

Thank you for purchasing this Esco Biological Safety Cabinet. Please read this manual thoroughly to familiarize yourself with the many unique features and exciting innovations we have built into your new equipment. Esco provides many other resources at our website, [www.escoglobal.com](http://www.escoglobal.com), to complement this manual and help you enjoy many years of productive and safe use of your Esco products.



# Service Manual

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**Airstream<sup>®</sup> Plus**

Class II

Biological Safety Cabinet

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Esco reserves the right to make periodic minor design changes without obligation to notify any person or entity of such change.

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## Warranty Terms and Conditions

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Esco products come with a limited warranty. The warranty period will vary depending on the product purchased, beginning on the date of shipment from any Esco international warehousing location. To determine which warranty applies to your product, refer to the appendix below.

Esco's limited warranty covers defects in materials and workmanship. Esco's liability under this limited warranty shall be, at our option, to repair or replace any defective parts of the equipment, provided that these parts, if proven to the satisfaction of Esco, were defective at the time of being sold and that all defective parts shall be returned, properly identified with a Return Authorization.

This limited warranty covers parts only, and not transportation/insurance charges.

This limited warranty does not cover:

- Freight or installation (inside delivery handling) damage. If your product was damaged in transit, you must file a claim directly with the freight carrier.
- Products with missing or defaced serial numbers.
- Products for which Esco has not received payment.
- Problems that result from:
  - External causes such as accident, abuse, misuse, problems with electrical power, improper operating environmental conditions.
  - Servicing not authorized by Esco.
  - Usage that is not in accordance with product instructions.
  - Failure to follow the product instructions.
  - Failure to perform preventive maintenance.
  - Using accessories, parts, or components not supplied by Esco.
  - Damage by fire, floods, or acts of God.
  - Customer modifications to the product.
- Consumables such as filters (HEPA, ULPA, carbon, pre-filters) and fluorescent / UV bulbs.

Factory installed, customer specified equipment or accessories are warranted only to the extent guaranteed by the original manufacturer. The customer agrees that in relation to these products purchased through Esco, our limited warranty shall not apply and the original manufacturer's warranty shall be the sole warranty in respect of these products. The customer shall utilize that warranty for the support of such products and in any event not look to Esco for such warranty support.

Esco encourages all users to register their equipment online at [www.escoglobal.com/warranty\\_registrations.php](http://www.escoglobal.com/warranty_registrations.php) or complete the warranty registration form included with each product.

ALL EXPRESS AND IMPLIED WARRANTIES FOR THE PRODUCT, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES AND CONDITIONS OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE LIMITED IN TIME TO THE TERM OF THIS LIMITED WARRANTY. NO WARRANTIES, WHETHER EXPRESS OR IMPLIED, WILL APPLY AFTER THE LIMITED WARRANTY PERIOD HAS EXPIRED. ESCO DOES NOT ACCEPT LIABILITY BEYOND THE REMEDIES PROVIDED FOR IN THIS LIMITED WARRANTY OR FOR SPECIAL, INDIRECT, CONSEQUENTIAL OR INCIDENTAL DAMAGES, INCLUDING, WITHOUT LIMITATION, ANY LIABILITY FOR THIRD-PARTY CLAIMS AGAINST YOU FOR DAMAGES, FOR PRODUCTS NOT BEING AVAILABLE FOR USE, OR FOR LOST WORK. ESCO'S LIABILITY WILL BE NO MORE THAN THE AMOUNT YOU PAID FOR THE PRODUCT THAT IS THE SUBJECT OF A CLAIM. THIS IS THE MAXIMUM AMOUNT FOR WHICH ESCO IS RESPONSIBLE.

These Terms and Conditions shall be governed by and construed in accordance with the laws of Singapore and shall be subject to the exclusive jurisdiction of the courts of Singapore.

**Technical Support, Warranty Service Contacts**

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Singapore: +65 6542 0833

Global Email Helpdesk: [support@escoglobal.com](mailto:support@escoglobal.com)

Visit <http://escoglobal.com> to talk to a Live Support Representative

Distributors are encouraged to visit the Distributor Intranet for self-help materials.

**Product Appendix, Warranty Listings**

Biological Safety Cabinets, Laminar Flow Cabinets, Laboratory Animal Research Workstations, HEPA-Filtered Cabinets (except Streamline brand)	3 years limited
Laboratory Fume Hoods	2 years limited
Ductless Fume Hoods	2 years limited
Cleanroom Equipment	1 year limited
Laboratory Ovens and Incubators	1 year limited
Laboratory Shaker	1 year limited
CO <sub>2</sub> Incubators	2 years limited
Containment/Pharma Products	2 years limited
Ultra-low Temperature Freezer	5 years limited 5 years on compressor
Laboratory Centrifuge	2 years limited
Freeze Dryer	2 years limited
Laboratory Refrigerator	2 years limited
Thermal Cyclers	3 years limited for MiniPro, Aeris, ProvoCell 2 years limited for Spectrum 2 years on blocks and Peltier units 2 years on all electronic components 3 years on the housing and fans

*Note: The warranty periods may vary by country. Contact your local distributor for specific warranty details.*

For international distributors, warranty period starts two months from the date the equipment is shipped from Esco facility. This allows shipping time so the warranty will go into effect at approximately the same time the equipment is delivered to the user. The warranty protection extends to any subsequent owner during the warranty period. Distributors who stock Esco equipment are allowed an additional four months for delivery and installation, providing the product is registered with Esco. User can register their products online at [www.escoglobal.com/warranty](http://www.escoglobal.com/warranty) or complete the warranty registration form include with each product.


Policy updated on 1<sup>st</sup> January 2015 (This limited warranty policy applies to products purchased on and after 1<sup>st</sup> January 2015)

# Introduction

## 1. Products Covered

Esco Class II Biological Safety Cabinet					
Model	Electrical Rating	0.9 meters 3 feet	1.2 meters 4 feet	1.5 meters 5 feet	1.8 meters 6 feet
Airstream, Glass Side	220-240 VAC, 50/60Hz	AC2-3E8-TU	AC2-4E8-TU	AC2-5E8-TU	AC2-6E8-TU
Airstream, Stainless Steel Side		AC2-3S8-TU	AC2-4S8-TU	AC2-5S8-TU	AC2-6S8-TU

## 2. Safety Warning

- Anyone working with, on or around this equipment should read this manual. Failure to read, understand and comply with the instructions given in this manual may result in damage to the unit, injury to operating personnel, and / or poor equipment performance.
- Any internal adjustment, modification or maintenance to this equipment must be undertaken by qualified service personnel.
- The use of any hazardous materials in this equipment must be monitored by an industrial hygienist, safety officer or some other suitably qualified individuals.
- Explosive or inflammable substances should never be used in the cabinet unless adequate risk assessment has been carried out.
- If chemical, radiological or other non-microbiological hazards are being used in the cabinet, additional protective measures should be taken based on an adequate risk assessment.
- This cabinet should not be used with cytotoxic substances unless it has been determined that the filter can be safely changed. Please note that cytotoxic substances cannot be inactivated by conventional gaseous decontamination method (e.g. formaldehyde) used to inactivate biological agents.
- The biological hazard symbol on the front panel of the cabinet indicates the presence of biological substances that pose a threat to human health.
- Before you process, you should thoroughly understand the installation procedures and take note of the environmental / electrical requirements.
- In this manual, important safety related points will be marked with the symbol. 
- If the equipment is used in a manner not specified by this manual, the protection provided by this equipment may be impaired.

## 3. Document Management

We recommend that you keep this manual, along with the factory test report close to the cabinet for easy reference by the cabinet operator and qualified maintenance personnel.

If you require replacements for any of the provided documentation (including factory test reports) you can request copies from Esco Customer Services\*. Please provide the following information when making requests for replacement documents:

- Company (Organization) Name
- Product Brand and Model
- Product Serial Number
- Documents requested

\* There may be a nominal charge for this service.

## 4. Limitation of Liability

The disposal and / or emission of substances used in connection with this equipment may be governed by various local regulations. Familiarization and compliance with any such regulations are the sole responsibility of the users. Esco's liability is limited with respect to user compliance with such regulations.

## 5. European Union Directive on WEEE and RoHS

The European Union has issued two directives:

- **Directive 2002/96/EC on Waste Electrical and Electronic Equipment (WEEE)**

This product is required to comply with the European Union's Waste Electrical & Electronic Equipment (WEEE) Directive 2002/96/EC. It is marked with the following symbol:

Esco sells products through distributors throughout Europe. Contact your local Esco distributor for recycling/disposal.



