ESCO® AIRSTREAM HORIZONTAL LAMINAR FLOW CABINETS

QUICKSTART

1. **This cabinet offers no operator protection (only product protection).**
2. **Refer to Packaging Contents on section 2.2 and ensure that all items are received.**
3. **Please fill up the log record at the end of this manual.**
4. **Please write the first date of usage on the place provided on the pre-filter.**
5. **This cabinet is capable of achieving ISO Class 3 air cleanliness within work zone as per ISO 14644.1 (equivalent to Class 1 as per US Federal Standard 209E).**
6. **Read all instructions before proceeding and observe the installation procedure and environmental/electrical requirements.**
7. **In this manual, important points will be marked with this symbol.** 
8. **Choose a suitable location for your cabinet (please refer to section 3.1).**
9. **The performance of your cabinet must be validated/certified before you start using them (please refer to section 3.4).**
10. **Connect cabinet to the main power supply. Please leave the cabinet on for 3 minutes in order to purge airborne contamination from the work area.**
11. **Adjust the seating position so that the user's face is above the front opening. Adjustable stool is recommended.**
12. **Prepare a written checklist of materials/apparatus necessary for immediate usage and surface-decontaminate them before loading them into the work zone. This is to prevent overloading and minimize the number of arm movements that might disturb the airflow.**

- **Never use the cabinet to store supplies or laboratory equipment.**

13. **Arrange the materials/apparatus to minimize the movement of contaminated items over clean items by segregating the contaminated items from the clean items**
14. **A clean long-sleeves laboratory coat may be used to protect personal clothing**
15. **Wash hands thoroughly using germicidal soap. Wear gloves for hand protection. Gloves should be pulled over the knitted wrists of the gown rather than worn inside.**
16. **Thoroughly surface-decontaminate the work surface and interior surface of the window using 70% ethanol or other disinfectant depending on the user's requirement. Do not use any disinfectant containing chlorine-based substance as this will cause corrosion to steel and stainless steel resulting in irreparable damage to the cabinet structure. Do surface decontamination as well to the UV lights and electrical outlet when present.**
17. **Minimize room activity (personnel movements, closing and opening of doors, etc.).**
18. **Minimize arm movement. Move arms in and out of the cabinet slowly to avoid disrupting cabinet airflow**
19. **It is recommended that the cabinet be operated continuously whenever possible to ensure cleanliness**.
20. **Wash hands thoroughly using germicidal soap. Turn off the cabinet.**
21. **Maintain your cabinet (please refer to chapter 5 for more details)**

ESCO® AIRSTREAM HORIZONTAL LAMINAR FLOW CABINETS

USER & SERVICE MANUAL

ESCO ®

Esco Manual Revision No. AHC v1.07.2004
Specifications subject to change without notice

WELCOME NOTE FROM ESCO

Congratulations! You have just purchased one of the finest laminar flow cabinets available.
It is a pleasure to welcome you to the growing number of customers who own and operate Esco laminar flow cabinets. For your convenience all exposed exterior and interior surfaces of this products has been and wiped down in a controlled clean environment, protective coverings on stainless steel and plastic surfaces, where present have also been removed.

Your new Esco Airstream® Horizontal cabinet includes many unique features and exciting improvements to simplify maintenance, enhance safety and improve ergonomics. These include:

- *transparent UV-resistant tempered glass sides to increase operator comfort and protection*
- *304 grade stainless steel work top for greater cleanability*
- *work zone lighting level above 1200 lux / 111 foot candles using 5000k fluorescent lamps for greater comfort and visibility during use*
- *integral metal filter guard on the ULPA filter prevents accidental damage to the filter media*
- *retrofit system that allows optional accessories to be easily fitted later in the field*

Please read the manual to take full advantages of the above features and familiarize yourself with proper installation, operation, and maintenance of the cabinet. We recommend that this manual, together with the factory test report, be kept near the cabinet for convenient reference by operators and qualified maintenance personnel

If you have any questions that are not addressed in this manual, please do not hesitate to reach us by e-mail at biotech@escoglobal.com or give us a call at +65 65420833.

With warm regards from Singapore,

Lim Lay Yew
Chief Executive Officer
Esco Micro Pte Ltd

TABLE OF CONTENTS

B. SERVICE SECTION

APPENDIXES

WARNING

- This cabinet offers no operator protection (only product protection)
- This cabinet is capable of achieving ISO Class 3 air cleanliness within work zone as per ISO 14644.1 (equivalent to Class 1 as per US Federal Standard 209E)
- Read all instructions before proceeding and observe the installation procedure and environmental/electrical requirements
- In this manual, important points will be marked with this symbol 

Declaration of Conformity *

In accordance with EN 45014:1998

We **Esco Micro Pte Ltd**

of 21 Changi South Street 1

Singapore 486777
Tel: +65 65420833
Fax: +65 65426920

hereby declare on our sole responsibility that the product:

Model : Airstream Horizontal Laminar Flow Cabinet

has been designed and manufactured to conform with the following standards,
when installed and used in accordance with the operating and maintenance manual:

- **EN 50081 - 1 : 1992** **Emissions**
- **EN 55022** **Class A Conducted Emissions**
- **EN 61000 - 3 - 2 / 3** **Harmonic Current Emissions and Voltage Fluctuations**
- **EN 55022** **Class A Radiated Emissions**
- **EN 50082 - 1 : 1997** **Immunity**
- **EN 61010 – 1 (1997)** **Electrical Equipment Safety Requirements**

This declaration is valid also as declaration of conformity to the following directives:

- **73/23/ EEC** **Directive on low voltage**
- **89/336/EEC** **Directive on electromagnetic compatibility**
- **93/68/EEC** **Directive on CE Marking**
- **98/37/EEC** **Directive on machinery**

More information may be obtained from Esco's authorised distributors located within the EU and a list of these parties and their necessary contact information is available on request from Esco.

Lim Lay Yew
Chief Executive Officer

* Applicable only to 230V 50 Hz cabinets

FREIGHT CLAIM INFORMATION

Esco inspects each product for defects before shipment. Esco products are then carefully packed in compliance with carrier regulations and thoroughly inspected before leaving our plant. Responsibility for their safe delivery is assumed by the carrier upon acceptance of the shipment. Occasionally damage occurs in transit. Claims for loss or damage sustained in transit must be made upon the carrier.

Please remember that you are responsible for all freight claims and the cost of all replacement pieces for each shipment you accept. Inspect each shipment very carefully before acceptance.

Carefully inspect each pallet or crate upon arrival. If a shipment is found to be damaged upon delivery, be sure to have the driver/carrier note all damage details on the delivery receipt. This is essential or your claim may be denied. Also if pallets are stacked, please note "Stacked Pallets" on the delivery receipt (pallets are not stacked when shipped, unless otherwise stated for certain products). Esco is not responsible for pallets stacked at carrier terminal. Any unloading difficulties or damages due to stacked materials are carrier's responsibility.

If freight damage is discovered, please refer to the following guidelines in order to process and effective freight claim:

ACCEPTED FREIGHT WITH NOTED/VISIBLE LOSS OR DAMAGE

- Any external evidence of loss or damage must be noted on the freight bill or delivery receipt and signed by the courier's agent or delivery driver
- (NOTE: Failure to properly describe evidence of loss or damage may result in the carrier refusing to honour a claim)
- Contact delivering terminal to arrange for a claim form and inspection report to be faxed or mailed to you
- Notify Esco Micro Pte Ltd regarding which items need replacement
- Keep all damaged items and packing material until claim is resolved between you and the carrier

ACCEPTED FREIGHT WITH CONCEALED LOSS OR DAMAGE

When a damage or loss is discovered during unpacking:

- Contact the carrier immediately upon discovery of damage and request for inspection by the carrier's agent.
- Carrier will determine inspection needs based on value and time elapsed

- Notify Esco regarding which items require replacement
- Esco will fax to you an order acknowledgment that includes value of items for claim (less freight amount)
- Esco will invoice you for replacement materials
- Esco standard payment terms will apply

UNACCEPTED FREIGHT

- If substantial damage is noted upon inspection you have the right to refuse part or all of a shipment. Do not unpack pallets or crates with damaged materials. Individual items cannot be refused. You must refuse the entire pallet or accept the freight with noted damage (see above)
- Esco will handle all freight claim procedures and process a replacement order for your company for the damaged pieces at no charge. (if the original order was shipped under CIF terms i.e. Esco had covered the insurance)

NOTE: Any correspondence with Esco regarding loss or damage must be accompanied by a copy of the shipping carrier's report. Esco will not accept returns that have not been authorized.

In the event of accepted freight with damage or loss, notification of loss or damage must be sent to the carrier within 10 days of receiving the freight. Notification outside the 10-day time frame may result in shipping damage claim being denied.

WARRANTY TERMS AND CONDITIONS

Esco warrants that this equipment will perform according to the specifications for 3 years from the date of purchase. With exceptions noted below *, this 3 years warranty applies to all parts and components of this equipment (* 3 years except consumable items – filter, light tubes, UV tubes, pre-filters)

Esco's liability under this warranty shall be limited to repair or replacement of the equipment at Esco's option, and under no circumstances shall Esco be liable for the equipment damage arising out of or in any way connected with the failure of the equipment to perform as set forth herein. This limited warranty is in lieu of all other expressed or implied warranties, including those of merchantability and fitness for a particular purpose.

In the event of a defect, a malfunction or failure during the warranty period, Esco will repair or replace, at its option, the product or component therein which upon examination by Esco shall appear to be defective, or not up to factory specifications. The purchaser must pay any transportation or labour expenses incurred in removing and returning the product to the service centre.

Esco cannot be held responsible for malfunctions, damage to people or property to non-compliance, poor or no maintenance or improper use of the cabinet.

This warranty shall not apply to any Esco product or part thereof which has been subject to misuse, abuse, accident, shipping damage, improper installation or service and testing, or damage by fire, flood, or acts of God. If the serial number of this product is altered, removed or defaced as to be illegible, the warranty shall be null and void in its entirety.

The use of non-Esco parts and/or parts not supplied directly by Esco or our authorized distributors, including but not limited to maintenance parts, spare parts, replacement parts, system components and/or system accessories, shall void all expressed or implied warranties.

To obtain warranty service, the defective product or part(s) must be returned to Esco or an authorized Esco Factory Service Centre along with a proof of purchase. ***It is mandatory, upon purchase, for the user to register receipt of the equipment with Esco online at www. escoglobal.com. Alternatively, the user can also complete the warranty registration form which can be found within this manual on page 38.***

Please take note that when returning the defective product or part(s), you must first obtain a return authorization (RA) number from Esco and it must be noted on the documents accompanying the return. **The defect reporting form can be found on page 39**.

CORPORATE PROFILE

BIOTECHNOLOGY EQUIPMENT DIVISION

Fig. 1 Esco Headquarters in Singapore

Esco supplies many high-tech industries with critical equipment that help keep products, people, and processes free from contamination. For example, our cleanroom construction components help pharmaceutical manufacturers meet GMP standards, keeping the drugs they produce clean. Our laminar flow mini-environments help microelectronics manufacturers increase product reliability and yields. In the laboratory, researchers use our safety cabinets for clinical biological research in order to develop vaccines for dangerous diseases. In a small way, Esco contributes towards these essential technologies that have become the backbone of our modern lives.

The Esco Biotechnology Equipment Division is a highly focused manufacturer of laminar flow, biohazard safety and other HEPA-filtered cabinets for the laboratory with a history of quality cabinets since 1978. We are predominantly oriented towards the international marketplace, with sales in more than 60 countries. A network of international distributors and partners allows us to provide quick and responsive local service and support.

Today, Esco's production capabilities for our laboratory equipment products are centralized in a 3,900 m 2 / 42,000 sq. ft facility separate from our Singapore corporate headquarters. This state-of-the-art fabrication centre houses the latest CNC (computer numerically controlled) sheet metal machinery and is highly automated to ensure that all products produced are of a high quality with less human intervention. An advanced powder-coating process is also operated in-house to ensure an aesthetic finish on all Esco laboratory equipment products. Esco is committed to making continuous investments in fabrication technologies to ensure superior quality and total customer satisfaction.

Fig. 2 Esco Production Facility

At Esco, continuous research and development is a corporate policy realized through tangible investments in personnel, equipment and facilities. Currently, 1 out of every 2 non-production staff at Esco works in a research and development position.

Visitors are welcome to visit the *Esco Biotech Equipment Technology Centre* located in Singapore at our worldwide headquarters, which features a demonstration laboratory, conference / training facilities for visitors, and various testing laboratories in which state-of-the-art research and tests are continuously conducted into improving the performance of our products.

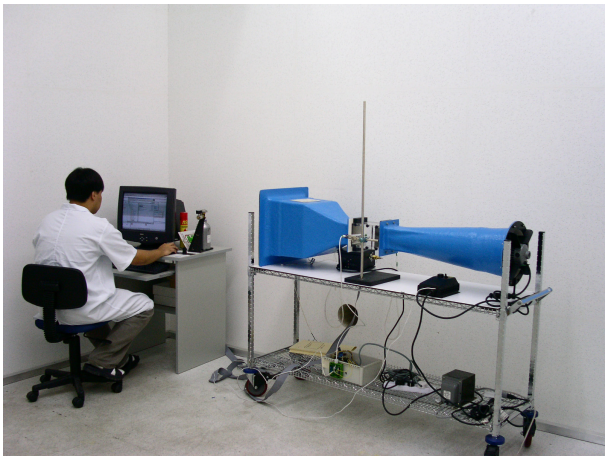


Fig. 3 Wind Tunnel Test Facility

USER SECTION

CHAPTER I
BASIC PRODUCT INFORMATION

Horizontal laminar flow cabinet offers proven protection for your sample and processes where operator protection is not required. They are suitable for application which requires ISO Class 3 air cleanliness within work zone as per ISO 14644-1 (equivalent to Class 1 per US Federal Standard 209E)

AIRFLOW PATTERN INSIDE THE CABINET

Room air is taken in from the top of the cabinet through a disposable pre-filter with 85% arrestance; this serves to trap larger particles and increase the life of the main filter.

Air is forced evenly across an H14 HEPA/ULPA-filtered vertical laminar flow air stream within the cabinet; the result is a stream of clean laminar air within the work zone of the cabinet; this dilutes and flushes all airborne contaminants from the interior.

A nominal filter face velocity of 0.45 m/s or 90fpm ensures that there is a sufficient number of air changes within the enclosed are of the cabinet in order to maintain cleanliness.

The purified air travels across the internal work zone of the cabinet in a horizontal, unidirectional stream and leaves the main work chamber across the entire open front of the cabinet.

