *International* Standard #49, by having the unit hold a pressure of 2 inches WC within ±10% for 30 minutes. A successful NSF pressure test may alleviate the need for movement of the BSC for the SBLT.

During the pressure test, a 2-inch magnehelic gauge is typically used to monitor the pressure in the BSC. Magnehelics are reliable and easy-to-read manometers for this application.

If the unit does not pass the NSF pressure hold test, then use the soap bubble test. This may require moving the cabinet and disconnecting any services such as compressed air, vacuum air, or natural gas.

If the NSF pressure hold test fails and the cabinet owner will not move the BSC for the soap bubble leak test, then have the owner sign a liability release for your protection.

Cabinet Preparation

NOTE: If hazardous material was used in the cabinet, the BSC should be decontaminated per NSF *International* Standard #49 *(Appendix G) before doing the leak test.*

In an ideal situation, the client has the foresight to install the BSC with access to all sides, easy-to-disconnect utilities, and a gas tight damper for the exhaust. When this is the case, the SBLT can be completed in a short time without moving the BSC. Most manufacturers provide gas tight exhaust dampers that may be used to seal the exhaust portion of the BSC.

In many situations, however, the unit must be moved to achieve a successful SBLT. Begin by making arrangements to move the BSC out and away from the walls to allow physical access to test each weld, gasket penetration, or seal. Easy-to-disconnect electrical and plumbing with shut-off valves should be part of any system where pressure testing will be done, although this is rarely the case. When exhaust connections are ducted to the outside, recommend an easily removable transition connection to the client.

When performing the leak test, remove all cosmetic panels, light canopies, and other items not associated with the primary walls before the testing.

If the BSC cannot be properly prepared for testing and the client insists on performing the SBLT, then the technician should be prepared for potential legal liabilities regarding any improperly tested unit.

Sealing Cabinets

A proper cabinet seal is most difficult and critical aspect of cabinet leak testing. Ideally, if one could combine solid panels for the intake opening and exhaust HEPA filter with a roll of duct tape and a few clamps (as it is tested at the factory), the SBLT would be much easier to do. Almost limitless varieties of intake and exhaust areas among manufacturers and different models make this impractical and, therefore, one must use plastic and tape to seal the openings to the BSC.

First place two rows of double-sided tape (carpet tape) around the perimeter of the BSC opening, dove-tailing the corners to ensure a continuous seal. All surfaces to be taped should be wiped with acetone or 70% alcohol to clean all oils and foreign materials from the surfaces that could inhibit good adhesion. A 10% ammonia water solution works well also.

Next, install the plastic film. An ideal thickness for the plastic thickness is 8 mils. Begin with the plastic rolled up. Start at one side of the BSC opening and roll the plastic across the opening without stretching and forming air pockets or kinks at the tape. Then trim the plastic to just cover the double-sided tape. Finish the seal by using duct tape to tape over the outside edges of the trimmed plastic to the BSC opening. This method is very successful.

Technicians at the Micro-Clean Tech Center in Philadelphia sealed a Class II type A BSC in the above manner. They pressurized the cabinet to 15.1 inches WC before the top left corner of the taped seal failed.

If a BSC leaks so much that the ±10% cannot be maintained, it may become necessary to pressurize the BSC continually with a high volume blower or com-pressed air source. A bleeder valve at the air supply is recommended to maintain a constant 2 inches of pressure in the BSC. On almost all BSCs, the compressed air source can be introduced at the drain valve, which also offers the ability to regulate the incoming pressure. However, a bleeder valve must be in-line to prevent the air compressor from cycling and overheating.

Conducting the Test

The viscosity of the soap bubble solution is very important. Therefore technicians should purchase off-the-shelf solutions, such as "Snoop," instead of develop-ing solutions independently.

If the solution is applied with a brush, it is less likely that a large leak could go unnoticed because of the applied solution being blown out too quickly. The dragging motion of a brush across the seams applies a coat of bubble solution that should reveal all leaks.

Once leaks are found, corrective action involves physical and mechanical sealing, such as tightening access panel nuts and tightening/sealing all penetrations (e.g., electrical, pneumatic, challenge ports, and damper ports).

When the gasket welds and joints are repaired, replace the hood on its final resting spot and retest the hood using the NSF pressure hold test.

The above conditions and recommendations also apply to halogen leak testing.

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SECTION 4

NOISE AND VIBRATION

Observation	Probable Cause	Corrective Action
1. Scraping noise	a. Blower impeller rubs on housing b. Foreign material in an impeller	a. Loosen, center, or tighten impeller setscrews. b. Remove foreign material from blower casing or impeller.
2. Whistling noise	Loose or torn blower boot	Repair or replace blower boot.
3. Fluttering noise	a. Foreign material in an impeller b. Foreign material in the filter plenum c. Loose or torn blower boot	a. Remove foreign material. b. Remove foreign material. c. Repair or replace blower boot.
4. Work surface vibration	a. Foreign material in an impeller. b. Unbalanced impeller c. Loose stiffener on the work surface.	a. Remove foreign material. b. Replace the impeller. c. Repair or replace the work surface (i.e., broken weld).
5. Whining noise, particularly at startup	Worn motor bearings	Replace the motor.

Table 4.1: Corrective Action for Noise and Vibration

Table 4.1 lists noise and vibration problems, probable causes, and possible corrective actions.

NOTE: If the cabinet has been used for work with hazardous materials, and the correction requires access to the blower compartment for removal of debris, it should be decontaminated according to NSF *International* Standard #49 *(Appendix G) before performing any step that requires removing access panels to the internal plenums and/or filter compartments.*

If foreign material is in the blower impeller and is accessible by lifting the work surface and removing the foreign material with long tongs, then decontamination may not be necessary, if proper personnel protection equipment is donned. Any retrieved foreign material should be considered contaminated and therefore be bagged for autoclaving or placed in a tray of disinfectant for proper disposal. The tongs (or whatever device is used for retrieval) should be surface decontaminated as a minimum.

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SECTION 5

MOTOR AND SPEED CONTROLLER SYSTEMS

Generally, when a biological safety cabinet does not operate, there is an electrical component failure. Before assuming this, a technician must verify that the BSC's apparent failure to operate is not the result of the manufacturer's installed fail-safe. It is a difficult task, but a technician must be familiar with all makes and models of BSCs because of their various safety mechanisms.