Recommended method of disposal is according to The Federal, State and Local Government regulations.

- **Directive 2002/95/EC on Restriction on the use of Hazardous Substances (RoHS)**

With respect to the directive on RoHS, please note that this cabinet falls under category 8 (medical devices) and category 9 (monitoring and control instruments) and is therefore exempted from requirement to comply with the provisions of this directive.

## 6. Symbols

Information in this manual may be prefaced with the following symbols. They are provided to help you identify important operational, safety, maintenance or conformance issues.



**Electrical Hazard:** Danger of electric shock



**Turn Off and Disconnect From Main Supply Before Proceeding:** Do not perform this operation while the unit is operational



**The Biohazard Symbol** on the front panel of the cabinet indicates the presence of biological substances that pose a threat to human health

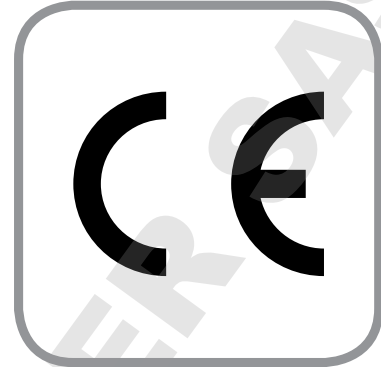


**Approved Service Engineer Only:** Operation to be performed only by approved engineers

## Declaration of Conformity

In accordance to EN ISO/IEC 17050-1:2010

We, Esco Micro Pte Ltd  
of 21 Changi South Street 1  
Singapore, 486777  
Tel: +65 6542 0833  
Fax: +65 6542 6920



declare on our sole responsibility that the product:

**Category** : Class II Biological Safety Cabinet  
**Brand** : Airstream  
**Model** : AC2-3E8-TU, AC2-4E8-TU, AC2-5E8-TU, AC2-6E8-TU, AC2-3S8-TU, AC2-4S8-TU,  
AC2-5S8-TU, AC2-6S8-TU

in accordance with the following directives:

**2014/35/EU** : The Low Voltage Directive and its amending directives  
**2014/30/EU** : The Electromagnetic Compatibility Directive and its amending directives  
**2011/65/EU** : The RoHS in Electrical and Electronic Equipment Directive and its amending directives

has been designed to comply with the requirement of the following Harmonized Standard:

**Low Voltage** : EN 61010-1:2010  
**EMC** : EN 61326-1:2013 Class B  
**Design/Performance Criteria** : EN 12469 (2000) Class I Microbiological Safety Cabinet

More information may be obtained from Esco's authorized distributors located within the European Union. A list of these parties and their contact information is available on request from Esco.

*Lim Lay Yew*

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Lim Lay Yew  
Director, Esco

This Declaration of Conformity is only applicable for 230VA

## Chapter 1 - Maintenance and Re-certification of the Cabinet

Esco products generally provide years of trouble-free operation however like all equipment they require maintenance and service. Maintenance and service should be carried out by trained personnel. Esco offers training courses to equip service providers with the latest skills, information and tools to successfully maintain and service Esco products. For more information on the nearest training course, please contact Esco.

Service providers should familiarize themselves with the basic operating principles of products before working on them. Suitable references include information in this Manual or brochures which may be downloaded from the Esco web site.

Biological safety cabinets generally require:

- Re-certification, when:
  - The cabinet is re-located.
  - Cabinet performance is suspect.
  - After filter or blower replacement.
  - At least once a year or based on your risk assessment.
  - During recertification:
    - Cabinet airflow velocities and flow patterns are verified against the manufacturer's specifications and relevant international standards
    - Filters are scan-tested to ensure they do not leak.
    - Operator comfort tests may be performed.
    - If airflow velocities are found to be off setpoint, adjustments are made as part of the certification process before final values are recorded.
- Airflow alarm calibration, when:
  - The cause of the airflow alarm cannot be determined.
  - Re-certification indicates the displayed airflow deviates by  $> 0.02$  m/s (4 fpm) from actual measured velocities (only for products with airflow velocity displays).
- Decontamination before filter or fan replacement, or as specified.
- Filter replacement, when:
  - The filters are clogged and the fan(s) are unable to compensate for the filter loading.
  - Filter leaks which cannot be repaired are found during scan-testing.

Note: Before filter replacement, the cabinet must be decontaminated.
- Fan replacement (typically rare) if failure occurs.
- Routine maintenance also includes:
  - Fluorescent lamp(s) replacement - typically once every 2 years.
  - UV lamp replacement - typically once every 1 year.
- For complete certification process, please refer to certification procedure form given. Please contact local distributor/Esco office for an enquiry of this form.

### 1.1. Installation Check

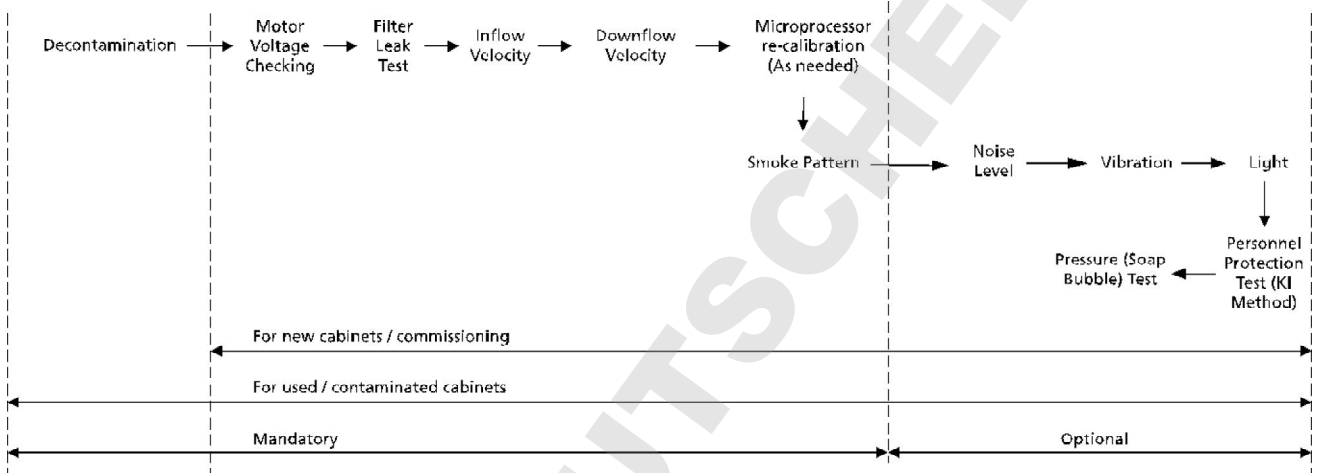
1. Check that the cabinet was installed away from air conditioning unit, heater, door, ceiling lamp, or any other equipment that affect cabinet airflow to ensure the sensor reading on top of cabinet is undisturbed.
2. Make sure the holes on the exhaust airflow sensor are not blocked, and the holes on the exhaust and downflow airflow sensors are perpendicular to the airflow path. If the airflow sensor is moved, then the microprocessor requires re-calibration.
3. Make sure the holes on the exhaust and downflow airflow sensors tube are perpendicular to the airflow path. If the airflow sensor tube is moved, then the microprocessor requires re-calibration.
4. Make sure that the exhaust filter is not blocked, and the downflow diffuser is properly installed.
5. Make sure that the downflow diffuser is properly installed.
6. Check that the fan duty cycle matches with the value given on the test report.

## 1.2. Cabinet Field Certification

Cabinet field certification must be performed on:

- New installation.
- Relocation of cabinet.
- Activation of airflow alarm with undetermined cause.
- When cabinet performance is suspect.
- At least once in a year or based on your risk assessment.

The steps to perform field certification:



## 1.3. Performing Calibration / Certification

### 1.3.1. Setting Cabinet in Maintenance Mode

To start the certification, ensure the fan and lamps are turned on. The cabinet should then be put to maintenance mode. In Maintenance Mode all alarms are defeated and the window can be moved without the light being switched off.

1. At normal mode LCD displays:

ESCO AC2-TUV	X: XX
Sash: OK	AirFlow: OK
I: 0.48 m/s	D: 0.35 m/s

OR

ESCO AC2-TUV	X: XX
Sash: OK	AirFlow: OK
I: 95 fpm	D: 70 fpm

2. Press MENU button to accessing microprocessor menu. The LCD will display:

ESCO AC2-TUV	X: XX
PASSWORD: 0	
Used ↑ / ↓ to change	
Then press set...	