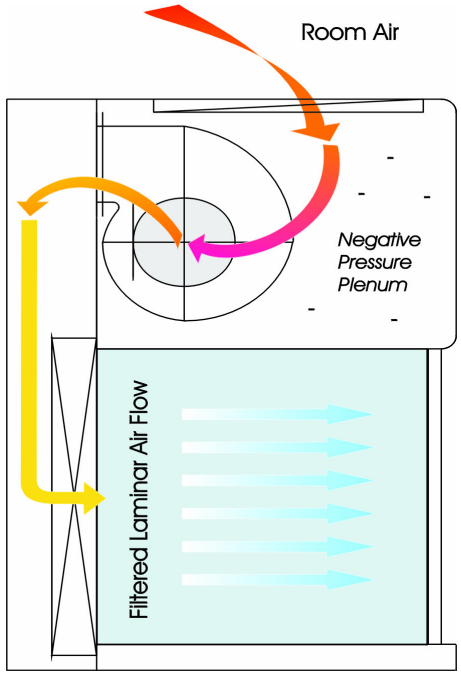


Fig. 4 Airflow Pattern Inside the Cabinet

SAFETY

- Raised edge at the back of work zone prevents spills from damaging the filter
- Integral filter metal guard on the ULPA filter prevents accidental damage to the filter media
- Seamless filter gasket is permanently moulded on the filter frame and will not deteriorate over time
- UV-resistant tempered glass sides provide a high level of protection against harmful UV rays when a UV lamp is installed
- Fulfil the safety requirement of IEC 61010-1/EN 61010-1/ UL 3101-1/CSA C22.2 No. 1010.1-92. All components are UL listed/recognized

PERFORMANCE

- Intelligent blower system which automatically compensates to maintain airflow as the filter loads. This unique feature eliminates the need for constant speed control adjustment and ensuring optimum performance
- Light tubes are mounted out of the air stream to provide better airflow uniformity
- Built-in solid state variable speed controller (infinitely adjustable from zero to the maximum setting) with built-in RFI and noise filters is superior to conventional “step” controllers
- ISO Class 3 work zone air cleanliness as per ISO 14644.1 (equivalent to Class 1 as per US Federal Standard 209E)
- Latest minipleat seperatorless H14 HEPA/ULPA filters operating at a typical efficiency of 99.9999% at MPPS, 0.3 and 0.12 microns to provide increased laminar airflow uniformity for better product and cross contamination protection

CLEANABILITY

- 304-grade stainless steel work top for greater cleanability
- Industrial-grade main body constructed for electro-galvanized steel with an abrasion resistant oven-baked powder coated finish to provide smooth and corrosion resistant exterior

OPERATOR COMFORT

The features incorporated in this cabinet allow for greater operator comfort and better working condition

- 5000k fluorescent lamp provides 1200 lux of work zone lighting for less glare and greater operator comfort
- Electronic ballast for fluorescent lighting resulting in lower heat output, higher energy efficiency, increase reliability and service life and most importantly zero-flicker

- Extremely low noise and vibration levels (less than 59 dBA at working position) due to proprietary construction and mounting technology
- An aerosol (DOP/PAO) challenge test port is included
- Germicidal UV lamp is placed out of operator's direct line of sight

EASE OF SERVICE

- Lifting handles for filter and blower maintenance on the back cover
- Convenient hand tool kit and extra fasteners is supplied with every cabinet

COST SAVING

- Permanently lubricated direct drive centrifugal blower energy-efficient external rotor type design

Please refer to chapter 2 of SERVICE SECTION for detailed product specification.

Each individual unit shipped is extensively tested for performance and safety and delivered with a detailed test report and certificate of performance. Testing performed at our factory laboratory includes:

- Airflow velocity
- Operator comfort tests: noise, light
- Filter integrity (PAO aerosol challenge)
- Particle counting for air cleanliness to ISO14644
- Electrical safety to IEC61010-1

Additional units are also randomly selected on a statistical sampling basis and re-tested using research-grade instrumentation and additional test protocols at our dedicated Product Development Laboratory.

Esco performs testing in accordance with more than 20 of the world's most recognized standards, of local, regional and international scopes. In particular, testing in our laboratory is most frequently conducted based on: EN12469, NSF49, and IEST-RP.

CHAPTER II
UNPACKING YOUR CABINET

This chapter aims to provide relevant information on how to handle the cabinet properly upon receipt. Failure to follow the following instructions may damage the cabinet. We strongly advise you to read this chapter carefully before proceeding further. Relevant information on **warranty terms and conditions can be found on page 7**.

2.1 STEP-BY-STEP PROCEDURE

1. Inspecting the crate

Upon receipt of your new cabinet, inspect the crate. If there is any visible damage to the exterior of the crate please refer to **freight claim information on page 5**.

NB: Some cabinets may be packed with corrugated carton instead of a wood crate, in which some of the following instructions would not apply.

2. Moving the crate

a. The crate is designed to protect our cabinet from any foreseeable circumstances. However, excessive impact onto the crate may also damage the cabinet. Prevent any direct impact or hitting to the crate when moving.

b. When lifting the crate, please always ensure that the floor jack or mechanical lift truck has always entered fully under the crate in order to achieve stability. Failure to do so will increase the risk of the crate falling off the floor jack or mechanical lift truck during handling. Please use a suitable extension bar when the situation arises.

Fig. 5 Moving the Crate Using Extension Bar

3. Opening the crate

a. Use a hammer or crowbar to open the top panel carefully. Be aware of exposed nails.

b. Remove the front panel, followed by the two side panels, and finally the back panel.

c. All the retrofit kits are packed separately and placed on top of the cabinet. These items are listed on the packing checklist pasted on the crate. Please check the packing checklist carefully to make sure that all items have been included. Remove them from the top of the cabinet before proceeding further.

If you did not receive one or more retrofit kits listed on the packing checklist, or if any of the items are damaged, please contact your distributor or Esco Micro Pte Ltd immediately for further instructions.

Please refer to section 2.2 for complete listings of items (aside from the retrofit kits) included with your cabinet.

4. Removing the packaging material

a. The cabinet is protected by styrofoam and shrink wrap.

b. The cabinet is secured with straps to the pallet.

c. Remove the styrofoam and shrink wrap but leave the strap securing the cabinet to the pallet intact.

d. If you find any damage during this stage of unpacking please refer to **freight claim information on page 5.**

e. It is the best practice to leave the cabinet secured with straps to the pallet until the cabinet is located in its approximate final position to facilitate ease and safety in handling.

Choosing the best location for your cabinet in order to achieve optimum operating performance of your cabinet is determined by a number of factors. Please refer to the next chapter for some guidelines.

5. Moving the cabinet

a. When lifting the pallet with the cabinet secured to it, please always ensure that the floor jack or mechanical lift truck has always entered fully under the pallet. This is to increase the stability of the cabinet and reduce the risk of the cabinet falling down. Please use extension bar when necessary.

b. During the moving of the cabinet, please ensure there is enough distance between the supports of pallet and the ground. Dragging the pallet against the ground (at one side or otherwise) will damage the pallet and possibly your new cabinet.

6. Removing the strapping

a. Remove the strapping by cutting it at a safe position to prevent any scratch on the surface of your new cabinet.

Fig. 6 Removing the strapping

b. Do not discard the packaging material for your cabinet until you have checked all of the components, installed and tested the unit.

7. Lifting the cabinet

a. The cabinet is not designed to support its own weight at the centre portion for extended periods. However, lifting the cabinet by mechanical lift truck in the centre is allowable. If you must lift the cabinet manually, use at least 4 persons.

b. Always lift up the cabinet with enough distance in between the fork of the mechanical lift truck and the centre of the cabinet.
Suggested distance: 50 cm for 3 ft and 90 cm for 4ft and above.
Install the cabinet on the existing work surface or Esco support stand (retrofit kit).

- **When installing the cabinet onto an existing work surface, ensure that the structure can safely support the combined weight of the cabinet and any related equipment. Some modifications to the work surface may be necessary.**
- **The work surface should be smooth and nonporous and resistant to the disinfectants and chemicals used in conjunction with the cabinet.**
- **Instructions on installing the Esco support stand can be found inside the cardboard box with the support stand**

Esco Micro is committed to protecting the environment. Please re-use the pallet if possible, and /or dispose the packaging materials and crate in a proper manner. Please hammer any exposed nail on the crate surface prior to disposal.

2.2 PACKAGING CONTENTS

The following items are included together with your manual:

1) Test certificate
2) Test report

   In case this manual and/or test report is lost or misplaced, Esco retains a copy in our files. A replacement copy can be obtained by contacting Esco Micro Pte Ltd and stating the cabinet model, serial number and a brief description of the information desired.
3) 1 bag containing fasteners replacement
4) 1 M4 screwdriver for maintenance and service

The following items are permanently attached to the cabinet in a Ziploc bag:

1) Test report
2) Electrical diagram

CHAPTER III
INSTALLING YOUR CABINET

3.1 CHOOSING A SUITABLE LOCATION

Please follow these guidelines when choosing a suitable location for your cabinet:

1. The location must be far away from :
    a. personnel traffic flows
    b. air vents (in and out)
    c. door and window
    d. any other sources of disruptive air currents or air drafts

    If drafts or other disruptive air currents exceed the face velocity of the filter, the potential exists for contaminated air to enter the work zone of the cabinet
2. A minimum distance of 50 cm to the top of the ceiling is recommended for blower changing purpose.
3. A clearance of 183 cm (6ft) in front of cabinet is strongly advised in order to maintain proper airflow.
4. Please permit adequate space for cleaning behind the cabinet.
5. Precautions must be taken to ensure that the cabinet is put on top of a mobile platform in order to facilitate proper filter changing from the back of the cabinet

3.2 ENVIRONMENTAL/ELECTRICAL CONDITIONS

This cabinet is designed to be used under the following conditions:

1. Indoor use.
2. Altitudes up to 2000 meters or 6600 ft.
3. 20% - 60% relative humidity.
4. Temperature range from 20 deg C to 30 deg C (68 deg F to 86 deg F).It is recommended that the temperature in the laboratory be maintained within +/-2 deg C under all conditions.
5. Main supply voltage fluctuations not to exceed +/- 10% of the nominal voltage. It is recommended that the voltage fluctuation doesn't exceed +/- 2% of the nominal voltage at all times.
6. Installation Category: 2.0

   Installation category (over voltage category) defines the level of transient over voltage which the instrument is designed to withstand safely. It depends on the nature of the electricity supply and its over voltage protection means. For example, in CAT II, which is the category used for instruments in installations supplied from a supply comparable to public mains such as hospital and research laboratories and most industrial laboratories, the expected transient over voltage is 2500 V for a 230 V supply and 1500 V for a 120 V supply.
7. Pollution Degree: 2.0

   Pollution degree describes the amount of conductive pollution present in the operating environment. Pollution degree 2 assumes that normally only non-conductive pollution such as dust occurs with the exception of occasional conductivity caused by condensation.

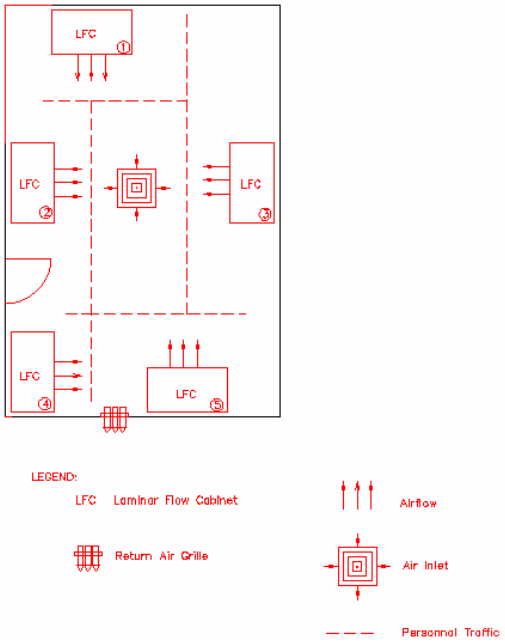


Fig. 7 Examples of the influence on cabinet airflow from room design and ventilation

Picture explanation:

No.1 The location of cabinet 1 is appropriate with respect to the avoidance of excessive air movements from the surrounding.

No.2 Cabinet 2 is too close to the doorway and could be influenced by the air inlet.

No.3 The airflow of cabinet 3 could be influenced by the air inlet.

No.4 Cabinet 4 is too close to the doorway.

No.5 Cabinet 5 is well-sited providing that the adjacent return air grille does not influence cabinet airflow.

The above diagram illustrates the influence on cabinet airflows from room design and ventilation systems. It is not intended to depict a typical installation. The location of such a number of cabinets in a small room, or in close proximity, is not recommended.

3.3 INSTALLING YOUR CABINET

1. Please refer to the unpacking your cabinet on the **previous chapter section 2.1 step no.7** on lifting the cabinet
2. Inspect your cabinet carefully, should you find any defect please refer to the **freight claim information on page 5** and our **warranty terms and conditions on page 7**
3. Wipe down the interior and exterior of the cabinet with water or a mild household detergent
4. Connect cabinet to the main power supply and turn on the blower. Please leave the cabinet on for 3 minutes in order to purge airborne contamination from the work area. **Each cabinet requires its own dedicated 13A (230V) or 15A (115V) power outlet which should not be shared with other appliances. For some cabinets which required 2 power sources, 2 separate and dedicated power outlets are needed.**
5. Prior to use, this cabinet should be certified by a qualified certifier. Under normal operating conditions, the cabinet should be recertified at least annually and when moved or serviced.
   For more on info on **performance validation/certification please refer to the next section 3.4**

DO NOT MOVE THE CABINET WITHOUT OBSERVING THE FOLLOWING PRECAUTIONS:

1. The cabinet must be recertified after being moved
2. Observe the necessary precautions when relocating the cabinet as it is heavy

3.4 PERFORMANCE VALIDATION/CERTIFICATION

After installation and prior to use, cabinet performance must be validated and certified to factory standards.

The following tests should be performed:

- Airflow velocity
- Particle count test
- Filter leak test (filter media leak test and filter gasket leak test)
- Site installation assessment test
- Optional tests:
  a. Electrical safety
  b. Light intensity test
  c. Noise level test
  d. UV intensity test

The testing methods and equipment required are specified on the test report. It is recommended that these tests be performed only by a **qualified technician** who is familiar with the methods and procedures for certifying laminar flow cabinets.

Esco conducts training courses on the validation and certification of laminar flow cabinets. If you are interested you are most welcome to contact your distributor or Esco.

3.4.1 THE IMPORTANCE OF PERFOMANCE VALIDATION/CERTIFICATION

- Airflow velocity value that falls below the value specified inside the test report will not provide adequate product protection.
- Possible product contamination when the filter is leaking.

3.4.2 RECERTIFICATION

After the initial certification, the cabinet shall be recertified at the following situations:

1. Relocation of cabinet
2. When the performance is suspected
3. Major maintenance or service (filter changing, blower changing, etc.)
4. At least annually

3.4.3 DISCLAIMER

The perfomance of the cabinet, while rigorously evaluated at the factory, cannot be guaranted once after transit and installation. Therefore the on-site testing is always recommended.

3.4.4 REFERENCES FOR QUALIFIED CERTIFIERS

1. NSF Accredited Class II Biosafety Cabinet Field Certifiers

   Please see http://www.nsf.org/Certified/Biosafety-Certifier for more information

2. I.A.F.C.A – member certifying company

   Please see http://www.iafca.com/listview.html for more information

3. Your distributor
4. Esco Micro Pte Ltd

CHAPTER IV
OPERATING YOUR CABINET

4.1 LAMINAR FLOW CONTROL SYSTEM

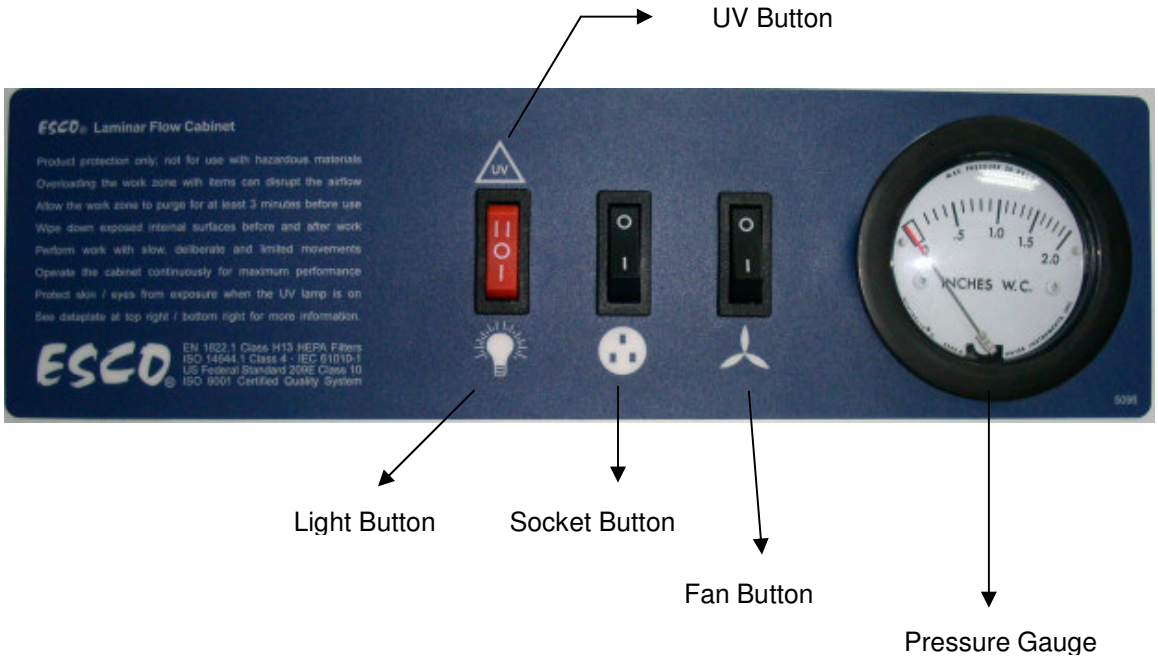


Fig. 8 Laminar Flow Control System

1. **Fan Button**

   To turn on and turn off the fan

2. **Light Button**

   To turn on the light

3. **UV Button**

   To turn on the UV (retrofit kit)

4. **Socket Button**

   To turn on and turn off the electrical socket (retrofit kit)

It is able to undertake AC-powered device up to 5 ampere. In case of overloading the outlet, the circuit breaker will trip. Disconnect the device from the outlet and reset the circuit breaker by pressing its button.