In some BSC's, when the downflow motor/blower senses a loss in exhaust flow (Class II Type B2) it will automatically shut down as a safety precaution, creating the appearance of an electrical problem. Some cabinet manufacturers also incorporate sash switches in their cabinets that, when raised or lowered, shuts down the internal motor/blower. Combinations of two motor/blowers, one for inflow and one for downflow, may be interlocked to protect the user from a positive flow when opening the BSC. The technician must verify that both motor/blowers are operational and not in fail-safe. Cabinets ducted to the outside atmosphere have many alarms to monitor exhaust flow. Monitoring duct pressure or duct flow may help in troubleshooting and/or maintenance of the exhausted BSC.

Therefore, first verify that the sash is in the correct position. Next, check that the in-house exhaust system operates within the cabinet manufacturer's specifications, and that all alarms are set and functioning properly. If everything is set up to the cabinet's design requirements and the cabinet still does not operate, then the technician should continue with electrical troubleshooting.

Normally the speed control for the motor/blower is at fault, but the technician should follow a planned and structured troubleshooting procedure to reduce the probability of changing the wrong parts. See the troubleshooting tables later in this section.

CAUTION: Before performing maintenance on electrical circuits, the technician should first verify the correct wiring of the outlet into which the BSC is plugged and verify that neutral bus is at ground potential.

The technician's next step is to understand the electrical circuitry of the BSC. Motor and speed control troubleshooting involves taking point-to-point electrical readings, such as voltage, current, or resistance, along the wiring of the BSC. Studying the electrical drawing or schematic is important and they should be supplied either in the operators manual or inside the BSC. Highlighting the path of the circuit in question will help define more clearly the overall schematic and will help with viewing when the actual troubleshooting is done.

Test the speed control by bypassing the controller electrically, using alligator clips and wires, to see if the motor will start. Should the blower begin to cycle, the technician can safely assume that the trouble is in a faulty speed controller. On the other hand, should the blower still fail to start, one can assume that the speed controller is not the problem.

The two most common blower/motor failures result from age (worn bearings) and cooling restrictions on the motor created by dirt and dust build up on the motor housing, which causes overheating and thermal shutdown.

When entering the internal portion of any cabinet, the technician should perform decontamination or should wear proper personnel protection equipment. In case of motor failure, means should be provided (i.e., via the auxiliary blower) to circulate decontaminating gas throughout the cabinet. Contact time of the decontaminating gas should be increased to ensure an acceptable contact time.

Occasionally, a motor with the wrong speed (rpm) is used in a cabinet. For example, cabinets with 9-inch diameter blowers most often will use 1,625 rpm motors and not 1,075 rpm motors. Different models from the same manufacturer may use different motors with different speed and horsepower requirements; always contact the manufacturer if there is any doubt. If a technician uses a 1,075 rpm motor to replace the 1,625 rpm unit installed by the manufacturer, then the slower motor will not deliver sufficient air volume to operate the BSC properly. If the reverse should occur, a 1,625 rpm motor installed where a 1,075 rpm unit has been specified, the faster motor will usually cycle, overload, and respond with a thermal shutdown.

Since capacitors are an inexpensive component, use this rule of thumb: whenever the motor is replaced, the capacitor should be replaced also. The electrical failure of a BSC is seldom attributable to the capacitor malfunction. Always verify that the correct capacitor is used with the newly installed motor.

Once the suspect component is found, additional resistance (ohms) testing should be performed for verification. Once the technician verifies a component is defective, the defective part is replaced with the identical OEM, or a manufacturer's equivalent part.

If failure was caused by excessive current draw (i.e., a blown fuse is found), the technician should expect repeated failure and must determine the defective part causing the failure. Often the defective component may cause excessive current.

The final step is to measure the current draw on the circuit in question. If it is within acceptable limits, the technician may feel comfortable that the electrical problem has been resolved. Typical current draw (amps) for standard motors follow in table 5.1. below.

Table 5.1: Typical Current Draw for Standard Motors

Motor Size	RPM	Clean Filter Amp Range	Normal
1/3	1,075	5.50 - 6.5	5.4
1/3	1,625	3.6/4.7 - 5.2	4.6
1/4	1,625	4.5 - 5.0	4.5
1/2	1,075	5.5 - 8.0	7.6
1/2	1,625	5.7/9.5 - 10.5	9.9
3/4	1,050	7.5 - 10.0	9.0
3/4	1,075	7.5 - 10.0	9.0
3/4	1,625	7.5 - 10.0	9.0

NOTE: When measuring amps, verify that the motor in question is the only component on the circuit at the point of measurement.

NOTE: Clean filters have maximum current draw. As they load, the current draw decreases.

Table 5.2 is corrective action for defective motor/blower systems and must be used with figures 5.2, 5.3, and 5.4.

Table 5.2: Corrective Actions for Defective Motor/Blower Systems

Observation	Probable Cause	Corrective Action
1. The motor will not start.	See figure 5.2.	See figure 5.2.
2. The motor starts, but it will not run continuously.	a. See figure 5.3. b. Low line voltage.	a. See figure 5.3. b. Install a motor with more horsepower.
3. Motor runs smoothly at speed controller maximum; at lower settings, it goes "chug-chug."	Defective triac assembly.	Replace triac assembly.
4. Motor runs only at speed controller maximum setting; it will not run at any lower setting.	See figure 5.4.	See figure 5.4.
5. Motor runs at high speed despite speed controller setting or control range is limited.	Defective triac assembly or maladjusted trimmer pot* on triac PC board.	Readjust trimmer or replace triac assembly.
6. Motor runs only at speed controller settings above and below desired setting.	Defective potentiometer.	Replace potentiometer.

* A trimmer pot is a secondary pot typically located within the potentiometer. It is used to set minimum velocity or stall speed setting.

Figure 5.1: Basic Motor Wiring Schematics For ⅓ hp and ½ hp Motors With Triacs.