Use the ▼ button until the cursor on the LCD is at "ENTER MENU". Press the SET button.

'PASSWORD' with flashing '0' will be displayed. Enter the ADMIN PIN. Follow procedure below to enter the default ADMIN PIN of 0009.

- a. Press SET button. Flashing '00' will be displayed.
- b. Press SET button. Flashing '000' will be displayed.
- c. Press SET button. Flashing '0000' will be displayed.

- d. Press ▼ button to key in 9
- e. Press SET button

3. Alarm will sound, wait until alarm stops. Display should read :

```
MENU OPTIONS  XX: XX
→SETTINGS
SET MODE
ADMIN SETTINGS
```

4. Use the ▼ button until the cursor on the LCD is at "SET MODE". Press the SET button.

```
MENU OPTIONS  XX: XX
NORMAL MODE
QUICKSTART MODE
→MAINTENANCE MODE
```

5. Use the ▼ button until the cursor is at "MAINTENANCE MODE". Press the SET button. Now the cabinet is in maintenance mode. Press the MENU button to exit from the menu mode.

6. The word "MAINTENANCE" is displayed on the LCD as shown below :

```
MAINTENANCE  XX: XX
Sash: OK
I: 0.48 m/s  D: 0.35 m/s
```

```
MAINTENANCE  XX: XX
Sash: OK
I: 95 fpm    D: 70 fpm
```

### 1.3.2. Adjusting Blower Speed and Airflow Set Point

Carry out the steps below to adjust the airflow:

1. Press MENU button. Enter the ADMIN PIN (Default ADMIN PIN is 0009)
2. If SETTINGS is displayed the ADMIN code has been removed proceed to step 3
  - a. Press SET with 0 flashing
    - b. Press SET with 00 last digit flashing
    - c. Press SET with 000 last digit flashing
    - d. Press SET with 0000 last digit flashing
    - e. Press ▼ button to key in 9
    - f. Press SET
3. Alarm will sound, wait until alarm stops. Cabinet should read.

```
MENU OPTIONS  20:15
→ SETTINGS
SET MODE
ADMIN SETTINGS
CALIBRATION
```

4. Use the ▼ button until the cursor on CALIBRATION. Press the SET button and LCD would show :

```
MENU OPTIONS  20:15
→ ZERO SENSOR
CALIBRATE SENSOR
SET STANDBY SPEED
```

5. Use the ▼ button until the cursor on CALIBRATE SENSOR. Press the SET button and LCD would show :

```
CALIBRATION    20:15
Calibrate Sensor
Read Manual !!!
And Press SET Button
```

6. Press the SET button and LCD would show:

```
CALIBRATION    20:15
Set to nominal speed
Exh. Speed blower 50%
Then Press SET . . .
```

7. Press ▲ or ▼ to change the exhaust blower speed, then press SET to confirm. And LCD will show:

```
CALIBRATION    20:15
Set to nominal speed
D/F. Speed blower 30%
Then Press SET . . .
```

8. Press ▲ or ▼ to change the downflow blower speed, then press SET to confirm. And LCD will show:

```
CALIBRATION    20:15
Enter Inflow: 0.48 m/s
Use ▲ / ▼ to change
Then Press SET . . .
```

9. Press ▲ or ▼ to change the inflow velocity nominal, then press SET to confirm. And LCD will show:

```
CALIBRATION    20:15
Enter Downflow
Velocity: 0.35 m/s
Then Press SET . . .
```

10. Press ▲ or ▼ to change the downflow velocity nominal, then press SET to confirm. And LCD will show:

```
CALIBRATION    20:15
New ADC IFN : 0855
New ADC DFN : 0745
Press SET When Stable
```

11. Press SET when ADC value has stable. And LCD will show:

```
CALIBRATION    20:15
Wait 01 Min
Time Left : 59:00
```

12. Wait 1 minute and then LCD will display CALIBRATION DONE or CALIBRATION ERROR. Calibration done mean calibration was success and correct, press MENU button twice to exit. Calibration error mean calibration was not success, please do recalibration.

### 1.3.3. Mandatory Annual Inspection of Sash Mechanism

Checking of Motorized Tubular Motor:

1. Remove screws from the left and right side of blue panel. Lift up the front panel.  
Caution: The front panel is equipped with a gas spring which will open the front panel automatically.
2. Check mounting screws on both sides of the brackets, ensure there are no loose screws.
3. Check the plastic end caps for any sign of cracks. Do not operate sash if cracks are found.
4. Check suspension belts are securely fastened to the sash glass. Check for any sign of tearing on the belt.

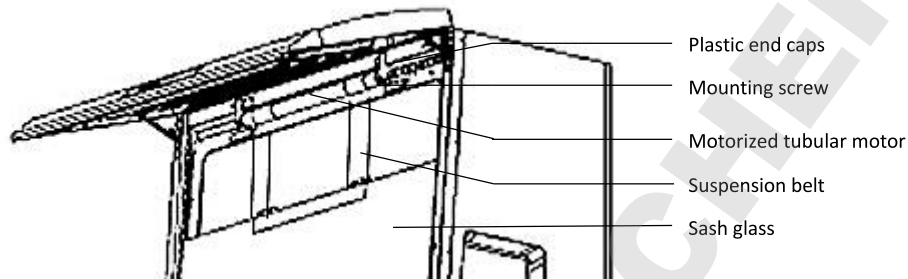


Figure 1.1. Motorized tubular motor

Checking of the Sliding Sash Mechanism

1. Remove screws from the left and right side of the sash cover.
2. Remove the sash covers for access to the sliding window mechanism.
3. Ensure Guide A is securely glued to the glass.
4. Check by lifting the glass out slightly and make sure Guide A does not detached from glass with finger force.
5. Check for the gap between the sash guides as per sketches shown above.
6. Check the position of switch to ensure it does not collide with the moving sash glass.
7. After all the above checks are done, install the sash cover and close the front panel.
8. Operate the sash and the glass should be moving smoothly up and down.
9. Ensure that the glass does not jam at any position and the suspension belt does not slack at any point in time.

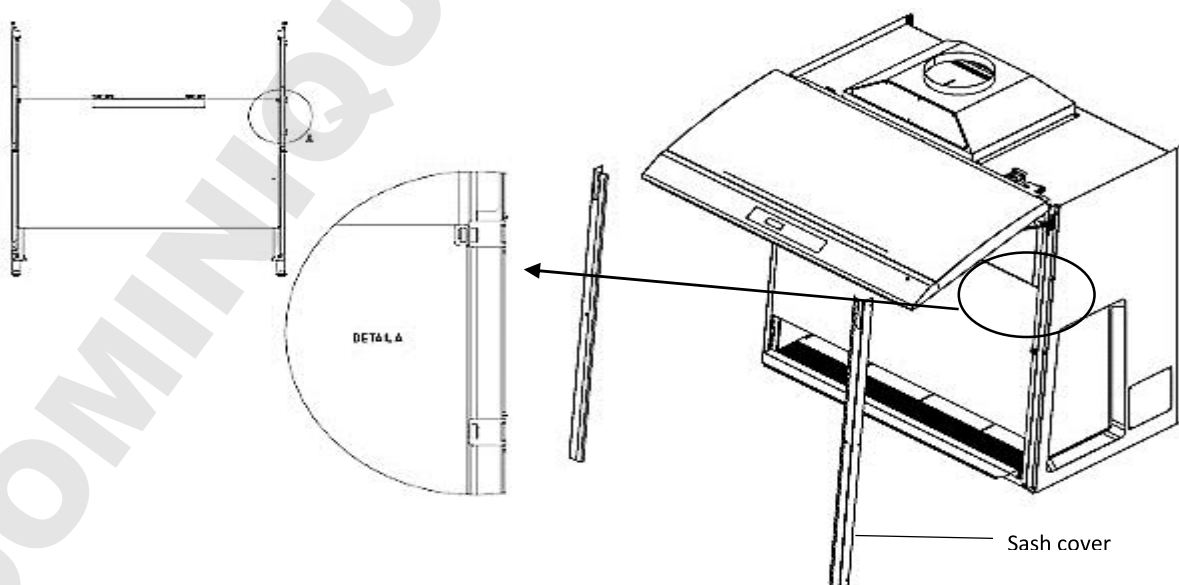


Figure 1.2. How to remove sash cover

## 1.4. Parts Replacement

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.