5. Pressure Gauge

To indicate the pressure drop across filter, to maintain nominal airflow velocity as specified inside the test report.

For more information on pressure gauge **please refer to Appendix C**

.

4.2 CABINET START-UP PROCEDURE

1. Adjust the seating position so that the user's face is above the front opening. Adjustable stool is recommended. **Please refer to section 4.5 about ergonomics** for more info.

2. Turn on the fan. Please leave the cabinet on for 3 minutes before start working in order to purge airborne contamination from the work area.

3. Prepare a written checklist of materials/apparatus necessary for immediate usage and surface-decontaminate them before loading them into the work zone. This is to prevent overloading and minimize the number of arm movement that might disrupt the airflow.

   - **Never use the cabinet to store supplies or laboratory equipment**
   - **Always surface-decontaminate everything before inserting them into the work zone**

4. Load and arrange the materials/apparatus to minimize the movement of contaminated items over clean items by segregating the contaminated items from the clean items.

5. A clean long-sleeves laboratory coat may be used to protect personal clothing.

6. Wash hands thoroughly using germicidal soap. Wear gloves for hand protection. Gloves should be pulled over the knitted wrists of the gown rather than worn inside.

7. Thoroughly surface-decontaminate the work surface and interior surface of the window using 70% ethanol or other disinfectant depending on the user's requirement.
   Do not use any disinfectant containing chlorine-based substance as this will cause corrosion to steel and stainless steel resulting in irreparable damage to the cabinet structure. Do surface decontamination as well to the UV lights and electrical outlet when present.

8. Minimize room activity (personnel movements, closing and opening of doors, etc.). Please refer to **installation guidelines on section 3.1**.

4.3 WORKING IN THE CABINET

1. Work from clean to dirty by following the segregation of clean and dirty materials/apparatus as described in the start-up procedure on top

2. Particularly critical objects may be arranged such that air flows directly against them.

3. Do not use a gas flame whenever possible as it interferes with airflow

   - **Do not use writing materials inside the work area as they generate aerosols**
   - **Do not change the cabinet original blower speed unless the change is required by a decrease in measured air velocity. Adjustment should be made only by a qualified technician**
   - **Do not operate the cabinet if fan fails to run**
   - **Do not cough or sneeze into the work zone**

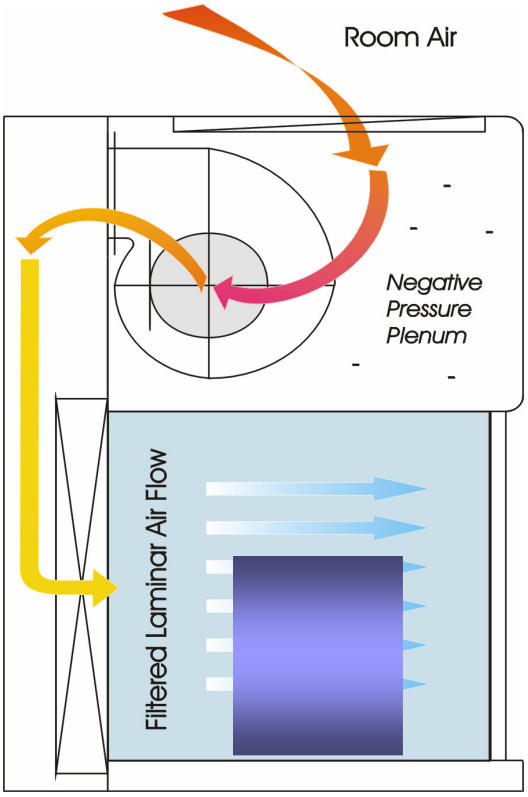
4. Minimize arm movement. Move arms in and out of the cabinet slowly to avoid disrupting cabinet airflow
   Be sure to surface-decontaminate first when inserting arms into the cabinet

5. Use absorbent pads on the work surface where appropriate to minimize splatter and aerosol generation in case of spillage.

6. Clean materials should be at least 150 mm away from aerosol generating objects to minimize the chance for cross contamination.

7. Hold lids/covers above dishes/sample plates in order to prevent air impingement where appropriate.

8. Arrange objects to avoid airflow turbulence (large objects can cause excessive turbulence in horizontal flow cabinets as illustrated below).



9. Keep your arms as far away as possible from items in the work zone

10. Keep heads (large potential for aerosol generation) out of the work zone

11. **It is recommended that the cabinet be operated continuously whenever possible to ensure and cleanliness**.

4.4 CABINET SHUTDOWN PROCEDURE

1. Install front cover (retrofit kits) and activate UV lamp when present

- **Eyes and skin should not be exposed to direct ultraviolet light**
- **Ultraviolet light should not be relied upon as the sole decontaminating agent**
- **Check the UV interlock regularly for correct operation**
- **The use of UV lamp in laminar flow cabinets is explicitly discouraged in all major international standards and recommendations. Please refer to Appendix B for more information**

2. Turn off the cabinet, remove laboratory coat and gloves and wash hands using germicidal soap thoroughly.

4.5 ERGONOMICS

During the operation of your cabinets, you will be more likely to do it in the sitting position.
Advantages of sitting position:

1. The physiological energy cost and fatigue are reduced
2. It provides the body with a stable support

However, sitting position also has some drawbacks:

1. Limited working area
2. Possible risk of being constrained in a fix posture for a long time
3. One of the most stressful position for the back

Fortunately, it is possible to create a more comfortable and healthier working condition by following these simple steps:

1. Ensure there is enough space for your leg and feet
2. Keep the lower back comfortably supported by your chair. Adjust the chair or use a pillow behind your back when necessary
3. Position your fleet flat on the floor or a footrest. Don't dangle your feet and compress your thighs
4. Vary your sitting position throughout the day. Don't sit in one fixed posture all day
5. Eyes , some guidelines:
   a. Give your eyes frequent breaks. Periodically look away from the work area and focus at a distant point.
   b. Keep your glasses clean
6. Arrange and position your frequently used work materials to minimize the possibility of straining yourself
7. Exercise regularly

Esco provides some ergonomics accessories such as:

- **a. Lab chair**
- **b. Footrest**

Please contact your local distributor or Esco for further information.

CHAPTER V
MAINTAINING YOUR CABINET

5.1 MAINTENANCE SCHEDULE

Please kindly follow the suggested maintenance schedule in order to maintain your Esco cabinet at its optimum performance.

Daily

1. Thoroughly surface-decontaminate the work surface and interior surface of the window using 70% ethanol or other disinfectant depending on the user's requirement. **Do not use any disinfectant containing chlorine-based substance as this will cause corrosion to steel and stainless steel resulting in irreparable damage to the cabinet structure**. Do surface decontamination as well to the UV lights and electrical outlet when present. When cleaning the interior, the operator should not insert any part of his/her body into the work zone (except hands).

Monthly

1. Using a damp cloth, clean the exterior surfaces of the cabinet, particularly the front and top of the cabinet, to remove any accumulated dust.
2. Check all the service fixtures (when present) for proper operation.
3. All daily activities

Quarterly

1. Replace pre-filters
2. All monthly activities

Annually

1. ***Have the cabinet recertified by a qualified certification technician.***
   Please refer to performance validation/certification section on Chapter 3 section 3.4
2. Replace the UV lamp, when present
3. All quarterly activities

Biannually

1. Replace the fluorescent lamps
2. All annual activities

5.2 DISINFECTING AGENTS

1. For stainless steel, all common disinfecting agents except chlorine-based agents are suitable.
2. For powder coated surfaces, all common disinfecting agents are suitable. However, the cabinet has been specifically evaluated for use with the following:
   a. 1N hydrochloric acid
   b. 1N sodium hydroxide
   c. 1% quaternary ammonium compound
   d. 5% formaldehyde
   e. 5,000 ppm hypochlorite
   f. 2% iodophor
   g. 5% phenol
   h. 70% ethyl alcohol

User Monthly Maintenance Schedule

Model:_____ **Year: _____**

Serial No:_____

Month	Clean exterior surface	Check all service fixtures	Operator Signature	Manager Signature
Jan				
Feb				
Mar				
Apr				
May				
Jun				
Jul				
Aug				
Sep				
Oct				
Nov				
Dec				

Daily

Surface decontamination

Quarterly

Replace pre-filters

Annually

1. Re-certification
2. Change UV lamp (when present)

Bi-anually

Replace fluorescent lamps

This form may be used by the lab manager/safety officer to enforce the user maintenance schedule

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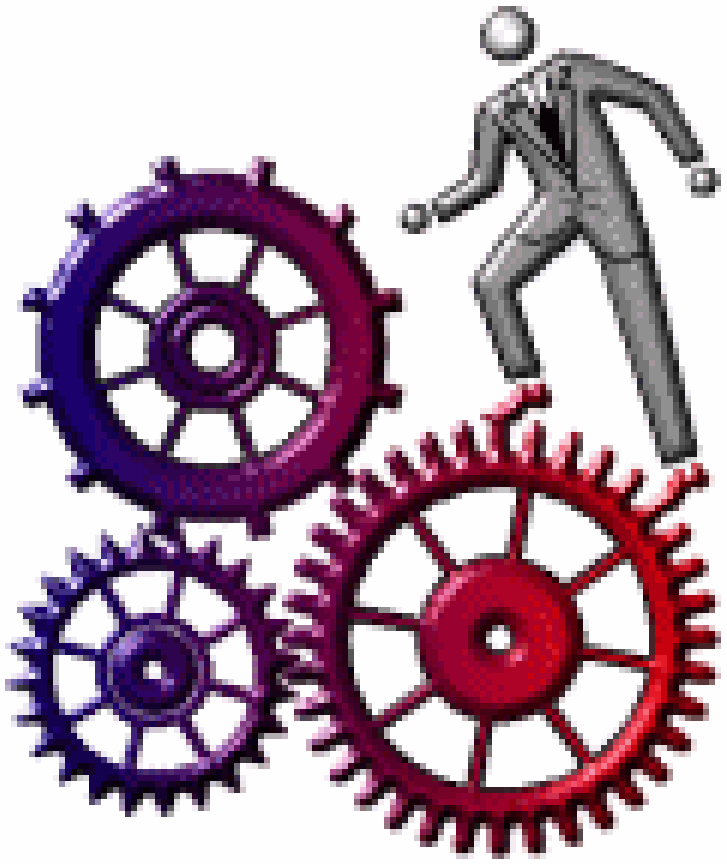
E-MAIL biotech@escoglobal.com WEBSITE www.escoglobal.com



SERVICE SECTION

CHAPTER I
MAINTENANCE BY SERVICE PERSONNEL

1.1 CABINET AIRFLOW BALANCING

After some period of usage, the pressure drop across HEPA/ULPA filters will increase, otherwise known as “filter loading”.

By increasing the fan speed, we can compensate this effect. However, there is a limit to this increment in speed which is the maximum supply voltage according to the fan performance curve.

If this happens, and the required cabinet performance cannot be achieved, the filters must be changed. (Please refer to the filter changing section below)

Please follow the steps described below to adjust the fan speed:

1. Remove pre-filter from the top of cabinet.
2. Adjust the speed control to achieve the required velocity.
3. Recertify the cabinet when speed is adjusted.

1.2 FILTER CHANGING

The HEPA/ULPA filter under normal usage and barring an accident (a puncture), do not need replacement until the airflow velocity cannot be maintained at the specifications required by the test report even though the fan has been set to maximum speed.

The filter changing procedure **is described in detail at the end of this chapter.**

The cabinet must undergo recertification after filter changing.

Before the new filters are installed, all surfaces should be thoroughly cleaned of silicon and/or adherent gasket material. The new filter should be carefully handled and examined prior to fitting. It is important that the filters and the gasket be checked for leaks prior to use.

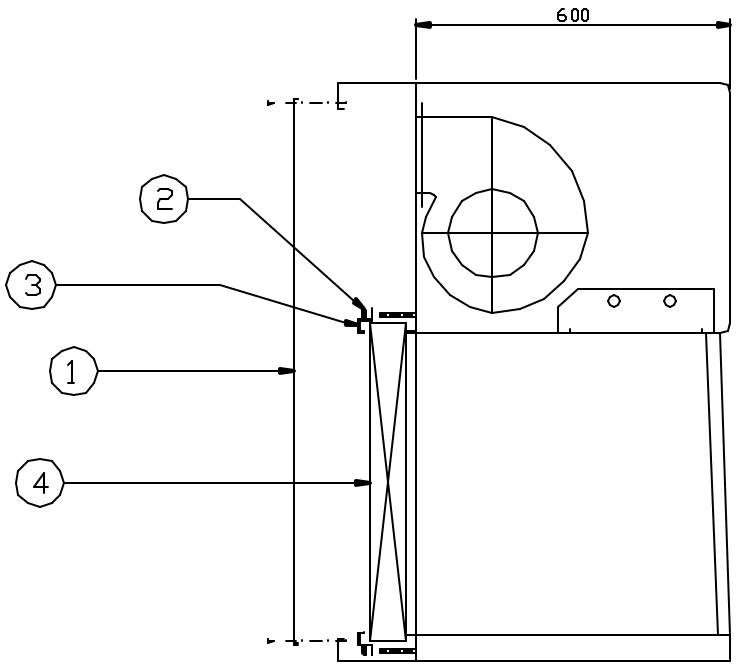
1.3 RECERTIFICATION

The following tests should be performed:

1. Airflow velocity
2. Particle count test
3. Filter leak test (filter media leak test and filter gasket leak test)
   Please **refer to the flow chart** at the end of this section
4. Site installation assessment test
5. Optional tests:
   a. Electrical safety
   b. Light intensity test
   c. Noise level test
   d. UV intensity test

The testing methods and equipment required are specified in details on the test report.
It is recommended that these tests be performed only by a **qualified technician** who is familiar with the methods and procedures for certifying laminar flow cabinets.