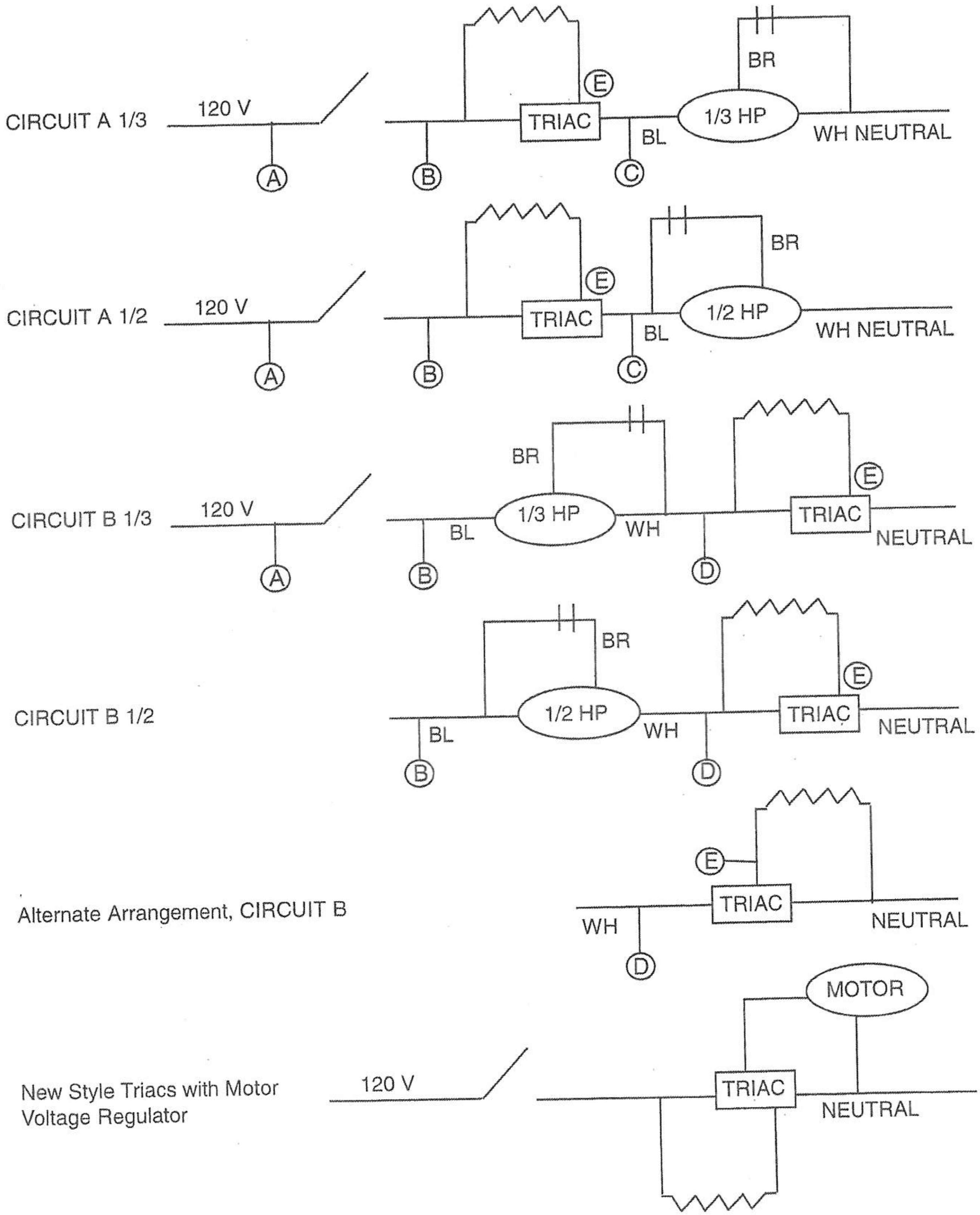


Figure 5.2: Troubleshooting Chart When Motor Does Not Start