### 1.4.1. Filter Replacement Procedure

*The filters should not be replaced until the entire cabinet has been decontaminated.*

Under normal usage and barring any accident (example - puncture), the two filters do not need replacement unless and until the inflow and / or downflow velocity can no longer be maintained within the specifications.

1. Before the filters are removed from the BSC, their contaminated faces should be taped off using plastic, cardboard or some other suitable material. This will minimize the risk of personnel in the event the decontamination was not thorough.
2. Used filters should be disposed in accordance with local regulations. They may have to be incinerated as medical waste. They should be double bagged and appropriately labeled after being removed from the cabinet.
3. Proper PPE (based on your risk assessment) should be worn while removing used filters. You should dispose of these things after the procedure. Finally you should properly wash your hands.
4. 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 before being fitted. It is important that the filters and the gaskets be checked for leaks prior to use.

*Two persons may be required to facilitate filter changing on 5' and 6' BSC.*

Instructions for filter replacement

1. Remove the screws located on the left and right side of the blue panel.
2. Open up the hinged front panel and put on the struts to support the front panel.
3. Remove filter/blower access panel, which are held in position by phillip panhead screws.
4. Release the bolts at the side of the supply plenum and lift up the supply plenum.
5. Carefully remove the supply filter from the front.
6. Replace new filters by reversing the above steps.

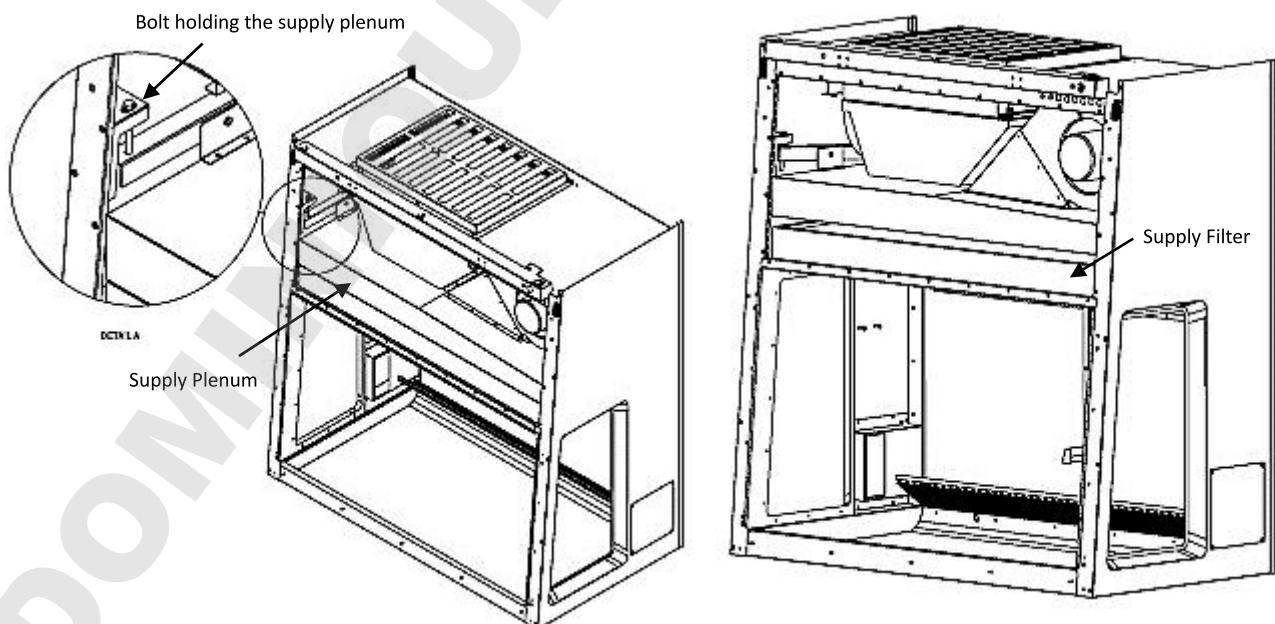


Figure 1.3. Unbolting the supply plenum to remove supply filter

### 1.4.2. Exhaust filter removal

1. Release the bolts at the side of the exhaust plenum to lower down the plenum until it is resting on top of the exhaust filter.
2. Carefully remove the exhaust filter.
3. Replace new filters by reversing the above steps.

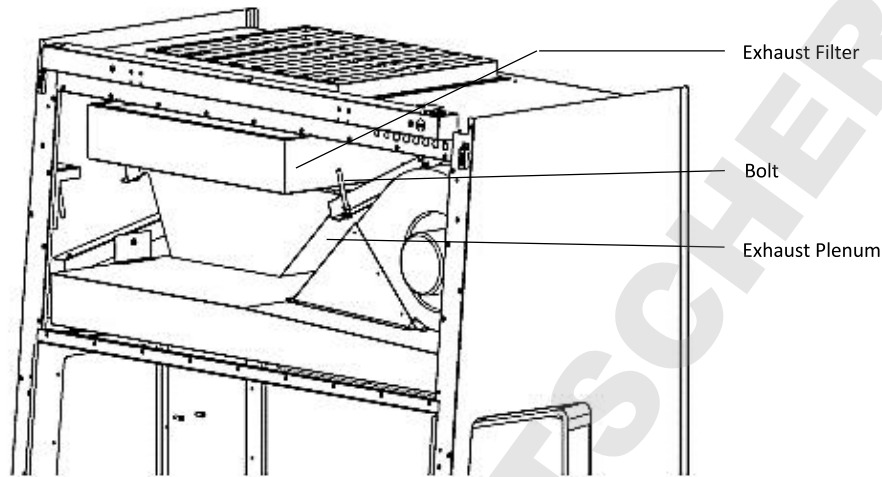


Figure 1.4. Unbolting the exhaust plenum to remove exhaust filter

Two persons may be required for changing the filter(s) of 5-foot and 6-foot cabinets

Under normal usage and barring any accident (example - puncture), the two HEPA/ULPA filters do not need replacement unless and until the inflow velocity cannot be maintained at the specifications required by the testing report even though the fan has been set to maximum speed.

The filters should not be replaced until the entire cabinet has been decontaminated.

1. Before the filters are removed from the cabinet, their contaminated faces should be taped off using plastic cardboard or some other suitable material. This would minimize the risk to personnel in the event of decontamination not being thorough.
2. Used filters should be disposed off in accordance with local regulations. They may have to be incinerated as medical waste. They should be double bagged and appropriately labeled after being removed from the cabinet. Refer to Limitation of Liability page **Error! Bookmark not defined.**
3. Proper personal protective equipment (PPE) (may consist of a disposable gown, gloves and respiratory protection device and the choice should be determined by adequate risk assessment) should be worn while removing used filters. You should dispose the disposable PPE and decontaminate reusable equipment after the procedure. Finally you should properly wash your hands.
4. 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 before being fitted. It is important that the filters and the gaskets be checked for leaks prior to use.

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.

### 1.4.3. Blower Replacement Procedure

To replace the blower, follow the steps mentioned below:

1. Check the replacement parts list at the end of this manual.
2. Follow the steps that have been pictorially illustrated in the blower replacement diagram below.
3. Take out the blower housing and unscrew the bolts that secure the blower to the blower housing.
4. Repeat this procedure in reverse order with the new blower to complete the replacement.