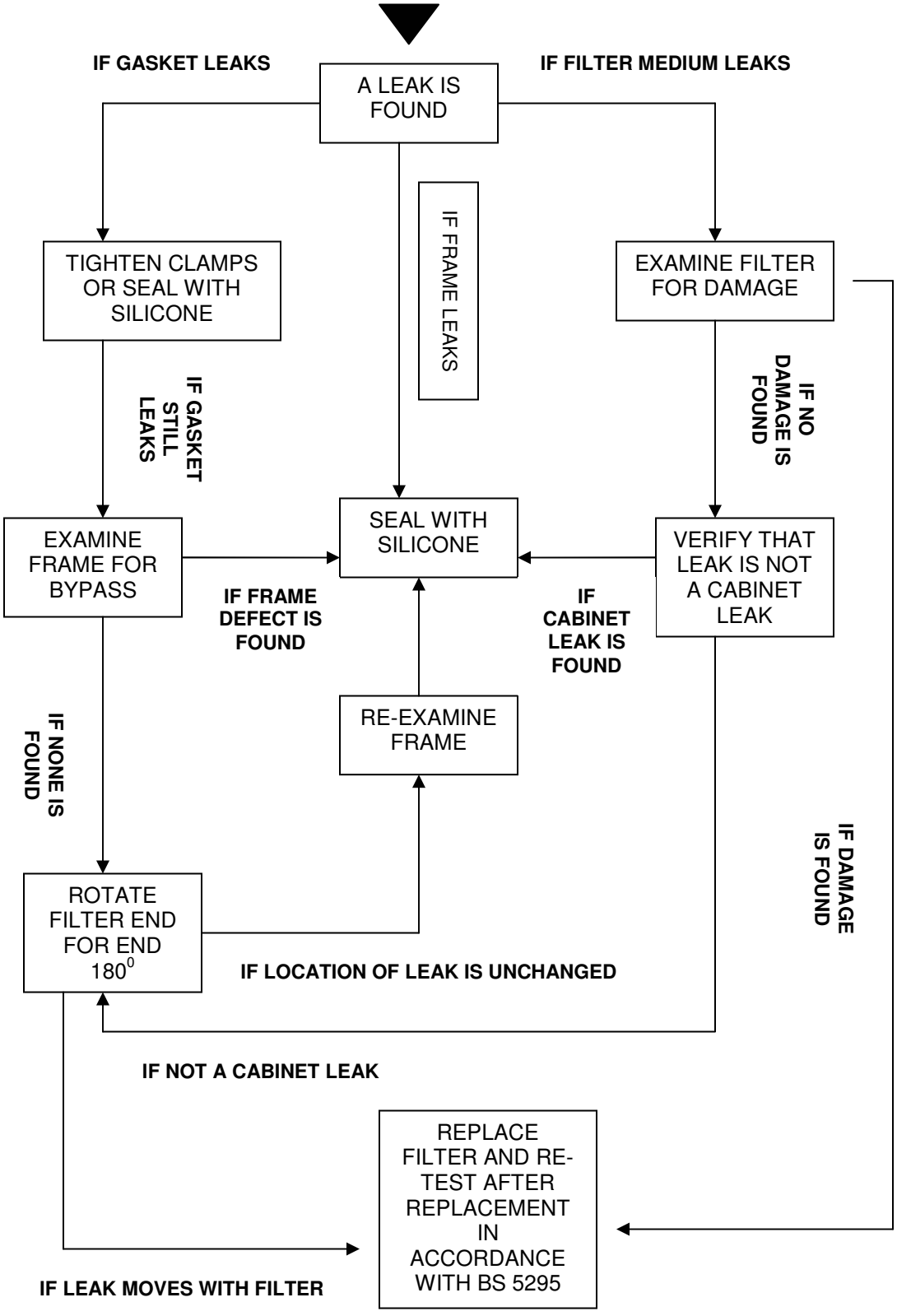
Esco conducts training courses on the validation and certification of laminar flow cabinets. If you are interested you are most welcome to contact your distributor or Esco Micro Pte Ltd.



REPLACEMENT OF FILTER FOR AHC/LHC

1. REMOVE BACK COVER
2. UNSCREW NUT USING SPANNER
3. REMOVE THE FILTER CLAMP
4. REMOVE HEPA FILTER

LEAK TESTING OF HEPA FILTERS



CHAPTER II
PRODUCT SPECIFICATION

2.1 ENGINEERING DETAILS (AHC-4AX)

PLEASE KINDLY REFER TO THE END OF THIS SECTION

2.2 OPTIONAL RETROFIT K ITS

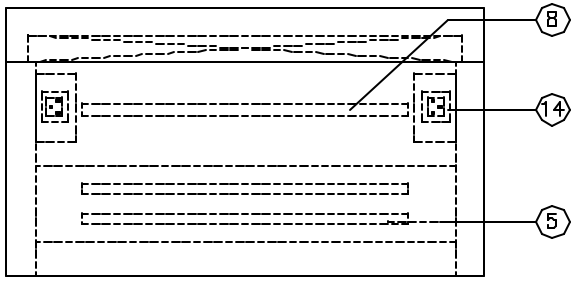
1. Support Stand (**WARNING:** 2 persons are required to assembly the support stand as it is heavy)
   To enable mobility of the cabinet within the laboratory and for users without bench space
   Types available:
   a. Standard (with castors)
   b. With levelling feet
2. IV Bar with 6 hooks
   For IV bags filling applications
3. Service Fixtures (both European and American style fixtures available)
   To provide supplies of gas, vacuum, water and compressed air to the cabinet
   For vacuum fixture, please install a filter between the work zone and the fixture.
4. Germicidal UV Lamp
   For germicidal decontamination
5. Electrical socket/GFCI outlets (total 6A rating for all outlets in cabinet)
   To allow users to use electrical devices, such as ultra-sonic bath, hotplate and electronic weighing scale inside the work-zone
6. Front cover (also known as Night Doors in some countries)
   To protect operator from harmful UV rays and also to keep work zone free from dust
7. Ergonomic footrest
8. Ergonomic adjustable lab chair

2.3 TECHNICAL SPECIFICATION

PLEASE KINDLY REFER TO THE END OF THIS SECTION

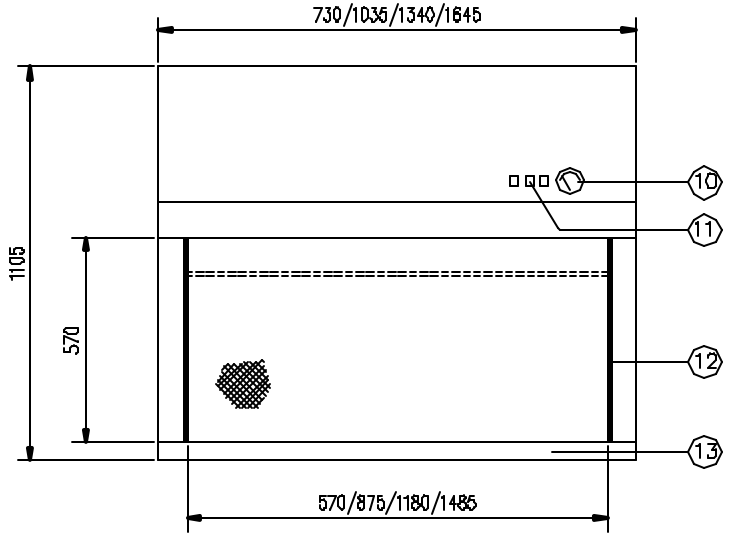
2.4 ELECTRICAL DIAGRAM

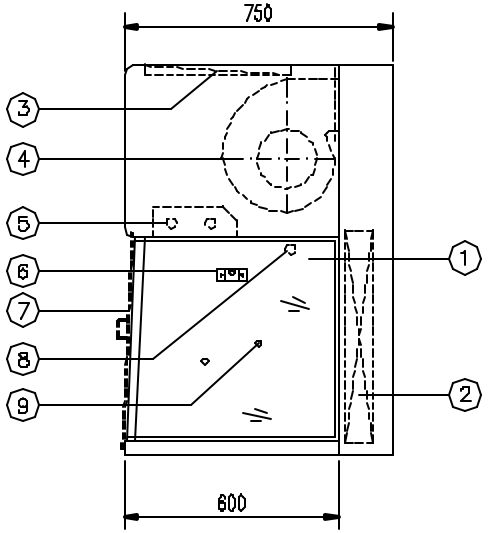
PLEASE KINDLY REFER TO THE END OF THIS SECTION



VIEW INSIDE WORK AREA CEILING

LEGEND
1 GLASS SIDE PANEL
2 ULPA FILTER
3 PRE-FILTER
4 BLOWER
5 FLUORESCENT LAMP
6 STANDARD IV BAR RETROFIT KIT PROVISION
7 FRONT COVER (OPTIONAL)
8 STANDARD UV LIGHT RETROFIT KIT SYSTEM
9 PLUG PENETRATION
(2 HOLES ON EACH SIDE)
10 PRESSURE GAUGE
11 OPERATING SWITCHES
12 SIDE TEMPERED GLASS
13 STAINLESS STEEL WORK TOP
14 STANDARD ESCO ELECTRICAL OUTLET RETROFIT KIT PROVISION
(2&3 FT MODEL - ONLY 1 SINGLE OUTLET IN WORK ZONE CEILING LEFT SIDE)
(4 & 5 FT MODEL - ONLY 2 SINGLE OUTLET IN WORK ZONE CEILING LEFT & RIGHT SIDE)

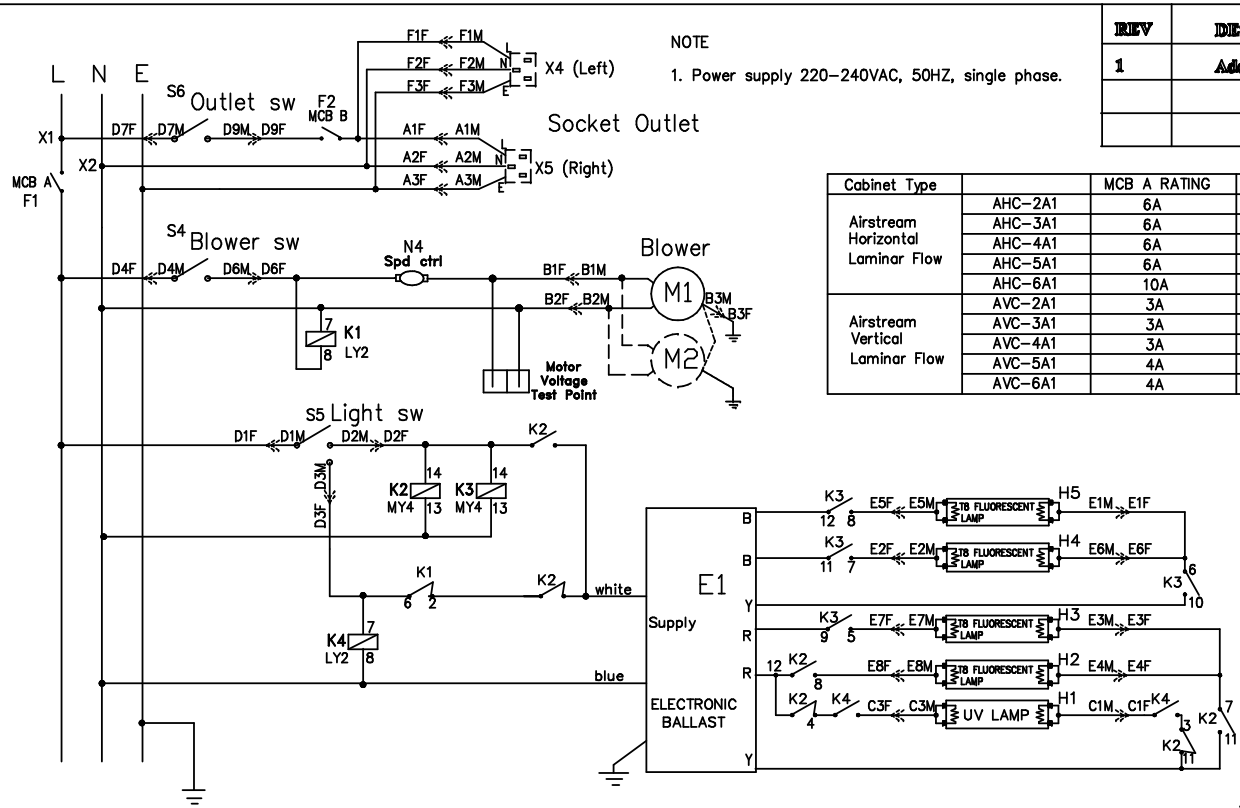




UNLESS OTHERWISE STATED: 1.TOLERANCES +/- 1 mm 2.BREAK SHARP EDGES 3.ALL DIMS ARE mm	**ESCO MICRO PTE LTD**	DRAWN: RANDY	CHECKED:	DRAWN: TO SCALE PRINTED: NTS
	CLIENT:	TITLE: AIRSTREAM HORIZONTAL LAMINAR FLOW CABINET	DWG NO: AHC-XA	DATE: 20/8/2003

TECHNICAL SPECIFICATIONS

General Specifications	AHC-2AX	AHC-3AX	AHC-4AX	AHC-5AX	AHC-6AX
External Dimensions (Width x Depth x Height)	730 x 750 x 1105 mm 28.7" x 29.5" x 43.5"	1035 x 750 x 1105 mm 40.7" x 29.5" x 43.5"	1340 x 750 x 1105 mm 52.7" x 29.5" x 43.5"	1645 x 750 x 1105 mm 64.8" x 29.5" x 43.5"	1950 x 750 x 1175 mm 76.8" x 29.5" x 43.5"
Internal Work Zone (Width x Depth x Height)	670 x 600 x 570 mm 22.4" x 23.6" x 22.4"	875 x 600 x 570 mm 34.4" x 23.6" x 22.4"	1180 x 600 x 570 mm 46.6" x 23.6" x22.4"	1485 x 600 x 570 mm 58.5" x 23.6" x 22.4"	1790 x 600 x 570 mm 70.5" x 23.6" x 22.4"
Air Volume (At Initial Velocity)	600 cmh / 350 cfm	900 cmh / 530 cfm	1205 cmh / 710 cfm	1500 cmh / 880 cfm	1800 cmh / 1060 cfm
Laminar Airflow Velocity	Average of 0.45 m/s or 90 fpm measured 150mm / 6" from filter face for 45 air changes / minute (uniformity is +/-20%)				
Standards Compliance	Individually performance tested and certified at factory under controlled conditions for:				
	General requirements: IEST-RP-CC002.2 and AS1386.5				
	Air cleanliness: ISO 14664.1 Class 3, IEST-G-CC1001, IEST-G-CC1002 and other equivalent air cleanliness requirements				
	Filter performance: IEST-RP-CC034.1, IEST-RP-CC007.1, IEST-RP-CC001.3 and EN1822				
	Electrical safety: IEC 61010-1 / EN 61010-1 / UL 3101-1 / CSA C22.2 No. 1010.1-92				
Air Cleanliness Within Working Area	ISO 14644.1 Class 3, US Federal Standard 209E Class 1 / M1.5, AS 1386 Class 1.5, JIS B9920 Class 3, BS5295 Class C, Class M10,000 as per KS 27030.1 and other equivalent cleanliness classifications of the VDI 2083 and AFNOR X44101				
Main Filter Type	ULPA filter with integral metal guards and filter frame gaskets; fully compliant with EN1822 and IEST-RP-CC001.3 requirements				
Main Filter Efficiency Ratings	Minimum: 99.9991% at 0.3µm / 99.9985% at 0.12µm / 99.9982% at MPPS				
	Typical: 99.9998% at 0.3µm / 99.9998% at 0.12µm / 99.9997%at MPPS				
Pre-Filter	Disposable and non-washable polyester fibers with 85% arrestance / EU3 rated				
Noise Level	Typically <59 dBA at initial blower speed setting measured as per IEST-RP-CC002.2, based on 4 feet cabinet, subject to acoustic properties of test environment				
Light Intensity	>1200 lux / >111 foot candles, measured at work surface level (zero background) as per IEST-RP-CC002.2				
Main Body Construction	1.5mmt / 0.06"" / 16 gauge electro-galvanised steel with white oven-baked epoxy powder-coated finish				
Side Window Construction	Colourless and transparent UV-absorbing 5-6mm / 0.2"-0.24" tempered glass				
Work Surface Construction	1.2mmt / 0.05"" / 18 gauge stainless steel grade 304				
Maximum Power Consumption /Current					
220-240VAC / 50Hz 1Ph	584W or 1993BTU / 2.54A	600W or 2048BTU / 2.61A	614W or 2096BTU / 2.67A	634W or 2164BTU / 2.76A	1631W or 5566BTU / 7.09A
110-130VAC / 60Hz 1Ph	828W or 2826BTU / 6.90A	844W or 2881BTU / 7.03A	858W or 2928BTU / 7.15A	878W or 2997BTU / 7.32A	1666W or 5086BTU / 13.88A
Net Weight (Approximate)	92 kgs / 203 lbs	112 kgs / 247 lbs	133 kgs / 293lbs	161 kgs / 355 lbs	208 kgs / 443 lbs
Max Shipping Weight	185 kgs / 408 lbs	200 kgs / 440 lbs	223 kgs / 492 lbs	251 kgs / 553 lbs	297 kgs / 655 lbs
Max Shipping Dimensions (W x D x H)	900 x 950 x 1630 mm 35.4" x 37.4" x 64.2"	1200 x 950 x 1630 mm 47.2" x 37.4" x 64.2"	1500 x 950 x 1630 mm 59.0" x 37.4" x 64.2"	1800 x 950 x 1630 mm 70.9" x 37.4" x 64.2"	2100 x 950 x 1730 mm 82.7" x 37.4" x 64.2"
Max Shipping Volume	1.39 cbm / 49.1 cbf	1.86 cbm / 65.7 cbf	2.32 cbm / 81.9 cbf	2.79 cbm / 98.5 cbf	3.45 cbm / 121.8 cbf