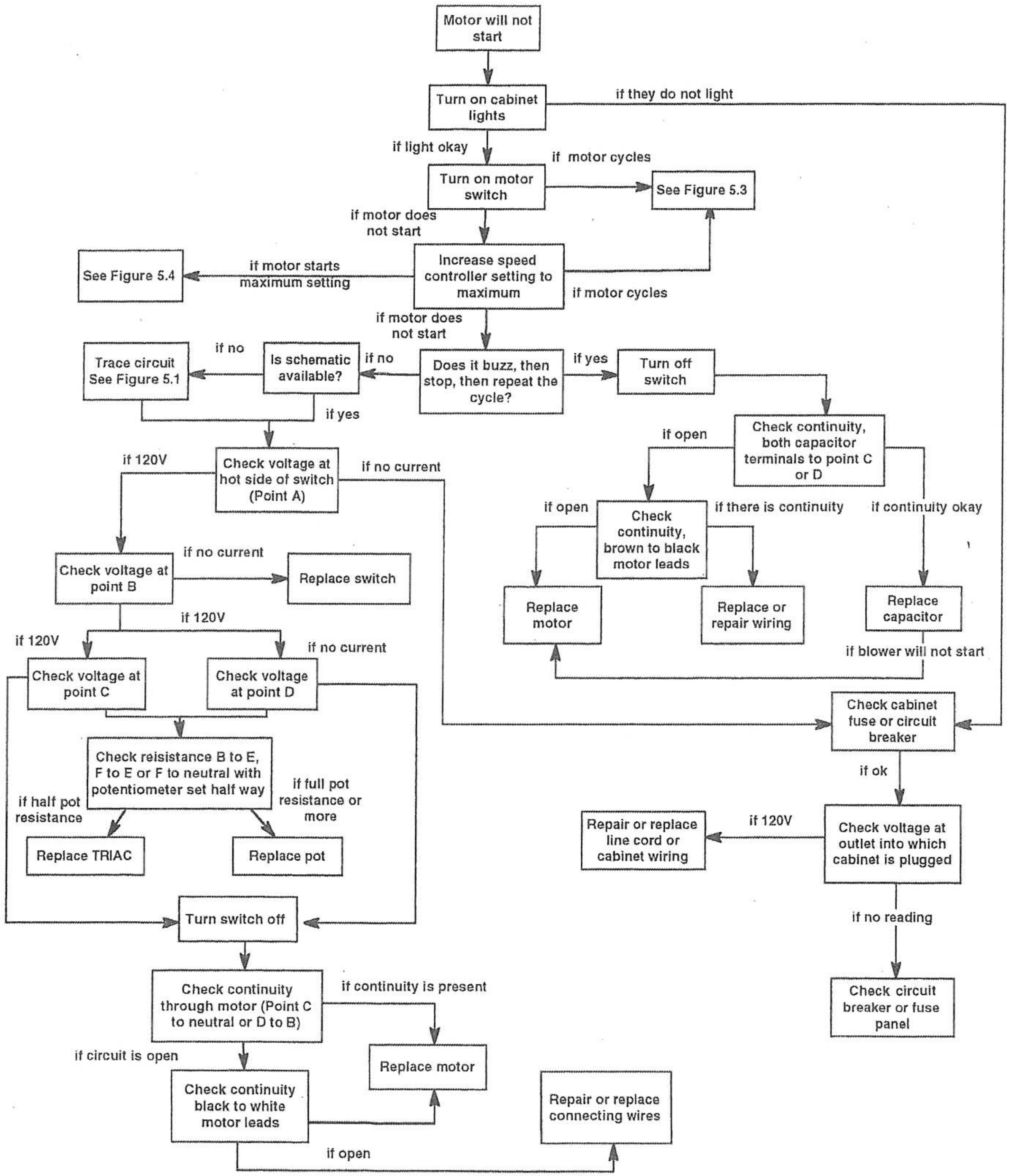
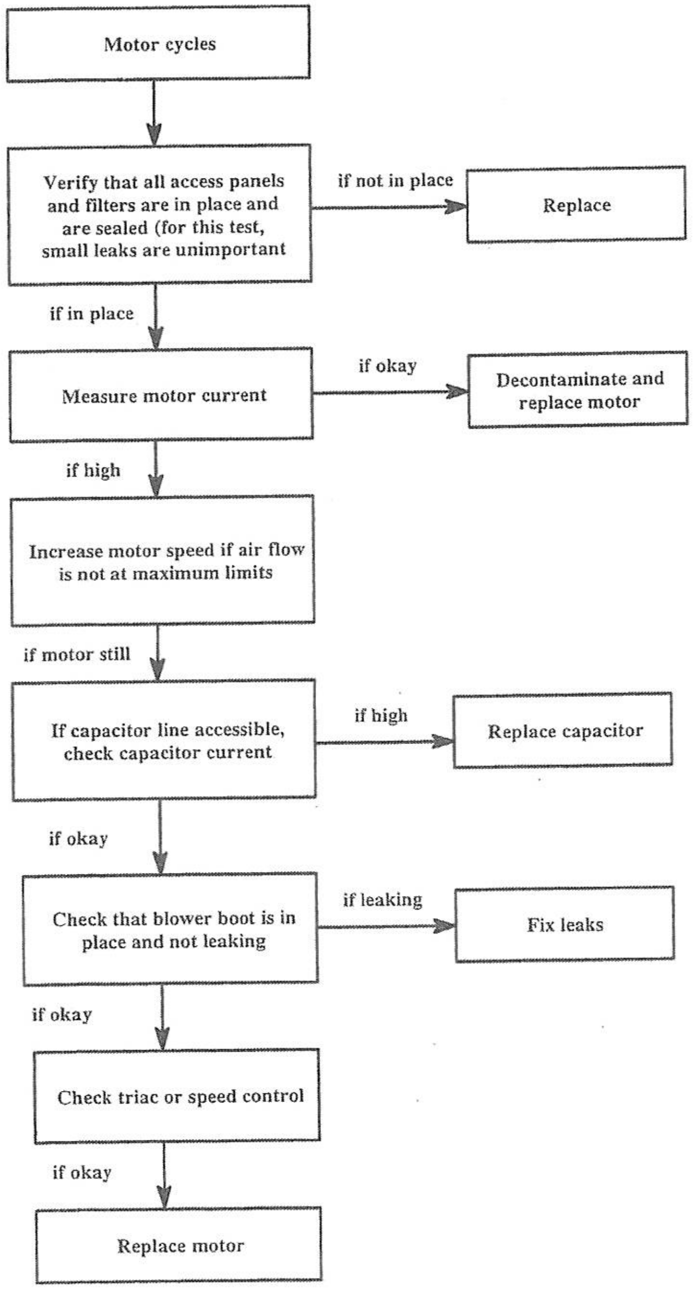
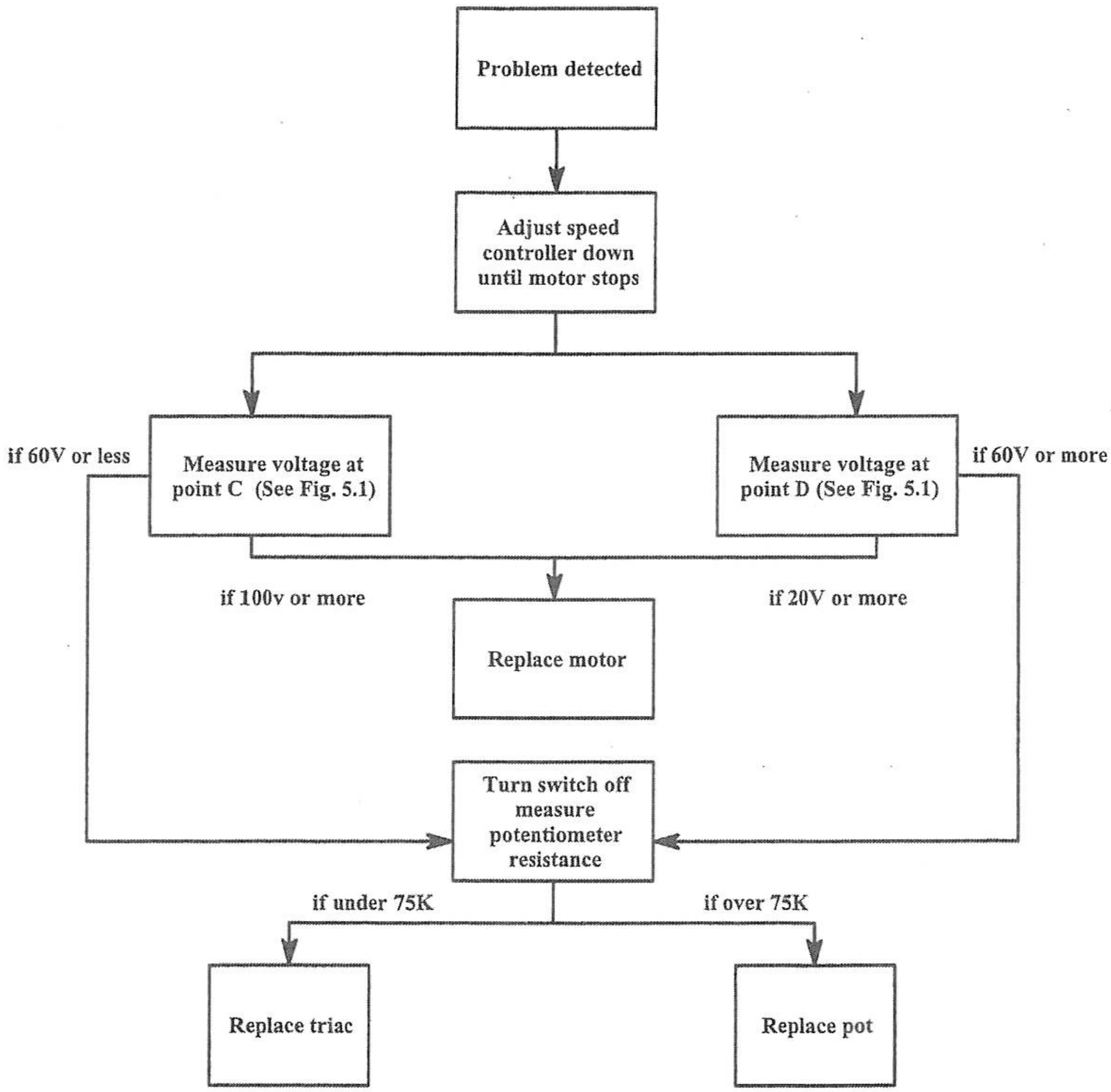