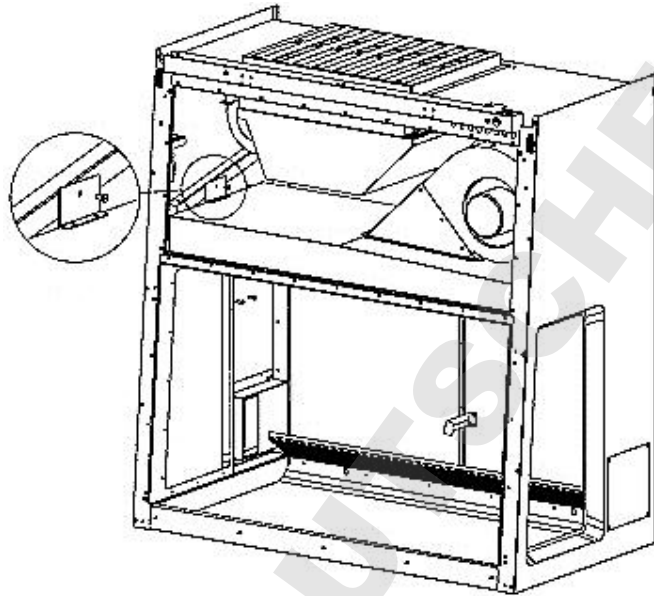


Figure 1.5. Supply plenum removal

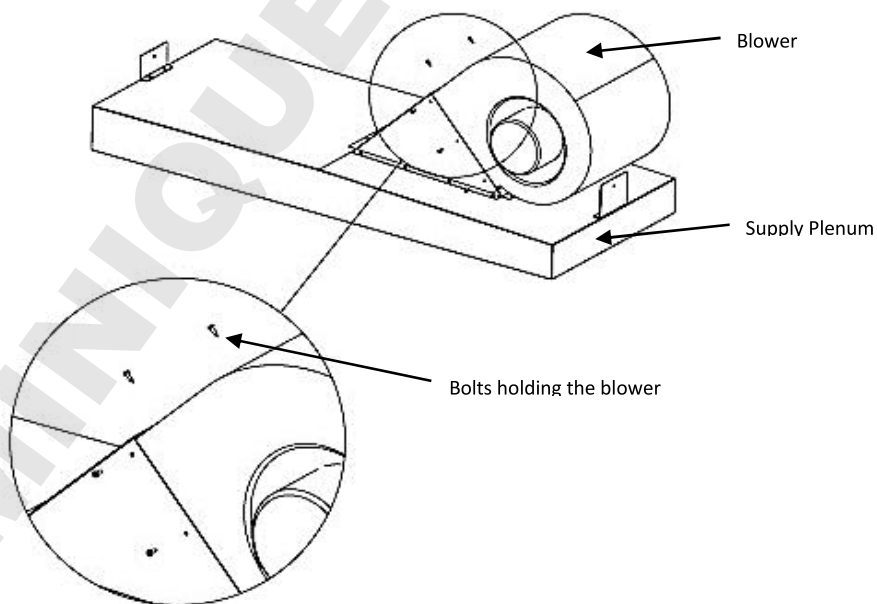


Figure 1.6. Supply blower removal

#### 1.4.4. Supply Blower Replacement Procedure

1. All electrical connections must be disconnected while working with blowers to prevent electrical hazard.
2. Supply filter must be removed before the supply blower can be replaced.
  - a. Unscrew the hinge holding the plenum onto the cabinet body.
  - b. Remove the supply plenum box from the cabinet (at least 2 persons are required to carry out the supply plenum box).
  - c. Remove the bolts securing the blower as shown.
  - d. Remove the blower.
  - e. Re-install new blower by reversing the above steps.

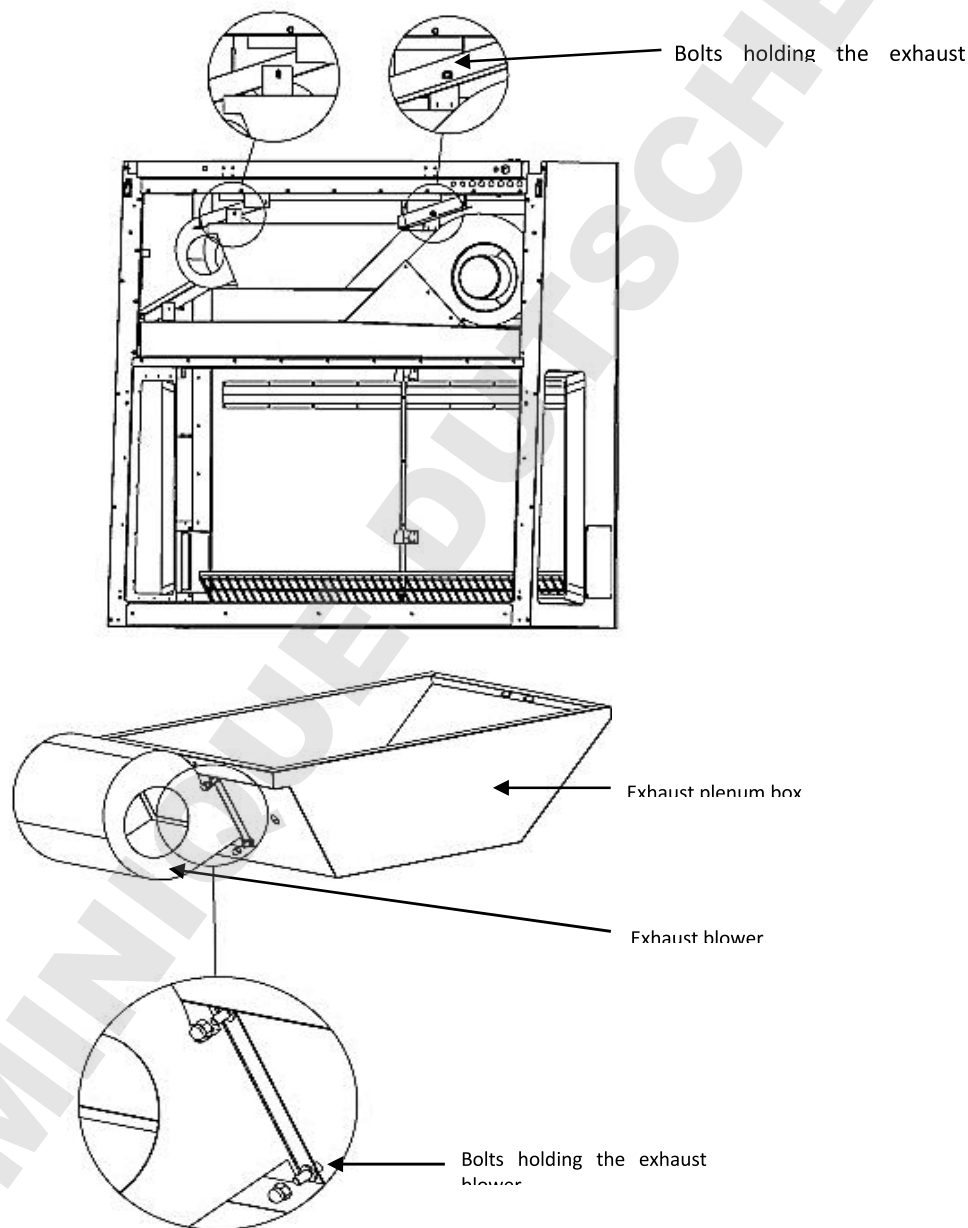


Figure 1.7. Exhaust blower removal

The exhaust plenum has to be removed before the blower can be removed.

1. Unlatch the exhaust plenum and lower the exhaust plenum slowly. Hold the exhaust blower while unlatching the plenum (at least 2 persons are required to carry out the supply plenum box – please note that the EC2-6LX uses two exhaust blowers).
2. Unscrew the bolts holding the exhaust blower and remove the blower.
3. Re-install new blower by tightening the bolts removed earlier.

#### 1.4.5. Fluorescent Lamp(s) Replacement Procedure

1. Disconnect the electrical connections.
2. Remove the screws from the bottom of blue panel and then lift up the front panel.  
**Caution:** Use the cylindrical struts to carefully hold open the front panel. Continue to work only after the front panel is secured.
3. The fluorescent lamp(s) is located behind the blue panel. Disconnect the old one(s) and replace with the new one(s).

#### 1.4.6. UV Lamp Replacement Procedure

1. Carry out necessary surface decontamination in the work zone prior to working on the UV lamp.
2. Disconnect the electrical connections.
3. Remove the old UV lamp by rotating it 90° counter clockwise and pull downward.
4. Install the new UV lamp by pushing it upward and rotating it 90° clockwise to secure the lamp in its socket.

#### 1.4.7. Service Fixture Plumbing

In order to replace, repair or install a plumbing system, follow the steps listed below:

1. Unscrew the four (4) pieces of countersunk screws to remove the side cover.
2. Replace / Repair / Install the plumbing while it is open. Ensure the connection is tight and Loctite / seal tape is being used to prevent leakage. Test the connections based on Esco pre-installed piping standard of 80 psi, and check whether there is leakage or not.
3. Place back the side cover and reverse the steps 1 to 3 to complete the installation.

#### 1.4.8. Airflow Sensor Replacement Procedure

##### 1.4.8.1. Airflow Sensor Replacement Procedure where Doughnut Sensor Housing is Used

Similar to the sensor box case, the airflow sensor is located on top of the cabinet. The sensor can easily be accessed in these cabinets.