Laminar Flow Switch Control

NOTE

1. Power supply 220–240VAC, 50HZ, single phase.

REV	DESCRIPTION	DATE
1	Add Relay K4, Add Switch S6	05/12/2003

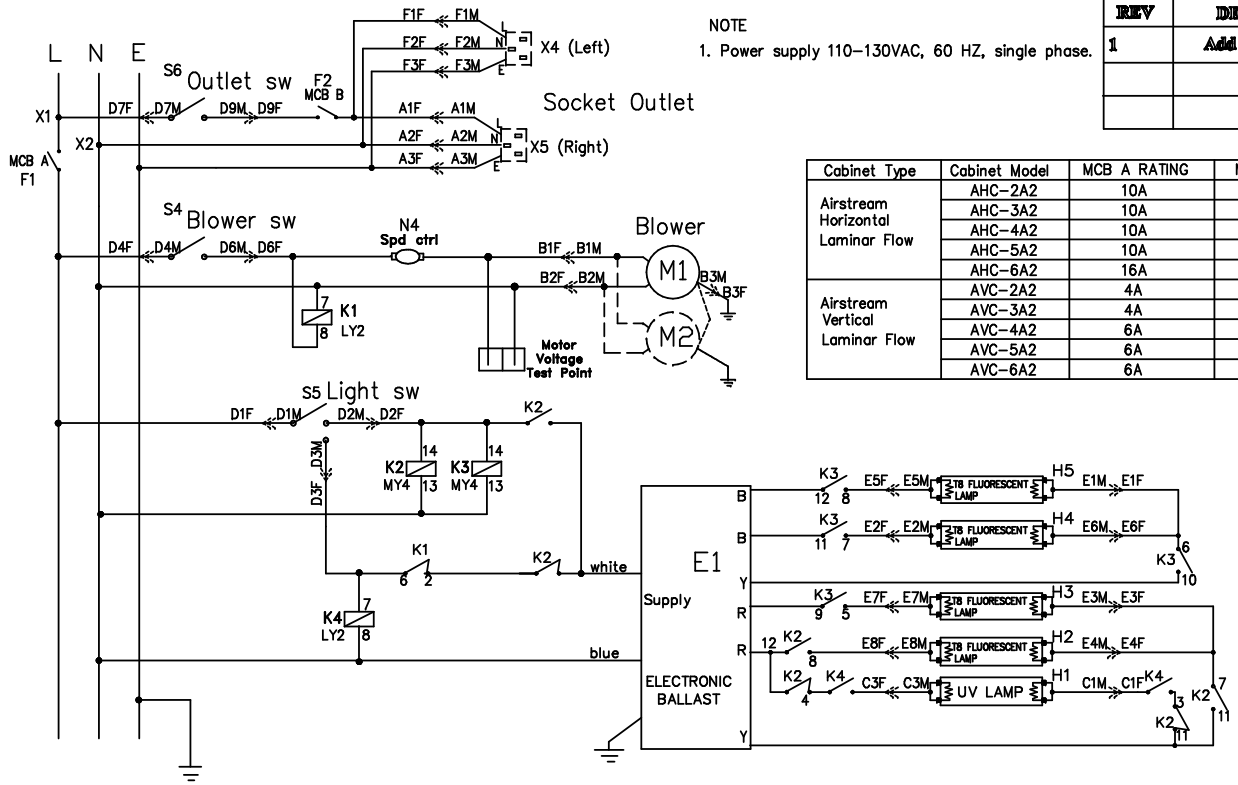
Cabinet Type		MCB A RATING	MCB B RATING	SPD CON'L RATING
Airstream Horizontal Laminar Flow	AHC–2A1	6A	6A	706–123SB
	AHC–3A1	6A	6A	706–123SB
	AHC–4A1	6A	6A	706–123SB
	AHC–5A1	6A	6A	706–123SB
	AHC–6A1	10A	6A	706–123SB
Airstream Vertical Laminar Flow	AVC–2A1	3A	6A	1 X KB ELECTRONIC,6A (KBWC–26)
	AVC–3A1	3A	6A	1 X KB ELECTRONIC,6A (KBWC–26)
	AVC–4A1	3A	6A	1 X KB ELECTRONIC,6A (KBWC–26)
	AVC–5A1	4A	6A	1 X KB ELECTRONIC,6A (KBWC–26)
	AVC–6A1	4A	6A	1 X KB ELECTRONIC,6A (KBWC–26)

220–240VAC, 50HZ

We hereby approve the design and specifications as correct and that we are fully responsible for any infringement of copyright patent or trademarks

Stamp Signature Date

ESCO MICRO PTE LTD		DRAWN: Wang Wu Zhi	CHECKED:	DRAWN: NTS
CLIENT:	TITLE: EP01(small switch)	DWG NO:		DATE: 28/10/2003

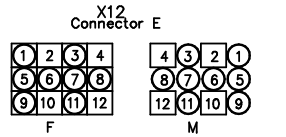


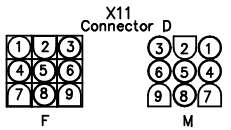
NOTE

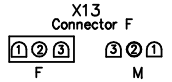
1. Power supply 110–130VAC, 60 HZ, single phase.

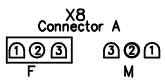
REV	DESCRIPTION	DATE
1	Add Relay K4, Add Switch S6	05/12/2003

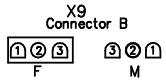
Cabinet Type	Cabinet Model	MCB A RATING	MCB B RATING	SPD CON'L RATING
Airstream Horizontal Laminar Flow	AHC–2A2	10A	6A	706–123SB ,10A
	AHC–3A2	10A	6A	706–123SB ,10A
	AHC–4A2	10A	6A	706–123SB ,10A
	AHC–5A2	10A	6A	706–123SB ,10A
	AHC–6A2	16A	6A	706–123SC ,15A
Airstream Vertical Laminar Flow	AVC–2A2	4A	6A	KBWC–15
	AVC–3A2	4A	6A	KBWC–15
	AVC–4A2	6A	6A	KBWC–15
	AVC–5A2	6A	6A	KBWC–15
	AVC–6A2	6A	6A	706–123SB ,10A

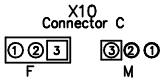












Laminar Flow Switch Control

110–130VAC, 60HZ

We hereby approve the design and specifications as correct and that we are fully responsible for any infringement of copyright patent or trademarks

Stamp Signature Date

ESCO MICRO PTE LTD		DRAWN: Wang Wu Zhi	CHECKED:	DRAWN: NTS
CLIENT:	TITLE: EP02(small switch)	DWG NO:		DATE: 28/10/2003

CHAPTER III
TROUBLESHOOTING OF COMMON PROBLEMS

Problem	Possible Causes	Corrective Action
Cabinet does not start	Wrong electrical connection	Check whether electrical cord has been connected properly
	Power failure	1. Check for electrical power at the wall outlet 2. Reset the circuit breaker by pressing the button
Motor silent	Blown fuse	Switch off the cabinet
	Faulty relays	1. Switch off the cabinet 2. Check K1 relay on the electrical panel. Ensure that C-NC connection is closed and C-NO open. 3. Replace the faulty relay(s)
	Faulty speed control	1. Short out control by placing jumper wire directly across the connections to the two speeds control leads. 2. If the fan operates, the speed control is defective. Call your distributor for replacement 3. If the fan does not run, the speed control is not the problem
	Auto-thermal cut-off	1. Blower was overheated. 2. Wait for 30 minutes and try again. Ensure that no hazardous materials inside the cabinet
	Motor failure	1. Disconnect two motor leads at the motor. Connect a proper AC voltage source directly to the motor. 2. If the motor starts to run, the problem is in the wiring connection. Refer to blown fuse or faulty relay section 3. If the motor does not run, the motor is defective. Replace motor
	Faulty capacitor	Replace the capacitor. Check for open wiring connection
Inoperative switches	Connection problem	Check whether the cable from electrical panel has been connected properly to the switch
Low airflow	Low speed control setting	Increase the speed control setting until motor starts

	Faulty capacitor	Replace the capacitor. Check for open wiring connection
	Faulty speed control	1. Short out control by placing jumper wire directly across the connections to the two speeds control leads. 2. If the fan operates, the speed control is defective. Call your distributor for replacement 3. If the fan does not run, the speed control is not the problem
Excessive fan noise	Loose Motor or Blower Wheel Mount	Check the tightness of the setscrew holding the blower wheel. Check the tightness of all blower and motor mounting bolts
Light always OFF	Faulty relay	Check K2 and K3 relay on the electrical panel. Ensure that C-NC connection is closed and C-NO open. Replace the faulty relay. Call your distributor for details
	Faulty light	Replace the faulty light
UV Light always OFF	Faulty relay	Check K2 and K4 relay on the electrical panel. Ensure that C-NC connection is closed and C-NO open. Replace the faulty relay. Call your distributor for details
	Faulty light	Replace the faulty light
Contaminated samples	Filter leaking	Repair or replace filter and recertify the cabinet
	Low airflow	Readjust the airflow and recertify the cabinet

COPYRIGHT INFORMATION

Esco Micro Pte Ltd
21 Changi South Street 1
Singapore 486777

WARRANTY REGISTRATION FORM

Thank you for purchasing an Esco product!
To be applicable for the latest product promotions and special offers, please complete this warranty registeration form and return it to Esco by fax or postal mail.

PRODUCT INFORMATION

Model Number : _____
Serial Number : _____
Date of Purchase : _____

CUSTOMER INFORMATION

Company : _____
Address : _____
: _____
Telephone : _____
Fax : _____
Email : _____

NAME OF ESCO DISTRIBUTOR

Contact : _____
Company : _____
Country : _____

YOUR COMMENTS

_____
_____
_____
_____

Please Fill in Your T-Shirt Size and Get a FREE Esco T-Shirt!
(Allow Up to 4 Weeks For Delivery)
T-Shirt Size*: Large / Extra-Large
* Delete Inapplicable Field

DEFECT REPORTING FORM

To submit your warranty claim or to obtain a Return Authorization (RA) number, please complete this defect reporting form and return it to Esco by fax or postal mail.

PRODUCT INFORMATION

Model Number : _____
Serial Number : _____
Date of Purchase : _____

CUSTOMER INFORMATION

Company : _____
Address : _____
: _____
Telephone : _____
Fax : _____
Email : _____

NAME OF ESCO DISTRIBUTOR

Contact : _____
Company : _____
Country : _____

BRIEF DESCRIPTION OF ERROR

_____
_____
_____
_____

WHEN DID THE ERROR OCCUR*

Transport Damage / Unpacking / Assembly / Routine Operation

RETURNING PRODUCTS/PARTS*

Under Warranty / For Service or Repair / For Replacement / Credit Note Requested

Name/Date: _____ Signature: _____

The use of non-Esco parts and/or parts not supplied directly by Esco or our authorized distributors, including but not limited to maintenance parts, spare parts, replacement parts, system components and/or system accessories, shall void all expressed or implied warranties.

REPLACEMENT PARTS LIST

PARTS LIST FOR AHC-2A1 (2 FEET, 220-240V, 50HZ)

Item	Item Code	Description	No. Per Cabinet
MECHANICAL REPLACEMENT PARTS			
1. FILTER	EQR/SP-FTR12	610X610-10/22 (2"X2"X66MM) Eff: >99.99% dP: 125Pa @ 0.45m/s	1
2. BLOWER	EQR/EL-BL-D4E200CC-230V	BLOWER CENTRIFUGAL D4E-200	1
3. TEMPERED GLASS	EQR/GL-22	TEMPERED GLASS 592 x 570 x 6MM 3 HOLES DIA 19MM	2
ELECTRICAL REPLACEMENT PARTS			
1. ELECTRIC MODULE	EP01-H10	COMPLETE ELECTRICAL PANEL 220-240VAC EP01 WITH SPEED CONTROLLER 10A	1
1.1. SPEED CONTROL*	EQR/EL-KH706-0155-060	SPEED CONTROLLER 10A	1
1.2. BALLAST*	EQR/EL-BAL-TP4/32IS	ELECTRONIC BALLAST	1
1.3. RELAY*	EQR/EL-REL-JQX220	RELAY 10A/2POLE, 220-240V	2
	EQR/EL-REL-JZX220	RELAY 5A/4POLE, 220-240V	2
2. CAPACITOR	EQR/EL-CCAP-25MF	CBB 60 capacitor, 400V, 25 mf	1
3. FLUORESCENT TUBE	EQR/EL-TUB-2F17W	FLUORESCENT TUBE 2FT	3
4. CIRCUIT BREAKER	EQR/EL-CB-6A	CIRCUIT BREAKER 6AMPS, WITH KNURL NUT	2
5. ROCKER SWITCH	EQR/EL-SW-RL1-411	ROCKER SWITCH (ON-OFF)	2
	EQR/EL-SW-RL1-413	ROCKER SWITCH RL (ON-OFF-ON)	1

* Item is included on complete main replacement electrical panel. However it may be replaced individually if required.

PARTS LIST FOR AHC-2A2 (2 FEET, 110-130V, 60HZ)

Item	Item Code	Description	No. Per Cabinet
MECHANICAL REPLACEMENT PARTS			
1. FILTER	EQR/SP-FTR12	610X610-10/22 (2"X2"X66MM) Eff: >99.99% dP: 125Pa @ 0.45m/s	1
2. BLOWER	EQR/EL-BL-D4E225CC-115V	BLOWER CENTRIFUGAL D4E-225- (115V)	1
3. TEMPERED GLASS	EQR/GL-22	TEMPERED GLASS 592 x 570 x 6MM 3 HOLES DIA 19MM	2
ELECTRICAL REPLACEMENT PARTS			
1. ELECTRIC MODULE	EP02-H10	COMPLETE ELECTRICAL PANEL 110-130VAC EP02 WITH SPEED CONTROLLER 10A	1
1.1. SPEED CONTROL*	EQR/EL-KH706-0155-060	SPEED CONTROLLER 10A	1
1.2. BALLAST*	EQR/EL-BAL-TP4/32IS	ELECTRONIC BALLAST	1
1.3. RELAY*	EQR/EL-REL-JZX110	RELAY 5A/4POLE, 110V	2
	EQR/EL-REL-JQX110	RELAY 10A/2POLE, 110V	2
2. CAPACITOR	EQR/EL-CCAP-40MF	CBB 60 capacitor, 400V, 40 mf	1
3. FLUORESCENT TUBE	EQR/EL-TUB-2F17W	FLUORESCENT TUBE 2FT	3
4. CIRCUIT BREAKER	EQR/EL-CB-6A	CIRCUIT BREAKER, 6AMPS, WITH KNURL NUT	1
	EQR/EL-CB-10A	CIRCUIT BREAKER, 10AMPS, WITH KNURL NUT	1
5. ROCKER SWITCH	EQR/EL-SW-RL1-411	ROCKER SWITCH (ON-OFF)	2
	EQR/EL-SW-RL1-413	ROCKER SWITCH (ON-OFF-ON)	1

* Item is included on complete main replacement electrical panel. However it may be replaced individually if required.