Figure 5.3: When Motor Cycles



Note: ⅓ hp motors normally overheat and cycle when motor current exceeds approximately 7 amps. ½ hp motors normally overheat and cycle when motor current exceeds approximately 10.5 amps. Capacitor current is normally under 1 amp.

Figure 5.4: Motor Only Runs When Speed Controller is at Maximum Setting.
(Traic Speed Controlled Only)



Refer to Manufacturer's schematic if above does not apply.

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SECTION 6

ULTRAVIOLET AND FLUORESCENT LIGHTING

This section is broken down into the components and types of circuits that the technician must understand successfully to troubleshoot ultraviolet and fluorescent lighting.

Components

Fluorescent Lamps—Fluorescent lamps more efficiently use energy to make light and operate at cooler temperatures than incandescent lamps. Since fluorescent lamps, unlike incandescent lamps, do not have a standard filament, their operation relies upon an electrical arc passing between two electrodes, one at each end of the lamp. The arc passes through a mixture of vaporized mercury and purified gases (usually neon and krypton or argon) within a glass tube lined with phosphorus. The result is the emission of ultraviolet light waves, which collide with the phosphorus coating to glow and emit white fluorescent light.

Ultraviolet Lamps—UV bulbs operate on the same principle as fluorescent bulbs. However, they do not have phosphorus coatings on the bulb walls, which are made of short-wave transmitting materials or quartz, not glass.

Both UV and fluorescent lamps are considered low pressure mercury vapor lamps.

Starter—The glow starter switch is a device that preheats the electrodes in the lamp tube to begin the desired chain reaction of the gases within the lamp.

Ballasts—Ballasts do three basic tasks:

1. They provide the properly elevated voltage to establish an arc between the two electrodes.

2. They regulate the electrical current that flows through the lamp to stabilize light output.

3. They compensate for voltage variations in the house electrical current.

There are two types of ballasts, the older electro-magnetic (core and oil) ballasts and the newer, elec-tronic ballasts.

Electromagnetic

The electromagnetic ballast consists of a core of steel laminations surrounded by two copper or aluminum coils. This assembly transforms electrical power into a form appropriate to start and regulate fluorescent lamps.

Another major component of most electromag-netic ballasts is a capacitor. The capacitor improves the ballast's efficiency to use energy. Electromagnetic ballasts equipped with capacitors are considered high power factor ballasts. The electromagnetic ballast must be designed with the proper number of core laminations and coiled windings to operate. In other words, an exact replacement part must be used.

Electronic

Electronic ballasts are formed by an entirely different technology than the electromagnetic ballast. Unlike the electromagnetic ballast's core of steel laminations encased by two copper or aluminum coils, in the electronic version electronic components control the starting and regulation of the fluorescent lamps. Today's electromagnetic ballasts operate at a voltage frequency of 60 hertz (Hz) or 60 cycles per second, which is the standard alternating current frequency available in the United States. Electronic ballasts convert this 60 Hz input to operate at frequencies between 20 and 60 kilohertz (kHz), 20,000-60,000 cycles per second, depending on the specific model.

Typically, electronic ballasts save 25% of energy over electromagnetic ballasts. Electronic ballasts are 75% quieter and do not have the humming noise of the electromagnetic ballasts. Additionally, electronic ballasts weigh half as much and operate 50° F to 85° F cooler than electromagnetic ballasts.

Circuits

The three major types of lighting system circuits in use today are rapid-start, preheat, and instant start (slim line). Each requires a special ballast design to operate UV or fluorescent lamps properly in the circuit.

I. Rapid-Start Circuit

Rapid start lamps use short, low voltage cathodes that are automatically preheated through a heater winding unit built into the ballast, eliminating the need for a starter. After ignition, the heater winding continues to produce a current for the lamp. Since the electrodes are continuously heated, the initial surge requires less voltage to light the lamp than does the slim line instant start. Rapid start lamps light immediately at a low level of brightness and reach maximum brightness in about two seconds. (see figure 6.1)

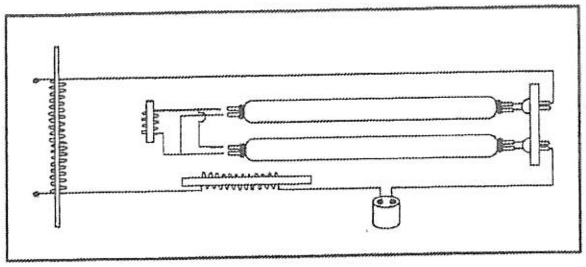

Figure 6.1 Rapid-Start Circuit

II. Preheat Circuit

Preheat fluorescent lamps require the lamp electrodes to be preheated before lighting. A manual or automatic starter switch must be placed in a series with the filaments, therefore bypassing the lamp. As power is impressed, current passes through the ballast, electrodes of the lamp, and the start switch. The current heats the electrodes until they emit electrons that travel the length of the lamp. During the start up cycle, the ballast limits the current flow to a calibrated value for preheating the electrodes. Within a few seconds, the electrodes reach the proper temperature and the starting switch automatically opens. This stops the current flow bypass, leaving the gas in the lamp as the only other path to travel. With help from the power supplied by the fluorescent lamp ballast, the current flows through the gas in the lamp to ignite the lamp. (see figure 6.2)