1. Disconnect the airflow sensor cable connector.



Figure 1.8. Disconnecting Airflow sensor Cable

2. Remove temperature sensor from the bracket.



Figure 1.9. Remove Temperature sensor

3. Remove the doughnut sensor housing from the bracket.



Figure 1.10. Remove doughnut sensor housing

4. Install the new sensor (it comes with the doughnut sensor housing) into the bracket and connect the sensor cable connector. Ensure the airflow direction described in the sensor housing is complied with during installation.



Figure 1.11. Airflow sensor direction

## Chapter 2 - Decontamination

BSC decontamination should be performed in any of the following eventualities:

- Before replacing the exhaust/downflow filters or blower.
- Before accessing the contaminated negative or positive plenum of the BSC.
- In case of an accidental spillage that might have contaminated any of the inaccessible surfaces.
- Before performance validation and re-certification.
- Before BSC relocation.
- Before any procedures mandated by user's risk assessment.

Appropriate Personal Protective Equipment (PPE) per user's risk assessment that may include gloves, gown, and respirator with filter suitable for the decontamination gas/vapor must also be used by the certifier or any other qualified personnel performing the decontamination.

Esco can provide the formalin vaporizer (FV-001) and decontamination bag needed for the decontamination procedure.

The information provided in this section does not construe a final advice on how decontamination must be carried out. Appropriate personnel including the safety personnel in the facility must be consulted and adequate risk assessment must be conducted to ensure the safety and efficacy of the decontamination procedures.

### 2.1. Decontamination Agents

#### 2.1.1. Formalin/Paraformaldehyde Decontamination

Typically the decontamination is performed using formalin gas by either vaporizing 37% formalin solution or by de-polymerization of solid paraformaldehyde.

Despite its widespread usage for decontamination, formalin gas presents the following health risks:

- External contact can cause irritation to skin, eyes, and mucous membranes.
- Inhalation in small concentrations can cause coughing, nausea, and diarrhea.
- Inhalation in large concentrations can cause convulsions, coma, and death.
- Long term exposure can cause cancer.

Although the Permissible Exposure Level (PEL) for formalin is 0.75 ppm, many scientists believe that there is no safe level of carcinogen exposure to humans. Therefore, typically the room must be evacuated when the decontamination process is performed, which leads to lab down time.

The use of formalin decontamination also has other disadvantages:

- The process is time-consuming.
- The certifier needs to pulse the BSC fan to circulate the formalin vapor. This can dislodge the tape holding the plastic sheet covering the exhaust filter.
- Due to excessive residue extensive cleaning must be done after decontamination and before use.

According to OSHA [Occupational Safety and Health Administration (USA)], formaldehyde Short Term Exposure Level (STEL) is 2 ppm for 15 minutes exposure, 4 times a day, minimum of 60 minutes in between exposures. Any additional local safety regulations should also be observed. Personnel should be given adequate training. The following links provide general guidelines on formaldehyde safety:

- Regulations (Standards - 29 CFR) Formaldehyde - 1910.1048, Occupational Safety and Health Standards, OSHA (Occupational Safety and Health Administration), U.S. Department of Labor: <http://www.osha.gov>
- OSHA Formaldehyde Fact sheet (PDF format). Available at: [http://www.osha.gov/OshDoc/data\\_General\\_Facts\\_formaldehydefactsheet.pdf](http://www.osha.gov/OshDoc/data_General_Facts_formaldehydefactsheet.pdf)

The time required to carry out formalin decontamination is outlined below:

No.	Process	Time
1	Set-up & sealing the BSC to make it air tight	1 hour
2	Formalin vaporization	½ hour
3	Formalin contact time to obtain target log of 4-6 kill	8 – 10 hours
4	Ammonia vaporization to neutralize formalin	½ hour
5	Ammonia contact time to neutralize formalin	2 hours
6	Exhausting the ammonia residue	1 hour
7	Tear-down & cleaning the (substantial) residue	1 hour
<b>TOTAL without ammonia neutralization</b>		<b>10½ – 12½ hours</b>
<b>TOTAL with ammonia neutralization</b>		<b>14 – 17 hours</b>

Ammonia is used to neutralize formaldehyde. OSHA prescribes the ammonia STEL is 35 ppm for 15 minutes exposure, 4 times a day, minimum of 60 minutes in between exposure.

Due to the adverse health effect of formalin gas, its use has been banned in some countries such as Germany, Austria, and Switzerland. Other European countries are expected to follow suit. Two primary candidates to replace formalin decontamination are chlorine dioxide gas and hydrogen peroxide vapor.

### 2.1.2. Chlorine Dioxide Decontamination

Chlorine dioxide decontamination is performed by injecting chlorine gas (Cl<sub>2</sub>) into a cylinder filled with solid sodium chlorite (NaClO<sub>2</sub>), which generates the greenish-yellow chloride dioxide gas (ClO<sub>2</sub>). Chlorine dioxide decontamination is much faster than formalin. Being a true gas, it spreads quickly, without the need of pulsing the BSC's blower. It can rapidly kill the micro-organisms with high efficacy with just 1 hour contact time. User must note that the concentration of chlorine gas inside the cabinet must decrease to a safe level (e.g. by using scrubber system) before user should open the air tight seal. The Short-Term Permissible Exposure Limit (STEL) for Chlorine Dioxide gas is 0.3 ppm. The time required for the entire process of chlorine dioxide decontamination is as follows:

No.	Process	Time
1	Set-up & sealing the BSC to make it air tight	1 hour
2	Chlorine dioxide gassing	½ hour
3	Chlorine dioxide contact time	1 hour
4	Chlorine dioxide "scrubbing"	½ hour
5	Tear-down & cleaning the (minimal) residue	½ hour
<b>TOTAL</b>		<b>3½ hours</b>

Chlorine dioxide has the PEL of 0.1 ppm, compared to 0.75 ppm for formalin. In both processes airtight BSC sealing is required to protect personnel from the gas exposure.

#### 2.1.2.1 Recommended Decontamination Sealing Method

This section gives an example of how the cabinet can be sealed when FV-011 formalin vaporizer is used. However, similar principle can be applied for other gaseous decontamination method.



1. Put the decontamination bag to enclose the entire BSC and support stand.



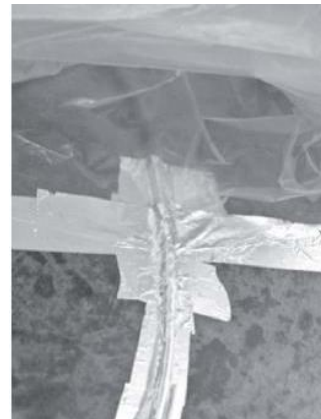
2. Use the 50 mm wide aluminum tape to seal the gap between the decontamination bag and the floor. To compensate for areas where the decontamination bag must turn, use multi section tape. Ensure that the two layers of tape overlap at the end points to prevent leakage.



3. Overlap the tape at the joints.



4. These 2 cables (for BSC and for vaporizer) should be combined so that only 1 cable should come out from the decontamination bag, to minimize chance of formalin leakage.



5. To seal the cable, first make an  $\Omega$ -shape aluminum tape around the cable, and make a 5 cm flat portion going to both directions. Then, paste the aluminum tape to the floor.
6. Put the bottom part of the decontamination bag on top of the aluminum tape, and then seal it with another layer of aluminum tape. Use multiple layer of aluminum tape (*at least 2 layers*) on both directions to ensure leak tightness.



7. The BSC is ready for formalin decontamination.

### 2.1.3 Hydrogen Peroxide Decontamination

Hydrogen peroxide ( $\text{H}_2\text{O}_2$ ) decontamination is performed by flash vaporization of an aqueous peroxide mixture, creating a vapor that is distributed throughout the inside the BSC.

STERIS and BIOQUELL are two major vendors of hydrogen peroxide generators. There are significant differences in operating principles.

- The STERIS principle is to avoid condensation on surfaces to minimize corrosion and optimize vapor distribution. The relative humidity inside the BSC must be lowered to 30% so that the remaining 70% relative humidity can be occupied by the hydrogen peroxide vapor.
- The BIOQUELL principle is to seek micro-condensation to achieve the kill. The generator releases tiny high-speed droplets inside the BSC.

Other than STERIS and BIOQUELL, Mobile BioVap™ from Esco also can be used to decontaminate BSC. Esco Mobile BioVap™ is a hydrogen peroxide bio-decontamination system which employs a process of atomizing hydrogen peroxide sterilant to create dry fog after it is injected into the space. This system creates a charge on the atomized droplets as it pass through the nozzle. This process happens during injection stage then followed by dwell stage when the sterilant is settle on the surfaces of the chamber and any materials inside the chamber as contact time for the bio-decontamination process. The last stage is aeration where the sterilant evaporates to gas and is extracted to the BioVap™ to be catalytically converted to oxygen and water.