PARTS LIST FOR AHC-3A1 (3 FEET, 220-240V, 50HZ)

Item	Item Code	Description	No. Per Cabinet
MECHANICAL REPLACEMENT PARTS			
1. FILTER	EQR/SP-FTR14	914X610-10/22 (2"X3"X66MM) Eff: >99.99% dP: 125Pa @ 0.45m/s	1
2. BLOWER	EQR/EL-BL-D4E200CC-230V	BLOWER CENTRIFUGAL D4E-200	1
3. TEMPERED GLASS	EQR/GL-22	TEMPERED GLASS 592 x 570 x 6MM 3 HOLES DIA 19MM	2
ELECTRICAL REPLACEMENT PARTS			
1. ELECTRIC MODULE	EP01-H10	COMPLETE ELECTRICAL PANEL 220-240VAC EP01 WITH SPEED CONTROLLER 10A	1
1.1. SPEED CONTROL*	EQR/EL-KH706-0155-060	SPEED CONTROLLER 10A	1
1.2. BALLAST*	EQR/EL-BAL-TP4/32IS	ELECTRONIC BALLAST TP4/32IS UNIVERSAL	1
1.3. RELAY*	EQR/EL-REL-JQX220	RELAY 10A/2POLE, 220-240V	2
	EQR/EL-REL-JZX220	RELAY 5A/4POLE, 220-240V	2
2. CAPACITOR	EQR/EL-CCAP-25MF	CBB 60 capacitor, 400V, 25 mf	1
3. FLUORESCENT TUBE	EQR/EL-TUB-3F25W	FLUORESCENT TUBE 3 FT	2
4. CIRCUIT BREAKER	EQR/EL-CB-6A	CIRCUIT BREAKER ZE-700-6, 6AMPS, WITH KNURL NUT	2
5. ROCKER SWITCH	EQR/EL-SW-RL1-411	ROCKER SWITCH (ON-OFF)	2
	EQR/EL-SW-RL1-413	ROCKER SWITCH (ON-OFF-ON)	1

* Item is included on complete main replacement electrical panel. However it may be replaced individually if required.

PARTS LIST FOR AHC-3A2 (3 FEET, 110-130V, 60HZ)

Item	Item Code	Description	No. Per Cabinet
MECHANICAL REPLACEMENT PARTS			
1. FILTER	EQR/SP-FTR14	914X610-10/22 (2"X3"X66MM) Eff: >99.99% dP: 125Pa @ 0.45m/s	1
2. BLOWER	EQR/EL-BL-D4E225CC-115V	BLOWER CENTRIFUGAL D4E-225-CC13-44 (115V)	1
3. TEMPERED GLASS	EQR/GL-22	TEMPERED GLASS 592 x 570 x 6MM 3 HOLES DIA 19MM	2
ELECTRICAL REPLACEMENT PARTS			
1. ELECTRIC MODULE	EP02-H10	COMPLETE ELECTRICAL PANEL 110-130VAC EP02 WITH SPEED CONTROLLER 10A	1
1.1. SPEED CONTROL*	EQR/EL-KH706-0155-060	SPEED CONTROLLER 10A	1
1.2. BALLAST*	EQR/EL-BAL-TP4/32IS	ELECTRONIC BALLAST	1
1.3. RELAY*	EQR/EL-REL-JZX110	RELAY 5A/4POLE, 110V	2
	EQR/EL-REL-JQX110	RELAY 10A/2POLE, 110V	2
2. CAPACITOR	EQR/EL-CCAP-40MF	CBB 60 capacitor, 400V, 40 mf	1
3. FLUORESCENT TUBE	EQR/EL-TUB-3F25W	FLUORESCENT TUBE 3Ft	2
4. CIRCUIT BREAKER	EQR/EL-CB-6A	CIRCUIT BREAKER , 6AMPS, WITH KNURL NUT	1
	EQR/EL-CB-10A	CIRCUIT BREAKER , 10AMPS, WITH KNURL NUT	1
5. ROCKER SWITCH	EQR/EL-SW-RL1-411	ROCKER SWITCH (ON-OFF)	2
	EQR/EL-SW-RL1-413	ROCKER SWITCH (ON-OFF-ON)	1

* Item is included on complete main replacement electrical panel. However it may be replaced individually if required.

PARTS LIST FOR AHC-4A1 (4 FEET, 220-240V, 50HZ)

Item	Item Code	Description	No. Per Cabinet
MECHANICAL REPLACEMENT PARTS			
1. FILTER	EQR/SP-FTR15	1219X610-11/22 (2"X4"X66MM) Eff: >99.99% dP: 125Pa @ 0.45m/s	1
2. BLOWER	EQR/EL-BL-D4E200CC-230V	BLOWER CENTRIFUGAL D4E-200	1
3. TEMPERED GLASS	EQR/GL-22	TEMPERED GLASS 592 x 570 x 6MM 3 HOLES DIA 19MM	2
ELECTRICAL REPLACEMENT PARTS			
1. ELECTRIC MODULE	EP01-H10	COMPLETE ELECTRICAL PANEL 220-240VAC EP01 WITH SPEED CONTROLLER 10A	1
1.1. SPEED CONTROL*	EQR/EL-KH706-0155-060	SPEED CONTROLLER 10A	1
1.2. BALLAST*	EQR/EL-BAL-TP4/32IS	ELECTRONIC BALLAST	1
1.3. RELAY*	EQR/EL-REL-JQX220	RELAY 10A/2POLE, 220-240V	2
	EQR/EL-REL-JZX220	RELAY 5A/4POLE, 220-240V	2
2. CAPACITOR	EQR/EL-CCAP-25MF	CBB 60 capacitor, 400V, 25 mf	1
3. FLUORESCENT TUBE	EQR/EL-TUB-4F32W	FLUORESCENT TUBE 4FT	2
4. CIRCUIT BREAKER	EQR/EL-CB-6A	CIRCUIT BREAKER , 6AMPS, WITH KNURL NUT	2
5. ROCKER SWITCH	EQR/EL-SW-RL1-411	ROCKER SWITCH (ON-OFF)	2
	EQR/EL-SW-RL1-413	ROCKER SWITCH (ON-OFF-ON)	1

* Item is included on complete main replacement electrical panel. However it may be replaced individually if required.

PARTS LIST FOR AHC-4A2 (4 FEET, 110-130V, 60HZ)

Item	Item Code	Description	No. Per Cabinet
MECHANICAL REPLACEMENT PARTS			
1. FILTER	EQR/SP-FTR15	1219X610-11/22 (2"X4"X66MM) Eff: >99.99% dP: 125Pa @ 0.45m/s	1
2. BLOWER	EQR/EL-BL-D4E225CC-115V	BLOWER CENTRIFUGAL D4E-225-	1
3. TEMPERED GLASS	EQR/GL-22	TEMPERED GLASS 592 x 570 x 6MM 3 HOLES DIA 19MM	2
ELECTRICAL REPLACEMENT PARTS			
1. ELECTRIC MODULE	EP02-H10	COMPLETE ELECTRICAL PANEL 110-130VAC EP02 WITH SPEED CONTROLLER 10A	1
1.1. SPEED CONTROL*	EQR/EL-KH706-0155-060	SPEED CONTROLLER 10A	1
1.2. BALLAST*	EQR/EL-BAL-TP4/32IS	ELECTRONIC BALLAST	1
1.3. RELAY*	EQR/EL-REL-JZX110	RELAY 5A/4POLE, 110V	2
	EQR/EL-REL-JQX110	RELAY 10A/2POLE, 110V	2
2. CAPACITOR	EQR/EL-CCAP-40MF	CBB 60 capacitor, 400V, 40 mf	1
3. FLUORESCENT TUBE	EQR/EL-TUB-4F32W	FLUORESCENT TUBE 4FT	2
4. CIRCUIT BREAKER	EQR/EL-CB-6A	CIRCUIT BREAKER 6AMPS, WITH KNURL NUT	1
	EQR/EL-CB-10A	CIRCUIT BREAKER , 10AMPS, WITH KNURL NUT	1
5. ROCKER SWITCH	EQR/EL-SW-RL1-411	ROCKER SWITCH (ON-OFF)	2
	EQR/EL-SW-RL1-413	ROCKER SWITCH (ON-OFF-ON)	1

* Item is included on complete main replacement electrical panel. However it may be replaced individually if required

PARTS LIST FOR AHC-5A1 (5 FEET, 220-240V, 50HZ)

Item	Item Code	Description	No. Per Cabinet
MECHANICAL REPLACEMENT PARTS			
1. FILTER	EQR/SP-FTR16	1524X610-10/22 (2"X5"X66MM) Eff: >99.99% dP: 125Pa @ 0.45m/s	1
2. BLOWER	EQR/EL-BL-D4E200CC-230V	BLOWER CENTRIFUGAL D4E-200	1
3. TEMPERED GLASS	EQR/GL-22	TEMPERED GLASS 592 x 570 x 6MM 3 HOLES DIA 19MM	2
ELECTRICAL REPLACEMENT PARTS			
1. ELECTRIC MODULE	EP01-H10	COMPLETE ELECTRICAL PANEL 220-240VAC EP01 WITH SPEED CONTROLLER 10A	1
1.1. SPEED CONTROL*	EQR/EL-KH706-0155-060	SPEED CONTROLLER 10A	1
1.2. BALLAST*	EQR/EL-BAL-TP4/32IS	ELECTRONIC BALLAST	1
1.3. RELAY*	EQR/EL-REL-JQX220	RELAY 10A/2POLE, 220-240V	2
	EQR/EL-REL-JZX220	RELAY 5A/4POLE, 220-240V	2
2. CAPACITOR	EQR/EL-CCAP-25MF	CBB 60 capacitor, 400V, 25 mf	1
3. FLUORESCENT TUBE	EQR/EL-TUB-3F25W	FLUORESCENT TUBE 3 FT	2
	EQR/EL-TUB-2F17W	FLUORESCENT TUBE 2 FT	2
4. CIRCUIT BREAKER	EQR/EL-CB-6A	CIRCUIT BREAKER 6AMPS, WITH KNURL NUT	2
5. ROCKER SWITCH	EQR/EL-SW-RL1-411	ROCKER SWITCH (ON-OFF)	2
	EQR/EL-SW-RL1-413	ROCKER SWITCH (ON-OFF-ON)	1

* Item is included on complete main replacement electrical panel. However it may be replaced individually if required.

PARTS LIST FOR AHC-5A2 (5 FEET, 110-130V, 60HZ)

Item	Item Code	Description	No. Per Cabinet
MECHANICAL REPLACEMENT PARTS			
1. FILTER	EQR/SP-FTR16	1524X610-10/22 (2"X5"X66MM)Eff: >99.99% dP: 125Pa @ 0.45m/s	1
2. BLOWER	EQR/EL-BL-D4E225CC-115V	BLOWER CENTRIFUGAL D4E-225-CC13-44 (115V)	1
3. TEMPERED GLASS	EQR/GL-22	TEMPERED GLASS 592 x 570 x 6MM 3 HOLES DIA 19MM	2
ELECTRICAL REPLACEMENT PARTS			
1. ELECTRIC MODULE	EP02-H10	COMPLETE ELECTRICAL PANEL 110-130VAC EP02 WITH SPEED CONTROLLER 10A	1
1.1. SPEED CONTROL*	EQR/EL-KH706-0155-060	SPEED CONTROLLER 10A	1
1.2. BALLAST*	EQR/EL-BAL-TP4/32IS	ELECTRONIC BALLAST	1
1.3. RELAY*	EQR/EL-REL-JZX110	RELAY 5A/4POLE, 110V	2
	EQR/EL-REL-JQX110	RELAY 10A/2POLE, 110V	2
2. CAPACITOR	EQR/EL-CCAP-40MF	CBB 60 capacitor, 400V, 40 mf	1
3. FLUORESCENT TUBE	EQR/EL-TUB-3F25W	FLUORESCENT TUBE F25T8/850	2
	EQR/EL-TUB-2F17W	FLUORESCENT TUBE 2 FT	2
4. CIRCUIT BREAKER	EQR/EL-CB-6A	CIRCUIT BREAKER 6AMPS, WITH KNURL NUT	1
	EQR/EL-CB-10A	CIRCUIT BREAKER 10AMPS, WITH KNURL NUT	1
5. ROCKER SWITCH	EQR/EL-SW-RL1-411	ROCKER SWITCH (ON-OFF)	2
	EQR/EL-SW-RL1-413	ROCKER SWITCH (ON-OFF-ON)	1

* Item is included on complete main replacement electrical panel. However it may be replaced individually if required.

PARTS LIST FOR AHC-6A1 (6 FEET, 220-240V, 60HZ)

Item	Item Code	Description	No. Per Cabinet
MECHANICAL REPLACEMENT PARTS			
1. FILTER	EQR/SP-FTR17	610X1829X66 ULPA W/ LAMINATOR, Eff: >99.99% dP: 125Pa @ 0.45m/s	1
2. BLOWER	EQR/BL-D4E250-230	BLOWER D4E250 230V	1
3. TEMPERED GLASS	EQR/GL-22	TEMPERED GLASS 592 x 570 x 6MM 3 HOLES DIA 19MM	2
ELECTRICAL REPLACEMENT PARTS			
1. ELECTRIC MODULE	EP01-H10	COMPLETE ELECTRICAL PANEL 220-240VAC EP01 WITH SPEED CONTROLLER 10A	1
1.1. SPEED CONTROL*	EQR/EL-KH706-0155-060	SPEED CONTROLLER 10A	1
1.2. BALLAST*	EQR/EL-BAL-TP4/32IS	ELECTRONIC BALLAST	1
1.3. RELAY*	EQR/EL-REL-JQX220	RELAY 10A/2POLE, 220-240V	2
	EQR/EL-REL-JZX220	RELAY 5A/4POLE, 220-240V	2
2. CAPACITOR	EQR/EL-CCAP-25MF	CBB 60 capacitor, 400V, 25 mf	1
3. FLUORESCENT TUBE	EQR/EL-TUB-3F25W	FLUORESCENT TUBE F25T8/850	4
4. CIRCUIT BREAKER	EQR/EL-CB-6A	CIRCUIT BREAKER 6AMPS, WITH KNURL NUT	1
	EQR/EL-CB-10A	CIRCUIT BREAKER , 10AMPS, WITH KNURL NUT	1
5. ROCKER SWITCH	EQR/EL-SW-RL1-411	ROCKER SWITCH (ON-OFF)	2
	EQR/EL-SW-RL1-413	ROCKER SWITCH (ON-OFF-ON)	1

* Item is included on complete main replacement electrical panel. However it may be replaced individually if required.

PARTS LIST FOR AHC-6A2 (6 FEET, 110-130V, 60HZ)

Item	Item Code	Description	No. Per Cabinet
MECHANICAL REPLACEMENT PARTS			
1. FILTER	EQR/SP-FTR17	610X1829X66 ULPA W/ LAMINATOR, Eff: >99.99% dP: 125Pa @ 0.45m/s	1
2. BLOWER	EQR/EL-BL-D4E225CC-115V	BLOWER CENTRIFUGAL D4E-225 (115V)	1
3. TEMPERED GLASS	EQR/GL-22	TEMPERED GLASS 592 x 570 x 6MM 3 HOLES DIA 19MM	2
ELECTRICAL REPLACEMENT PARTS			
1. ELECTRIC MODULE	EP02-H15	COMPLETE ELECTRICAL PANEL 110-130VAC EP02 WITH SPEED CONTROLLER 15A	1
1.1. SPEED CONTROL*	EQR/EL-KH706-0155-075	SPEED CONTROLLER 15A	1
1.2. BALLAST*	EQR/EL-BAL-TP4/32IS	ELECTRONIC BALLAST	1
1.3. RELAY*	EQR/EL-REL-JZX110	RELAY 5A/4POLE, 110V	2
	EQR/EL-REL-JQX110	RELAY 10A/2POLE, 110V	2
2. CAPACITOR	EQR/EL-CCAP-40MF	CBB 60 capacitor, 400V, 40 mf	1
3. FLUORESCENT TUBE	EQR/EL-TUB-3F25W	FLUORESCENT TUBE	4
4. CIRCUIT BREAKER	EQR/EL-CB-6A	CIRCUIT BREAKER 6AMPS, WITH KNURL NUT	1
	EQR/EL-CB-16A	CIRCUIT BREAKER 16AMPS, WITH KNURL NUT	1
5. ROCKER SWITCH	EQR/EL-SW-RL1-411	ROCKER SWITCH (ON-OFF)	2
	EQR/EL-SW-RL1-413	ROCKER SWITCH (ON-OFF-ON)	1

* Item is included on complete main replacement electrical panel. However it may be replaced individually if required.