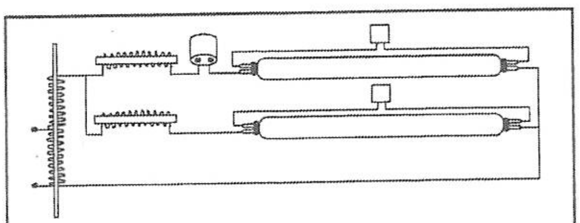

Figure 6.2 Preheat Circuit

III. Slim Line Instant Start Circuit

A. (Lead Lag Circuit)

To overcome preheat fluorescent lamps' starting delay, the slim line instant start lamp was introduced. With a slim line instant start circuit, lamps are started by creating a high initial voltage between the lamp electrodes, without the assistance of a starter. This high initial voltage requires a larger auto-transformer as an integral part of the ballast. A larger "choke coil" or "reactor" must also be included to reduce the initial high starting voltage to the rated operating voltage of the lamp. The lead-lag slim line instant start circuit differs from the preheat ballast only in the level of initial voltage produced and the exclusion of the lamp starters. If lamps are wired in parallel, this ballast provides the necessary starting voltage to ignite each lamp independently. (see figure 6.3)

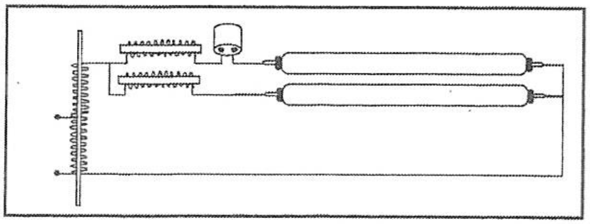

Figure 6.3 Slimline Instant Start (Lead Lag Circuit)

B. (Series Sequence)

To reduce the size, weight, and cost of the slimline instant start lead lag ballast, a series-sequence ballast was introduced. In the slimline instant start circuit, two lamps in series are started in sequence. The series-sequence circuit differs from others in that each circuit performs a separate function. The starting circuit supplies sufficient voltage and current to the first lamp and the remaining lamp ignites in sequence using the same voltage and current.

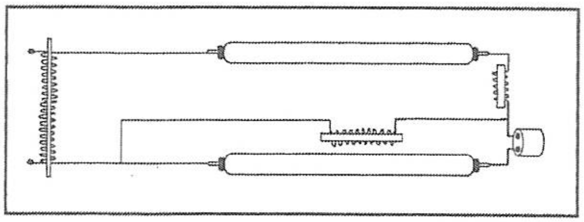

Figure 6.4 Slimline Instant Start (Series Sequence Circuit)

Because the lamps are in series, the operating circuit is not required to supply individual lamp currents. The power requirement reduction makes it possible to produce a lighter, smaller, and more efficient fluorescent lamp ballast to operate slim line instant start lamps. (see figure 6.4)

Troubleshooting

Normally, when UV or fluorescent lamps fail, the bulb life is depleted and the lamp must be replaced. This is usually verified easily because the ends of the lamps are darkened by the electrodes. Replace the bulb; if it is a multiple bulb system, replace both bulbs.

Troubleshooting is predominately the same for UV as for fluorescent lamps. Those cabinets that have built-in UV lights sometimes use the same switch that controls the fluorescent lights. If the UV lamp is not operating properly because the distance between the lamp sockets is wider than the bulb, the technician can adjust the lamp sockets or place a shim behind the bulb sockets to reduce the space.

Occasionally, a new UV lamp flickers a great deal and a standing wave can be seen in the tube. This usually corrects itself during the first few hours of use and is not considered a defect.

To prevent a lamp from disengaging from its socket, technicians install various types of locking mechanisms, such as plastic clips or fiber washers, as a safety precaution; these should be reinstalled after replacing a bulb.

If an initial visual inspection of the bulb(s) does not show that the lamp is defective, then use Table 6.1 on the next page to troubleshoot the problem.

Table 6.1: Troubleshooting Defective Lamps

Observation	Corrective Action
There is no light. Only one lamp of two lights. Lights cycle on and off. Lights flicker.	Check lamp(s) to insure satisfactory operation. If bulbs are dark or blackened, replace them. As lamps are removed, check all sockets to assure proper and positive contact with lamp pins. Replace them as necessary. If starters are used, check each starter and starter socket. Replace as necessary. Check line voltages before and after the lamp control switch. Replace the switch if necessary. Examine all connections within the cabinet lamp circuit to insure their conformance with the wiring instructions or diagram on the cabinet schematic or ballast. See "Circuits" above. Examine the ballast. Look for overheating or physical defects. Replace as needed.

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SECTION 7

ELECTRICAL SAFETY

Within the electrical safety test are four methods to measure the potential shock hazard of a biological safety cabinet. An initial visual inspection indicates possible failures such as heated, frayed, or brittle wires and overheated components. Typically, motors are isolated or on separate circuits form the lights and receptacles.

New cabinets are less likely to fail electrical safety tests since the tests are done at the factory before shipment. Biological safety cabinets are most likely to fail electrical tests because of age, electrical component failure, or a defective replacement.

The four different electrical tests are:

1. Electrical leakage
2. Ground circuit resistance
3. Polarity
4. Ground fault interrupter

Table 7.1 below lists these tests and the corrective actions a technician should take.

Table 7.1: Troubleshooting Electrical Safety *(continued on the next page)*

Observation	*Corrective Action*
1. Electrical leakage over 500 micro amps.	Remove various circuits from the cabinet and measure leakage. Typically, components or wires need to be replaced when worn, brittle, or burned.
2. Excessive ground circuit resistance.	Make sure the work or tested surface has no corrosion underneath it that will increase resistance. Clean soiled surfaces or tighten mounting brackets or hardware. Check line and plug cord resistance and repair or replace as required.
3. The utility duplex outlet polarity is incorrect.	Check the duplex outlet into which the cabinet is plugged. If the duplex outlet is acceptable, then rewire each duplex outlet within the cabinet.

Table 7.1: Troubleshooting Electrical Safety (continued from page 37)

Observation	*Corrective Action*
4. Ground fault trip is below 5 micro amps (tested at 1, 2, 3 micro amps).	Perform electrical leakage test and/or replace damaged or soiled ground fault interrupter (GFI) receptacles.

NOTE: When testing GFI receptacles, always test the last receptacle tied into that line or branch.