Hydrogen peroxide vapor is non-carcinogenic, but highly effective against micro-organisms. Hydrogen peroxide ( $\text{H}_2\text{O}_2$ ) vapor breaks down under catalytic action to become air and water, making it environmentally friendly and it leaves no residues. The BSC is often aerated by ducting to speed up the breaking down of hydrogen peroxide vapor.

The time needed for the entire process is outlined below:

No.	Process	Time
1	Set-up & sealing the BSC	½ hour
2	Conditioning and decontamination cycle	½ - 1 ½ hour
3	Ducting out H <sub>2</sub> O <sub>2</sub> H <sub>2</sub> O <sub>2</sub> generator doing aeration	½ hour      8 hours
4	Tear-down	½ hour
<b>TOTAL</b>		2 - 3 hrs      9½ - 10½ hrs

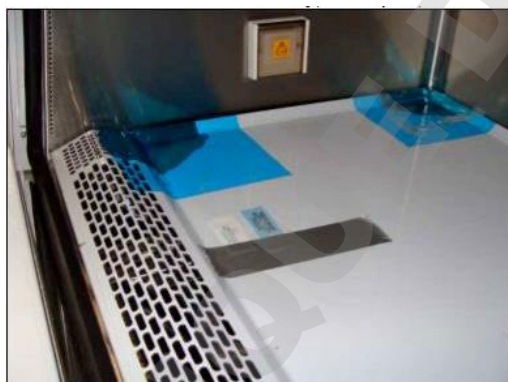
For hydrogen peroxide decontamination, the BSC need to be equipped with two ports:

1. One port located in front opening or side wall, penetrating the work zone area
2. One port located on top of the exhaust filter.

The generator used defines the port function as described below:

	Steris	Bioquell	BioVap
<b>Hydrogen peroxide source</b>	Injected into the BSC	Generated inside or into the BSC	Generated inside the BSC
<b>Bottom front / side port</b>	Hydrogen peroxide introduction	Hydrogen peroxide re-introduction or introduction	Hydrogen peroxide re-introduction
<b>Top port</b>	Hydrogen peroxide extraction	Hydrogen peroxide extraction	Hydrogen peroxide extraction

The Steps to perform the hydrogen peroxide decontamination with Bioquell:



1. Place the BIs on the work tray, drain pan, exhaust:



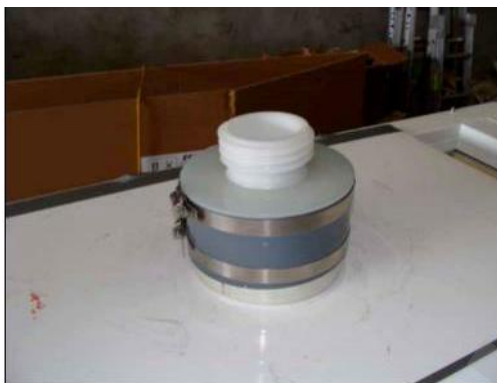
2. Place the internet catalyst and vaporizer on tray



3. Insert the hydrogen peroxide bottle:



4. Point the vaporizer fan towards front grille:



5. Cover exhaust filter with plate with 3" exhaust port:



6. Tape exhaust plate to cabinet. Connect 3" hose:



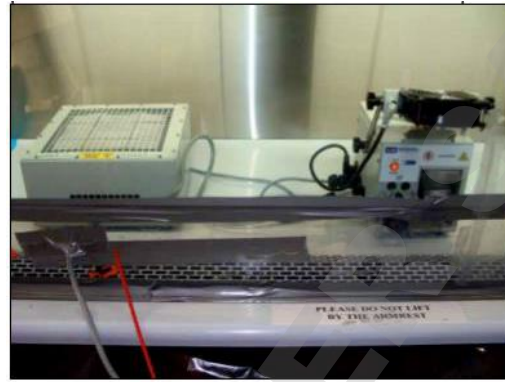
7. Connect 3" hose to 3" inlet on external catalyst:



8. Connect 1" hose to 1" outlet on external catalyst:



9. Open the small panel on side dress panel. Connect the 1" hose to port inside side dress panel:



10. Install front Perspex. Make control cable and pressure tube come out from holes. Seal with tape.



11. Put a wedge on left & right sash track cover:



12. Put the wedge behind the blue panel.



13. Adjust the valve at 3" outlet to get  $-10$  Pa:



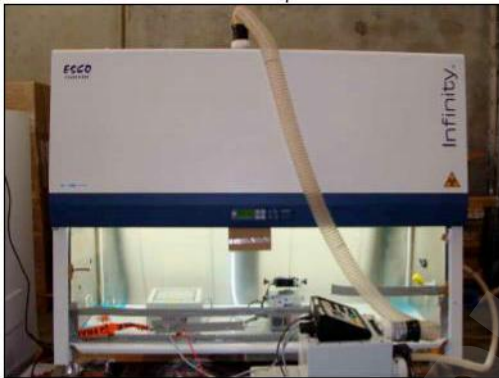
14. Ensure the pressure in cabinet is around  $-10$  Pa:



15. Press 155 ml on controller despite we use 100 ml



16. The timer on control panel starts:



17. This is how the entire set-up looks like:



18. You may see condensation that then disappears:



19. Check the H<sub>2</sub>O<sub>2</sub> concentration = 0 along tapes:



20. After gassing period ends, mute the alarm:



21. During aeration, set 3" outlet valve to full open, to increase the airflow and speed up the process:



22. During aeration, remove tapes at perspex holes to speed up aeration. Note that internal catalyst is on:



23. Check that  $H_2O_2$  concentration = 0 inside cabinet by inserting the probe through the hole:



24. Remove Perspex, hoses, etc. Put BIs in soy broth and incubate for 48 hours at  $37^\circ C$ :

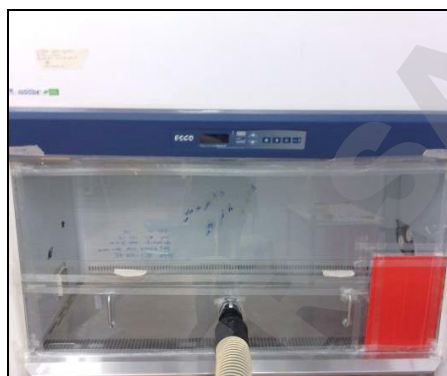
The steps to perform the hydrogen peroxide decontamination with **Bioquell model Clarus L2**:



1. Place Biological Indicator (BI) of 6 log *Geobacillus stearothermophilus* and Chemical Indicator (CI) for  $H_2O_2$  on the work tray, drain pan, and exhaust filter.



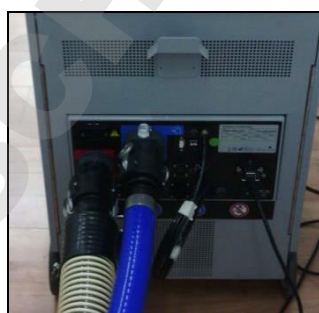
2.a. For cabinet equipped with VHP port on the side wall, move down the sash glass to fully close then install the sash clamps.



2.b. For cabinet without VHP port, place Perspex cover with VHP port on the front opening then tape the perimeter.