APPENDIX A
INTRODUCTION TO LAMINAR FLOW CABINET

In the 1960's, due to the increased need for clean air in industry, laminar flow cabinets (also known as cleanbenches or laminar airflow hoods) were first developed to provide product protection for small-scale experimental procedures. A laminar flow cabinet provides a controlled environment in which levels of particulates, microbes, and contamination of all kinds are regulated and kept to a minimum by constant air filtration with industrial-grade filters.

How Does a Laminar Flow Cabinet Work

A laminar flow cabinet creates a particle-free working environment by taking air through a filtration system and exhausting it across a work surface in a laminar or unidirectional air stream. Commonly, the filtration system comprises of a pre-filter and a HEPA filter. Because the air within the cabinet does not contain any airborne particles, it is also sterile.

The laminar flow cabinet is usually enclosed on the sides and kept under constant positive pressure in order to prevent the infiltration of contaminated room air.

Laminar Flow Cabinets and Cleanroom Technology

In order to further understand the technology behind laminar flow, it is helpful to consider that these cabinets were first developed as an adjunct to cleanroom technology. Just like the interior of a laminar flow cabinet, cleanrooms are also controlled "clean environments" used in many modern industries. However, while industrial cleanrooms can span thousands of square metres, with sophisticated protocols, entry systems and working garments, a laminar flow cabinet provides a much more economically viable solution for smaller scale processes.

The only drawback of the laminar flow cabinet is its inability to accommodate extremely large pieces of equipment due to physical constraints within the working zone.

What Are Laminar Flow Cabinets Used For?

In industrial applications, laminar flow cabinets can be placed within a cleanroom to create an ultra-clean mini-environment. When a laminar flow cabinet rated at Class 10* or Class 100* levels is placed within a Class 1000* cleanroom, the air within the cabinet can often meet Class 1* levels.

This arrangement is usually very economical versus operating a full-sized Class 1* cleanroom. However, the most common application of the laminar flow cabinet is using it to provide an individual clean air environment for small items not requiring a full-size cleanroom.
In the laboratory, individual laminar flow cabinets are commonly used for specialized work such as tissue culture to eliminate airborne contamination would otherwise interfere with work processes.

** Particles of 0.5 microns in size per cubic foot of air*
The lower the cleanliness class, the cleaner the air
For more information refer to the US Federal Standard 209E

If air flows in straight, parallel paths throughout an enclosed space, the airflow is said to be laminar.
In Esco Laminar Flow Cabinets, the "laminar flow" is a stream of clean air conditioned by a sophisticated industrial-grade filtration system. Proprietary construction technology guarantees that the internal plenum of the cabinet is pressurized uniformly.

This serves to increase filter life by evenly loading the filter and also guarantees the uniformity of airflow within the working zone of the cabinet, which helps to enhance product protection.
Laminar airflow guarantees that air throughout the cabinet is replaced in a consistent fashion. This also ensures that particles generated in the cabinet due to normal work processes do not become trapped in dead air corners, where they may otherwise accumulate and cause product contamination.

Laminar Flow Cabinets Provide Product Protection

Product or sample protection is important in a wide variety of modern industries. This includes the pharmaceuticals industry, in which clean air is necessary for the sterile production of drugs.
In the semiconductors and microelectronics fields, a single dust particle can cause irreversible product damage during the manufacturing process, which is why clean air is necessary to protect sensitive components, without which the miniaturization of electronics would otherwise be impossible.

In the laboratory, airborne contamination can often influence experimental procedures and results, which is why processes should be carried out under controlled environment conditions.
An Esco Laminar Flow Cabinet equipped with a state of the art filtration system can reduce airborne contamination levels greatly within the working area, depending on the filtration system of choice.

International Standards and Norms

The most common standard referred to by most manufacturers of laminar flow systems is the US Federal Standard 209E. It is important to understand that the 209E does not apply specifically to laminar flow cabinets and that is only applies in general to air cleanliness for cleanrooms.

The US Federal Standard 209E does not deal with general aspects of laminar flow cabinet construction. However, it deals with the most important aspect of cabinet performance which is the level of product protection provided (in other words the cleanliness of the air) within the working area of the laminar flow cabinet. Most laminar flow cabinets meet Class 100 (with HEPA filters) or Class 10 (with ULPA filters) standards.

This is the reason that Esco specifically declares that the clean working area provided within our cabinet complies to the US Federal Standard 209E for Class 100 cleanliness.
Other standards and norms similar to the US Federal Standard 209E (dealing with cleanrooms and clean air) are the BS 5295, AS 1386, VDI 2083 and the recently released ISO standard 14664.

The main filtration process in all Esco laminar flow cabinets comprises of a HEPA (high efficiency particulate air) filter that removes airborne contaminants, including all particulate matter, bacteria and spores, with an efficiency of 99.999%, rated at a particle size of 0.3 microns. All HEPA filters have integral metal faceguards in order to prevent accidental damage.

While other manufacturers may utilize HEPA filters efficient to only 99.97%, which is the minimum requirement for a HEPA filter, Esco only utilizes HEPA filters efficient to 99.999% at 0.3 microns, which increases product protection by 30 times. Although HEPA filters provide product protection to Class 100 levels and are the standard main filtration system of choice, Esco offers customers the option of using ULPA filters instead of HEPA filters. ULPA filters have an efficiency of 99.9995% at 0.12 microns and may be necessary for certain special applications with more critical requirements with regards to cleanliness and product protection.

General Information About HEPA/ULPA Filters

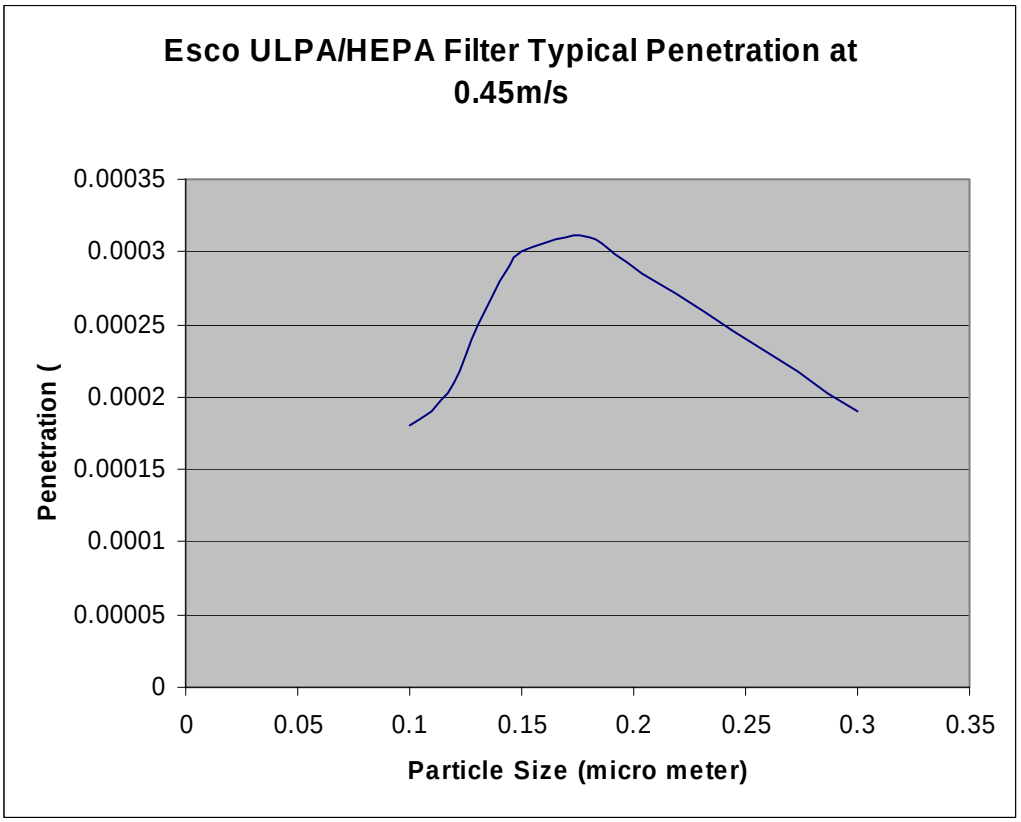
HEPA filters are least efficient when it comes to trapping particles of 0.3 microns in size. For airborne particulates less or more than 0.3 microns in size, the efficiency of the filter increases beyond its rated level

In order to illustrate the size of a 0.3 micron particle, consider that a human hair has a diameter of approximately 100 microns, whereas 10 microns is the smallest size visible to the naked human eye. A micron is a measure of length that equals one millionth of a meter.

The medium of a typical HEPA filter is a single sheet of borosilicate fibers which has been treated with a wet-strength water-repellant binder. The filter medium is pleated to increase the overall surface area, and the filter is then attached to a metal frame.

Esco only uses the latest HEPA filters produced using the latest minipleat manufacturing process which lowers costs without compromising efficiency. We are probably the only manufacturer of laminar flow cabinets to own our own filter production facility.

All HEPA / ULPA filters used in Esco Laminar Flow Cabinets are of the highest quality and are laser scan tested after production to ensure leak-free performance and efficiency. After being mounted onto the each cabinet, each filter is once again individually tested at our factory for filter leaks with the most sophisticated airborne particle counters.



APPENDIX B

UV LAMPS IN LAMINAR FLOW AND BIOLOGICAL SAFETY CABINET

Introduction

Ultraviolet light is part of the electromagnetic (EM) spectrum, and is divided into 3 wavelength ranges: UV-C, from 100 nanometers (nm) to 280 nm; UV-B, from 280 nm to 315 nm; and UV-A, from 315 nm to 400 nm.

The germicidal ultraviolet lamp emits high intensity ultraviolet radiation concentrated around the wavelength of 253.7nm (i.e. "UV-C radiation"). 95% of the radiation emitted by germicidal lamps is at this wavelength which also happens to be in the region of maximum germicidal effectiveness.

Before laminar flow cabinets were developed in the 1960s and 1970s, biologists in the laboratory used dead air boxes constructed of plastics with nothing more than an UV lamp in them to keep the interior of the box sterile. The UV lamp would be turned on to decontaminate the interior of the box, switched off, leaving the box ready for use. Of course we have come a long way since then - the dead air box system was rudimentary and without any positive pressure airflow (from inside the box to the outside) contaminated room air could easily have been induced into the box again.

Naturally as the use of laminar flow cabinets become increasingly popular UV lamps were also incorporated on these new clean air devices for their germicidal properties. Typically in a laminar flow or biological safety cabinet the UV lamp is activated while the cabinet is not in use to keep the interior of the work zone clean and decontaminated (for example throughout the night until the user returns the next day to use the cabinet again). Modern cabinets have also improved on this feature and some have UV timers to allow the user to control the decontamination cycle (for example to turn the lamp on for a few hours, then shut it down, instead of leaving it on the entire night) in order to conserve lamp life (these lamps have a rated lifespan after which effectiveness rapidly deteriorates).

However, in the late 1970s and 1980s as the use of laminar flow and biological safety cabinets became increasingly prevalent; manufacturers became increasingly aware of the detrimental effects of the UV lamp when used on these cabinets. It is the purpose of this technical paper to discuss the negative effects of using UV lamps in modern laminar flow and biological safety

cabinets, in the hope that this will educate users, purchasers, and anyone involved in laminar flow or biological safety cabinet technology, to ensure better safety all for laboratory users.

1. The use of the UV lamp in laminar flow and biological safety cabinets is explicitly discouraged in all major international standards and recommendations. May we refer the reader to the following references:

a. NSF Standard 49 for Class II Biohazard Safety Cabinetry

"UV lighting is not recommended in Class II (laminar flow) biosafety cabinetry. If requested by the purchaser, it shall be installed in such a manner that it does not reduce the required performance (of the cabinet) ... UV irradiation can cause erythema of skin and eye damage." (Section 5.25.2)

b. European Standard EN12469:2000 for Microbiological Safety Cabinets

"Ultraviolet (UV) radiation is not recommended for use in safety cabinets. However, if requested, it should be installed in such a manner that it does not affect the airflow and containment performance of the cabinet." (Annex A Section 2)

c. Australian Standard AS1386.5 for Clean Workstations (Laminar Flow Cabinets)

"It is recommended that the use of UV-lamps be avoided. The need for UV-lamps should first be established by the user. Special safety precautions need to be in use for protection of personnel, products and materials. There is a potential for misuse of UV-lamps with resulting injuries and deleterious effects of pharmaceutical products." (Section 5.12)

d. Australian Standard AS2252.1 for Class I Biological Safety Cabinets
"Installation of UV lamps is not recommended ..." (Section 4.7)

e. Australian Standard AS2252.2 for Class II Biological Safety Cabinets
"Installation of UV lamps is not recommended ..." (Section 4.7)

f. Australian Standard AS2567 for Laminar Flow Cytotoxic Drug Safety Cabinets
"Installation of UV lamps is not recommended ..." (Section 4.7)

g. American CDC Publication "Primary Containment for Biohazards: Selection, Installation and Use of Biological Safety Cabinets"

"Ultraviolet (UV) lamps are not required in BSCs" (Page 26)

2. Personnel safety issues

a. Exposure to UV radiation can cause erythema of skin and eye damage.

b. In addition the cabinet needs to be properly equipped with UV-filtering materials (front / side covers) and proper interlocking mechanism to prevent exposure, which increases the overall cost and complexity of the cabinet. When one considers all this additional extra precautions need to be taken, plus the facts concerning the ineffectiveness of the UV lamp (see below), clearly the reasons for not using the UV lamp are compelling.

c. Some UV lamps also contain mercury and breaking the lamp can result in undesirable exposure to this toxic compound.

d. UV radiation is also reflected off some surfaces like stainless steel, which means additional safety precautions need to be taken as well. A front cover / night door must always be utilized on a cabinet when UV is employed to prevent UV exposure of other personnel in the laboratory when the UV lamp is activated.

e. One of the problems in working with UV radiation is that the symptoms of overexposure are not immediately felt so that persons exposed do not realize the hazard until after the damage is done.

f. Germicidal UV lamps produce ozone which can also be toxic in high concentrations.

3. Performance degradation of the cabinet

a. Ultraviolet radiation can potentially degrade materials in the cabinet such as certain plastics (when they may be used) and sealant (such as RTV / silicone) used to ensure joints / seams are airtight. In the most extreme / dangerous situation for biological safety cabinets, this could cause critical joints to degrade, in turn resulting in other performance issues: loss of pressure tightness integrity (potentially allowing biological hazards to escape through these seams), or allowing contamination to accumulate in these joints posing a cleanability / decontamination problem.

While Esco ensures that all materials in our cabinets are resistant to ultraviolet radiation, this may not be the case for other manufacturers. In addition, clearly by eliminating this extra performance variable (i.e. not using an ultraviolet light) especially after considering the other detrimental effects of the UV lamp, the long-term overall performance of the cabinet can be better ensured.

b. Airflow interference and turbulence. When UV lamps are installed as a permanent fixture in the work zone (which is usually the case for reasons of convenience) they cause unnecessary airflow turbulence which can in turn disrupt product and cross contamination protection. In other words the UV lamp causes turbulence which disrupts the laminar / unidirectional nature of the air stream, which is critical to maintaining proper cabinet product / cross contamination performance.