Reactions to Electrical Currents

Each person responds to electrical current differently, though generally people will react in one or more of the following ways:

- Perception – An individual's perception or fear of electricity can greatly affect that person's work practices.
- Reaction – When a person receives an electrical shock, their reaction can often be more hazardous than the initial shock.
- Let-go – occurs when the hand or body part contracts because of the current and the completed circuit that the body creates cannot be broken.
- Burning – The electrical burn is a result of an extended shock episode in which the electricity elevates the skin temperature to detrimental levels.

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SECTION 8

DIFFERENTIAL PRESSURE GAUGES

Pressure gauges mounted on BSCs show differential pressure across the supply HEPA filter or pressure in the plenum. The gauge should be maintained and adjusted so it always reads correctly at zero. Correct readings should be recorded as a reference tool and an indicator of change in performance that may occur in the future. Installed pressure gauges may read positive or negative, depending where the manufacturer of the cabinet places the sample lines.

NOTE: Pressure gauge readings should never be used as a primary method for setting air flow.

If the cabinet is hard-ducted to the outside atmosphere, the technician must close the gas tight damper first to ensure that the negative exhaust flow through the cabinet does not affect the zero reading when the blower is turned off. If the BSC does not have a gas tight damper, then the exhaust fan must be shut down to ensure a correct zero reading.

Vibration and jarring may affect the calibration, so the pressure gauge should be checked at each certification. Small gauges (minihelics) sometimes jam if their mounting screws have been overtightened.

Lines connecting the gauge to the cabinet are also critical. If the lines are loose, and the gauge is reading positive pressure, then contaminated air will leak out of the loose lines, creating a potential biohazard in addition to making the gauge read incorrectly.

If a 10% change in gauge reading and/or two minor scale divisions are noted, then airflow volumes and velocities should be verified.

Table 8.1 on the following page lists the pressure gauge deficiency generally experienced with possible causes and solutions.

Table 8.1: Troubleshooting Pressure Gauge Deficiency

Positive Pressure Gauges	
Observation	**Probable Cause**
Higher reading	HEPA filter loading. The speed control fails to close circuit. The alarm circuit activates.
Lower reading	There is a problem with the internal panel or plenum. In an audible alarm, or a two internal blower system, one blower motor fails or runs backwards. The blower boot fails. The prefilter is dirty. Debris restricts the blower impeller. Debris restricts the internal screens.

Negative Pressure Gauges	
Observation	**Probable Cause**
Higher reading	The speed control fails to close circuit. The prefilter is dirty. The alarm circuit activates. Debris restricts internal screens or blower.
Lower reading	HEPA filter loading. There is a problem with the internal panel or plenum. In a two internal blower system, one blower/motor has failed or is running backwards. The blower boot fails. The prefilter is dirty. Debris restricts the blower impeller. Debris restricts the internal screens.

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SECTION 9

IMPROVING THE PERFORMANCE OF EXISTING BIOLOGICAL SAFETY CABINETS

Whether an employee of the owner of the biological safety cabinets or an outside contractor, the certifying technician has a responsibility to recommend to the end user current or state-of-the-art technology that should be applied to existing cabinets.

Some older cabinets must be removed from service since they cannot meet current guidelines or operational NSF *International* Standard #49 minimum specifications. Biological safety cabinet performance should be documented and proper administrative procedure should be started for decommissioning and replacing unsatisfactory cabinets.

The following recommendations for improving the performance of BSCs are broken down by location, venting, and performance/safety issues.

Location

1. Safety cabinets should be located away from normal traffic patterns and away from doorways and windows that can be opened. Installation personnel should consider air currents from room air supply vents that could disrupt the work access opening air barrier and compromise the contaminant.
2. Windows in the laboratory should remain closed at all times.
3. Auxiliary room ventilation equipment, such as window air conditioners, portable heaters or recirculating fans, should not be located in such a manner that the equipment would blow across the front opening or onto the exhaust filter of the safety cabinet.

Venting

1. If a Class II type A or type B3 safety cabinet is hard-ducted to an exhaust system, then the cabinet supply blower should be interlocked with the building exhaust system to prevent pressurization of the exhaust duct work resulting in a loss of face velocity and/or containment.
2. If a Class II Type A/B3 cabinet is hard-ducted to an exhaust system, then the BSC should not be turned off, and the exhaust fan should continue to run. Turning off the BSC will result in reverse airflow through the supply HEPA, contaminating the supply filter's clean side with room air and unnecessary particulate collection on the exhaust HEPA.
3. All four types of safety cabinets should be placed in rooms with exhaust ducts that have gas tight dampers to permit final adjustment to the exhaust flow and closure for decontamination.
4. The minimum clearance for acceptable performance of a BSC is 4 to 6 inches between the top of cabinet and the ceiling. Some manufacturers suggest 12 to 16 inches of clearance as a minimum.

5. When a BSC is exhausted by a remote blower, some combination of the following should be provided to indicate either failure or reduction of exhaust flow:

- a vacuum or flow sensor,
- an audible alarm, or
- a warning light.

6. An exhaust thimble connection should be maintained under slight negative pressure, usually 0.03 to 0.05 inches of WC.

Safety/Performance

1. Safety glass or plastic view screens should be abrasion resistant and must be replaced if hazing or clouding reduces vision.
2. Latches and other support mechanisms should provide an even and secure support.
3. Sliding sash enclosures should include an audible and/or visual alarm that is actuated when the sash is raised or lowered beyond the manufacturer's specified work opening height.

NOTE: When the view screen is higher, there is a potential loss in personnel protection. When the view screen is lower, there is potential loss in sterility or product protection over the work surface and possible overheating within the work zone.

4. Class II type A biological safety cabinets that exhaust into the room should have a perforated exhaust filter guard that provides protection to prevent damage to the filter and/or blockage of exhaust air. Most manufacturers supply these filter guards.
5. Electrical outlets on interior wall surfaces should have drip-proof caps or gasket seal covers over the plug-ins.
6. Any cabinet drain trough should be fitted with a minimum ⅜-inch ball valve.
7. Front and rear grill blockage may disrupt the airflow balance or air barrier causing turbulence and possible contamination of ambient air onto the work surface and/or potential escape of internally-generated particulate or aerosols.
8. If the supply fan of the BSC fails, then the exhaust fan should continue to run and a properly installed alarm should signal the failure.
9. Items placed just outside the cabinet access opening may block or interfere with front intake airflows/velocities. Technicians should be aware that such a disruption the air barrier holds the potential for escape of internally-generated particulate or aerosols.