As detailed in many of the international standards above, the cabinet is tested with the UV lamp in place in order to ensure that it does not degrade this performance aspect. Again, while Esco ensures this by conducting rigorous testing in our in-house research laboratory, this may not always be the case for other manufacturers.

In conclusion, while it is reasonable to say that the UV lamp largely has no effect on the product protection and cross contamination protection of the cabinet, it is also very reasonable to conclude that by eliminating this variable the overall performance of the cabinet can be increased - especially when the other factors in this document as considered as a whole.

4. Ineffectiveness of the UV lamp on modern laminar flow and biological safety cabinets

When considered in the modern perspective of laminar flow and biological safety cabinet technology, the ultraviolet lamp on the whole in generally ineffective for the following reasons:

a. The laminar flow or biological safety cabinet should be operated 24 hours a day (an economic possibility especially when some of Esco's latest energy efficient models are used) to ensure complete sterility, eliminate lengthy startup times, and keep the work zone ready to use at all times, prevent non-decontaminated biological hazards from escaping the work zone from the interior in the case of safety cabinets. When this recommendation is observed the ultraviolet lamp becomes irrelevant.

b. The ultraviolet lamp to a large extent has become largely a fallacy among users of laminar flow and biological safety cabinets today. Again when one considers the way in which these lamps are used this easily becomes apparent.

As mentioned above usually the operator will shut down the blower, install a front / night cover (when available), then turn on the UV lamp. The work zone is then "decontaminated" (or so the user believes) overnight, and the next day when he / she returns to the lab the UV lamp is turned off, and the lamps deactivated. Clearly since the front / night cover is not totally air-tight during this interval the cabinet could already be contaminated before the user has a chance to start the fans, thus rendering whatever "decontamination" that took place in the night useless.

In some extreme situations, UV lamps are used without front / night covers which not only pose a safety risk, but also makes the use of the lamp ridiculous. In other words the user turns the lamp on, exits the laboratory, returns the next day and shuts the lamp down. Even during the "decontamination" at night of the cabinet by the lamp the user did not realize that air in the room was already moving into the cabinet thus contaminating all exposed surfaces, thus negating the use of the lamp.

c. Presence of surface contamination in the work zone
During the period when the blowers are shut down, the front / night covers installed, and the UV lamp activated, clearly there is ample opportunity for contaminated room air to infiltrate and contaminate the work zone. UV lamps are ineffective as long as any surface contamination (dust particles etc.) is present as UV has limited penetrating power.

d. The lamp does not decontaminate all surfaces in the cabinet
On some cabinet designs, the placement and design of the lamp means that not all surfaces in the cabinet are exposed to UV radiation. This is especially the case for biological safety cabinets where the lamp on all cabinet designs does not decontaminate the critical contaminated air return plenum beneath the work surface.

In addition, occasionally some users (disregarding manufacturer recommendations) may store objects inside the cabinet. When this is the case the UV lamp is totally ineffective for these shadowed areas.

e. The lamp must be cleaned regularly (to remove surface dust on the glass surface of the lamp) for maximum effectiveness but this aspect is often ignored by users which therefore degrades the performance of the UV lamp.

5. The UV lamp encourages bad working practice

The lamp encourages bad working practice by giving users a "false sense of security". While manufacturers like Esco constantly emphasize that when the lamp is used it is ONLY an aid to surface decontamination, some users, lulled into a sense of security, may disregard usual surface decontamination practices

In other words before using the cabinet they believe the work zone is clean and do not wipe down with for example 70% alcohol. After using the cabinet they also disregard the wipe down process which is especially important on biological safety cabinets.

When one considers that the UV lamp, for the reasons stated above, is ineffective, this work habit (or the lack thereof) and false sense of security that the UV lamp encourages in users, is detrimental to the performance of the cabinet.

6. Lack of validation

a. UV lamps are not changed when they have to

As mentioned above, UV lamps have a specific life cycle and need to be changed after a certain number of hours to maintain effectiveness (radiation intensity). Unfortunately not many service companies have the capability to check the intensity of the UV lamp and consequently the user may persist in using a lamp which has already become ineffective.

b. The effectiveness of the UV lamp cannot be validated

There does not exist a single convenient technique that is widely employed for validating the effectiveness of the UV lamp after every decontamination cycle. The best option that exists is the use of a special decontamination paper "strip" that changes appearance after exposure to sufficient radiation, but this is not employed by many cabinet users.

c. Lack of consistency in validation technique

Even when the service company may check the intensity of the UV radiation, there exists a general lack of validation technique in the industry. For example even the NSF49 does not have a performance test for validating this aspect of the cabinet. Consequently validation technique often depends on the service company and is not reproducible throughout the industry. Furthermore many service companies simply take one reading in the centre of the work zone which clearly does not suffice given the fact that the user is expecting the UV lamp to be effective in decontamination all work zone surfaces. But then clearly measuring the UV intensity at all work surface positions is impracticality.

APPENDIX C
THE ROLE OF THE PRESSURE GAUGE IN HEPA-FILTERED CLEAN AIR DEVICES

Abstract

HEPA-filtered clean air devices – systems containing both a fan and a HEPA filter – are prevalent today in many modern applications. They include laminar flow/biological safety cabinets (hoods) for laboratory applications, in addition to cleanroom equipment such as fan filter units. This technical paper outlines the theory of operation of the pressure gauge, which is commonly used in the industry as an indicator on HEPA-filtered clean air devices are discussed in detail. Proper usage practices are also recommended.

Introduction and Theory of Operation

The pressure gauges found on all HEPA-filtered clean air devices, are, at the most fundamental level, indicators of differential pressure. In a HEPA-filtered clean air device, for air to move across a HEPA filter, there must be a difference between the pressures of the plenums (and enclosed air space in which the pressure at multiple points is almost uniform) before and after the filter. Air will then move from a region of higher pressure across the filter to a region of lower pressure. A fan is used to create this pressure difference.

For example, a fan may be used to pressurize air positively (with respect to the ambient environment) in a plenum. Air is then forced from a region of high pressure before the filter, across the filter, into a region that has a pressure roughly equal to that of the ambient atmosphere. This last region may be, for example, the work zone of a laminar flow cabinet. In theory this region may be defined to be under slight positive pressure (due to “velocity” pressure or the pressure “exerted” by the laminar air stream) but in practice it may be considered to have a pressure equivalent to that of the ambient environment. In this scenario the fan can be thought of as “blowing” air across the filter. It is also possible for a fan to be “sucking” air across a filter – fundamentally this is the same and a pressure difference also exists. The pressure difference is also referred to a “pressure loss across the filter” or a “pressure drop across the filter”.

Therefore, a pressure gauge indicates the difference in pressure between the plenums present before and after the filter. In the example above (“blowing”), the pressure gauge indicates the

difference between the region of high pressure before the filter, and that of the ambient environment (atmosphere). Practically this value is derived by subtracting the ambient pressure value from the actual value of the positive pressure plenum before the filter. Note that on all HEPA-filtered clean air devices the pressure gauge only reads in one direction (i.e. its value cannot be negative).

When a pressure gauge is present on a HEPA-filtered clean air device it indicates pressure as follows: one sampling tube will be connected to the plenum just before the filter and the other sampling tube will be connected to the plenum just after the filter. The gauge then indicates the pressure difference between both plenums. In the case of a laminar flow cabinet, for example, a sampling tube will be connected to the positive pressure plenum just before the filter, and the other tube connected to the exterior of the cabinet to sample ambient pressure. In the case of Esco laminar flow cabinets, the second tube is connected to the region of negative pressure that is before the fan but after the pre-filters. Hence on Esco cabinets the pressure gauge indicates the pressure difference not only across the main HEPA filter but across the entire fan system (taking into consideration the drop across the pre-filters).

Differential pressure gauges (also called a manometer) are available in different display units. Common display units include inches of water, millimeters of water, or Pascal's. The most common pressure gauge suitable for indicating the relatively low differential pressures present on HEPA filters is unequivocally the Minihelic / Magnehelic series of gauges manufactured by Dwyer Instruments Inc. Esco products make use of a gauge displaying in terms of inches of water ("Inches W.C.").

Using the gauge on HEPA-Filtered Clean Air Devices

A HEPA filter when new and unused has a certain pressure drop to produce a certain amount of airflow. For example, new Esco filters are rated at less than 125Pa / 0.5" W.C. to produce an linear air velocity (across the filter) of 0.45m/s or 90fpm. Most manufacturers try to optimize the performance of their HEPA-filtered clean air device by minimizing this initial pressure loss. The lower the initial pressure loss value, the less "work" the fan has to "do" to maintain airflow and the more efficient the fan system.

However, as a filter "loads" during the normal course of operation, to maintain the same air velocity across the filter, the pressure loss will increase. For example, the pressure drop required to maintain 0.45m/s or 90fpm on an Esco filter may increase from 125Pa / 0.5"W.C. to 150Pa as the filter "loads". This is due to the fact that during the normal course of operation the filter will

“collect “fine particulate matter in the media bed, causing greater resistance to airflow. In practical terms all manufacturers would recommend that the user adjust a variable speed control regularly to increase the speed of the fan system (above its initial speed setting) to compensate for this increase in resistance and maintain airflow in the system. This adjustment must in most cases be validated by a true airflow velocity meter. Adjustments CANNOT be performed using the pressure gauge. This is because the pressure drop across the filter, to maintain the SAME amount of airflow, is NOT a constant and depends on the health of the filter. It is only a known constant when the filter is new.

In any HEPA-filtered clean air device the user’s concern is undoubtedly to maintain a proper quantity of airflow in the system. On a laminar flow cabinet the user’s goal will be to maintain a laminar airflow velocity of approximately 0.45m/s or 90fpm for example. On a Class II biosafety cabinet the user will try to maintain certain downflow and inflow setpoints / velocities which in turn translate to a certain amount of airflow across the entire filtration system. Airflow, NOT pressure loss across the filters, is the primary factor that translates into performance and/or safety (apart naturally form other aspects such as filter integrity and efficiency)

The pressure loss across the filter as indicated by the differential pressure gauge may be thought of as an indicator of the “health” of the filter or the efficiency of the entire blower system provided that airflow is maintained by (a) speed control adjustment and (b) validation with a true airflow velocity meter. The higher the operating pressure loss of the filter, the “poorer” its health and the less efficient the blower system.

The user will note that on every filtration system there are two operating pressure points that can be determined. When the filter is new there will be a certain operating point to maintain a certain airflow setpoint. As the filters become loaded and the speed of the fan is increased to maintain airflow the filtration and fan system will soon reach another operating value – this operating value can be thought of as a “maximum” beyond which the fan cannot work any “harder” to deliver airflow. Hence, a theoretical application of the pressure gauge is, provided that airflow is maintained and measured with an independent meter, as a liner “scale of filter loading” – a scale ranging from the initial value explained above to the final value. That is, as the reading on the gauge increases from the initial value the user will know how much “pressure capacity” the fan has left to maintain airflow. As the reading on the gauge approaches the “known maximum” the user will know that the filter must soon be replaced. In practice this is hard to apply because for every single unit the initial and final operating points may be different.

Practically though the pressure gauge has some useful applications. On Esco cabinets, the initial operating pressure corresponding to the required airflow setpoint is recorded at the factory during initial commissioning. If the setting on the variable speed control has been accidentally reset or adjusted before actual use the user may, upon actual use, adjust the variable speed control so as to operate the filters at the same pressure point.

In general the pressure gauge can also indicate very roughly airflow across the filter. On a new filter an operating point of 125 pa or 0.5" W.C. corresponds to a filter velocity of roughly 0.45m/s or 90fpm. Although this operating pressure point may increase as the filter loads, under all conditions, an increase in pressure across the filter (in the same operating "health" condition) correspond to an increase in airflow. The pressure gauge may hence be used as a relatively inaccurate airflow meter that is "true in itself".

In pharmaceutical applications, to meet GMP requirements, a pressure gauge is useful from the point of view that is allows the user to record operating conditions in terms of the pressure loss across the filter. In many cases, a pressure gauge is the only airflow meter available economically and may be thought of as "better than nothing" (although it is far from ideal). If there is a pressure loss across the filter, the user knows that there is airflow across the filter (although he or she will not know the airflow velocity).

Remember that a pressure gauge is not an indicator of airflow (as much as manufacturers may like to lead you to believe otherwise) and should not be used as such under any circumstances. Esco has encountered in the industry many false recommendations such as "the filters should be changed when the pressure exceeds 1.5 inches W.C.". (yes, this is correct, PROVIDED that airflow is maintained with an independent meter – this is something hat is often unstated). Other recommendations read in such a manner as to lead (in our opinion) the user to think of the pressure gauge as an airflow meter.

Increasingly, pressure gauges are being replaced by "true" electronic airflow meters on higher-end equipment (such as biosafety cabinets). At Esco, pressure gauges have already been replaced on all higher-end Esco Labculture horizontal and vertical laminar flow cabinets, in addition to all biosafety cabinets.

APPENDIX D
REFERENCE MATERIALS

Books and Standards

1. **Introduction to Contamination Control and Cleanroom Technology by Matt Ramstorp**
2. **ISO 14644-1 - Classification of air cleanliness**
3. **ISO 14644-2 - Specifications for testing and monitoring**
4. **ISO/TC 209 - ISO 14644 Standards and IEST Technical Guides to the ISO Standards**
5. **ISO/DIS 14644-7 - Separative enclosures**
6. **IEST-G-CC1001 - IEST technical guide for counting airborne particles for classification and monitoring of cleanrooms and clean zones**
7. **IEST-G-CC1002 - IEST technical guide for determination of the concentration of airborne ultra fine particles**
8. **IEST-G-CC1003 - IEST technical guide for measurement of airborne macro particles**
9. **IEST-G-CC1004 - IEST technical guide for sequential-sampling plan for use in classification of the particulate cleanliness of air in cleanrooms and clean zones**
10. **IEST-RP-CC001.3 - IEST recommended practices for HEPA and ULPA filters**
11. **IEST-RP-CC007.1 - IEST recommended practices for testing ULPA filters**
12. **IEST-RP-CC021.1 - IEST recommended practices for testing HEPA and ULPA filter media**
13. **IEST-RP-CC034.1 - IEST recommended practices for HEPA and ULPA filter leak tests**
14. **EN1822 (Parts 1 to 5) - European air filters standard**
15. **EN 13091 - Biotechnology. Performance criteria for filter elements and filtration assemblies**
16. **EN 112741 – Biotechnology. Laboratories for research, development and analysis**
17. **EN 12296 – Biotechnology. Equipment. Guidance on testing procedures for cleanability**
18. **EN 12297 – Biotechnology. Equipment. Guidance on testing procedures for sterilizability**
19. **EN 12298 – Biotechnology. Equipment. Guidance on testing procedures for leak tightness**
20. **AS 1386 – Cleanrooms and Clean Workstations**
21. **IEST-RP-CC002.2 – Unidirectional Flow Clean-Air-Devices**

Websites

1. NSF Accredited Class II Biosafety Cabinet Field Certifiers

   Please see http://www.nsf.org/Certified/Biosafety-Certifier for more information

2. I.A.F.C.A – member certifying company

   Please see http://www.iafca.com/listview.html for more information

3. www.escoglobal.com
   Esco Micro Pte. Ltd.

Log Record

<u>Installed By</u>

Date :_____________________ **Cabinet Model:______________**

Company :_____________________ **Serial Number:______________**

Responsible Person :_____________________

Please record any major maintenance procedure performed by the technician and/or operator, for example: filter changing, recertification, uv lamp replacement, pre-filter replacement, speed control adjustment, etc.

Date	Event	Operator Signature	Manager Signature

Date	Event	Operator Signature	Manager Signature

Date	Event	Operator Signature	Manager Signature

Date	Event	Operator Signature	Manager Signature

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