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SECTION 10

UNIQUE TROUBLESHOOTING PROBLEMS WITH CABINETS

New cabinets are less likely to fail electrical safety tests since the tests are done at the factory before shipment. Biological safety cabinets are most likely to fail electrical tests because of age, electrical component failure, or a defective replacement.

Blowers Running Backwards

Blowers in Class II cabinets usually cannot run backwards, but the external blowers on Class I cabinets and Class II type B cabinets can have reversible motors. A blower will still deliver air flow when running backwards, but at a greatly reduced volumetric flow. A rule of thumb would be about 25-35% of rated design airflow. Whenever reduced air flow is noted in a new cabinet, the direction of blower rotation should be added to the check list.

In a system with dual blowers, both must be started at the same time. If one blower starts substantially ahead of the other, the second blower may run backwards because the suction provided by the correctly running blower causes reverse airflow through the slower-to-start blower. If each blower has an independent speed control, then care should be taken that both speed controls are set at equal voltage settings.

Controls Located in a Contaminated Section of the Cabinet

Some older safety cabinets, built prior to the NSF *International* Standard #49, have controls, switches, ballasts, and other electrical components in the contaminated plenum of the BSC.

NOTE: If such a biological safety cabinet has been used for work involving hazardous materials, then the safety cabinet should be decontaminated. Appropriate precautions should be taken and/or proper personal protective equipment should be donned before servicing any of these components.

Units with Flow Meters

Some safety cabinets have a rotameter-type flowmeter on the control panel that indicates proper air flow. Two tubes are attached to the rotameter—one at the top and one at the bottom. As air passes through the flowmeter, an indicator float rises. The height of the float can be compared to a graduated scale for general comparison of volumetric flow. The rotameter's measurement depends on the sampling location point of the two tubes connected to the rotameter (total pressure vs. static pressure at the blower inlet, blower inlet to plenum static, plenum static to ambient, etc.) The rotameter can measure either positive or negative flow of air. Once airflows for the unit are validated, the technician can adjust the height of the float in the rotameter until it reaches the proper height on the indicator scale (usually green).

Since the connecting tubes are often located on the dirty side of the HEPA filters, the tubes will become dirty over time and should be cleaned at each opportunity. If not properly cleaned, then dirt will eventually plug the tube and the flowmeter will reflect low or unreliable readings.

NOTE: If the cabinet has been used with hazardous materials, then it should be decontaminated, appropriate precautions should be taken, and/or proper personal protective equipment should be donned before attempting to clean or service this flowmeter.

Wiper Seals on Moveable Sashes

Most safety cabinets with sliding sashes have wiper seals behind the view screen to ensure containment. The wiper seals deteriorate over time (especially if UV lighting is used), allowing room air to be drawn in through the top of the view screen and possibly into the work zone. This deficiency can be detected by generating a visible smoke source outside the cabinet and checking for penetration through the wiper seal. If there is penetration, then replacement wiper seals should be installed.

Speed Controls

Various manufacturers have incorporated speed controllers in newer model safety cabinets that compensate for voltage fluctuations. Initial field problems by some manufacturers result in wiring upgrades and/or complete replacement of newly designed speed controllers with more improved models. Technicians should contact the manufacturer to get the latest information on upgrades if a speed controller problem is suspected.

Electrical Support Devices

As a result of age and normal life expectancy, some relays, pilot lights (showing power availability for operation), alarm indicators, micro switches and other electrical components tend to wear or burn out long before the BSC shows signs of failure. The troubleshooting and repair of these items can often be as involved and costly as a general performance problems. At the time of testing, the technician should check and verify that these components are operational.

See electrical troubleshooting in sections 5 and 7 for more information.

Diffusers, Soundproofing, and Prefilters Installed Internally

Some Class II Type B1 cabinets, particularly older units, incorporate a closed "Scott" foam type of diffuser to supply air into the work zone. These foam diffusers are typically located just under the supply HEPA filter and above the work surface. Over time the foam will tend to break down (especially with the use of UV lighting) and shed large black particulate onto the work surface.

To check the current condition at the time of testing, a technician may run a gloved finger along the foam diffuser. If brittle, the particulate will fall to the work surface indicating the need for replacement with Original Equipment Manufacturer (OEM) foam. This procedure also applies to older cabinets with soundproofing.

NOTE: If the cabinet has been used with hazardous materials, then the cabinet should be decontaminated, appropriate precautions should be taken, and/or proper personal protective equipment should be donned before attempting to service the foam diffuser or soundproofing.

Finally, if prefilters are brittle, collapsed, or just dirty, replace them during certification or sooner if needed.

Secondary HEPA Filters Above the Work Surface

Some styles of Class II Type B1 cabinets incorporate additional HEPA supply filters after the internal blowers and above the work surface. These HEPA filters serve two purposes: to clean the air which has passed across the motor/blower assembly and to facilitate additional diffusion of air into the work area.

Since the primary supply HEPA filter, located under the work surface tray, is leak tested for integrity as part of the certification procedure, this additional filter is not normally tested for integrity, but probably should be on the initial certification.

Internal Dampers, Screens, and Diffusers

Standard procedures require that whenever a safety cabinet is decontaminated and opened for service that all internal dampers, balancing screens, motor mounts, impeller blades, diffusers and air flow monitors should be thoroughly cleaned. This potentially eliminates future motor overheating and airflow problems as a result of restrictive dust build up. On a few BSC models' screens, coarse prefilters or diffusers are hidden from view either in the rear wall return or under the work surface.

Operational Hardware

Before a safety cabinet test can be considered complete, various operational hardware should be inspected and replaced if necessary, including but not limited to the following:

- Hinges: look for wear and tear and improper function.
- Switches: check for proper mechanical operation.
- Latches and closure devices: look for wear and proper compression of gaskets.

Liquid Seal HEPA Filters

For a limited time, some manufacturers incorporated a liquid seal for HEPA filters. The sealing compound was similar to high-vacuum grease or silicon grease, but tended to dry out and crack, causing bypass leakage. This problem can be corrected with a custom-ordered field retrofit kit which replaces the liquid seal knife edge with a standard clamping surface so a normal closed cell gasket HEPA filter can be installed.

Motor Maintenance

Some manufacturers incorporated motors that require lubrication with 20-30 drops of SAE-20 non-detergent or electric motor oil once a year at the time the HEPA filters are replaced.

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