3. On the exhaust filter, install top box or Perspex cover with VHP port then tape the perimeter.



4. Install the 'input hose' and 'exhaust hose' to Bioquell Clarus L2



5. Connect the 'input hose' from Bioquell to the cabinet VHP port on the side wall or front opening.



6. Connect the 'exhaust hose' from Bioquell to the cabinet VHP port on the exhaust filter.



7. Fill up the sterilant bottle with 30% H<sub>2</sub>O<sub>2</sub>.



8. This is the entire set up.



9. Press 'STORED CYCLES' to edit the settings parameter

Recommended settings:

Pressure set point: -10 Pa

Airflow set point: 25 m<sup>3</sup>/hr

Delivery temperature: 65 °C

Gassing injection rate: 4 g/min

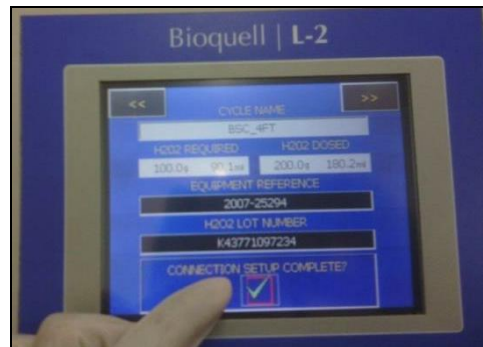
Conditioning time : 20-30 min

Gassing time for 3 – 4ft cabinet : 25 min

Gassing time for 5 – 6ft cabinet : 40 min

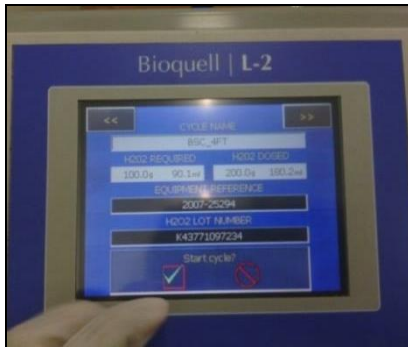
Dwell time : 30 min

Aeration time: 180 – 300 min



10. Press 'CYCLE RUN' button.

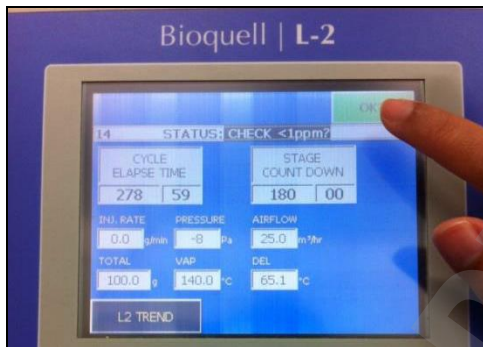
11. Choose 'CYCLE NAME' and press 'tick' button



12. Press 'START' button



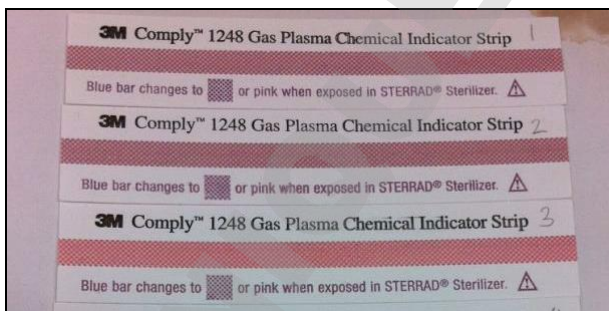
13. During decontamination cycle, monitor the concentration of H<sub>2</sub>O<sub>2</sub> in the room using low concentration sensor. H<sub>2</sub>O<sub>2</sub> concentration in the room should be under PEL (Permissible Exposure Limit) value of the country, 0.5 or 1 ppm for 8 hours, and 2 or 3 ppm for 15 minutes.



14. Press 'OK' when this display appear after the aeration is complete and H<sub>2</sub>O<sub>2</sub> concentration <1ppm



15. Press tick to end the cycle



16. Remove BI and CI from the BSC. Label the BI and CI in accordance with the location. Visual check and record the color change of the CI



17. Inoculate the decontaminated BI and 1 untreated BI as positive control to soy broth medium. Incubate all BI and 1 broth medium as negative control at 55-60°C for 7 day. Observe and record the result daily for the evidence of the growth.

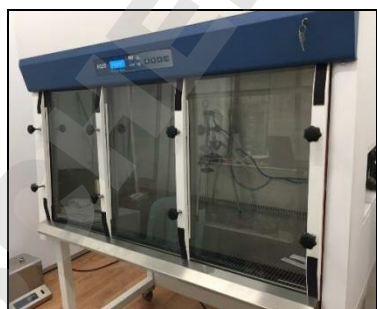
The steps to perform the hydrogen peroxide decontamination with **Esco Mobile BioVap™**:



1. Place Biological Indicator (BI) of 6 log *Geobacillus stearothermophilus* and Chemical Indicator (CI) for H<sub>2</sub>O<sub>2</sub> on the work tray, drain pan, and exhaust filter.



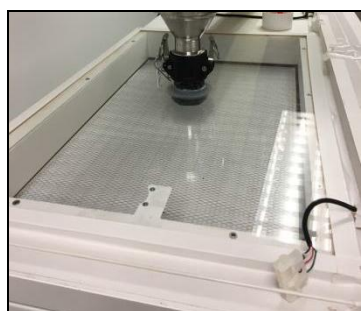
2. Put BioVap™ nozzle and the tripod on the cabinet work zone.



3.a. For cabinet equipped with VHP port on the side wall, move down the sash glass to fully close then install the sash clamps.



3.b. For cabinet without VHP port, place Perspex cover with VHP port on the front opening then tape the perimeter.

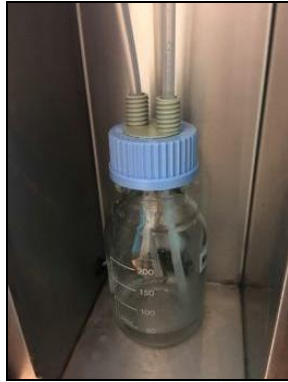


4. On the exhaust filter, install top box or Perspex cover with VHP port then tape the perimeter.



5. Connect the 'input hose' from BioVap™ to the cabinet VHP port on the side wall or front opening and the 'exhaust hose' to the the exhaust filter.





6. Fill up the sterilant bottle with 30% H<sub>2</sub>O<sub>2</sub>.



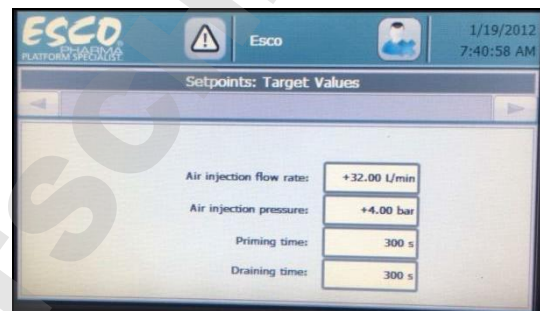
7. Connect BioVap™ to compressed air.



8. Turn ON the BioVap™ and press F2 button to edit the setting parameters. Set the cycle setting. Input the time for each stage and pump stroke period by pressing the box and key in the value of each parameters.

Recommended settings:

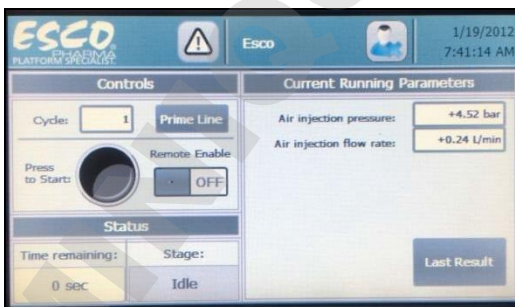
- Injection time for 3-4ft cabinet: 1600 s to deliver 100 ml of H<sub>2</sub>O<sub>2</sub>
- Injection time for 5-6ft cabinet: 2400 s to deliver 150 ml of H<sub>2</sub>O<sub>2</sub>
- Dwell time: 1200 s
- Aeration time: 7200 s
- Pump stroke period: 800 ms



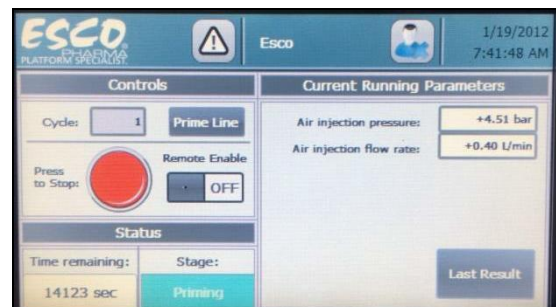
9. Key in the target value for each parameter by pressing the value box.

Recommended setpoints:

- Air injection flow rate: +30 L/min
- Injection expected time of RH: +0 %
- Priming time: 300 s
- Draining time: 300 s



10. Select cycle number and press "Start" button



**a. Priming Stage:** in this stage, the H<sub>2</sub>O<sub>2</sub> liquid will be pumped from the inlet line to the return line to fill in the inlet line with H<sub>2</sub>O<sub>2</sub> before injection stage.



**b. Injection Stage:** in this stage, the  $H_2O_2$  liquid will be pumped to the nozzle and injected with compressed air to produce  $H_2O_2$  mist.

Set the BioVap™ hose valves to close position during this stage.

Turn ON the cabinet blower periodically to distribute the  $H_2O_2$  mist inside the cabinet. It is recommended to turn ON the cabinet blower for 2 minutes, then OFF for 1 minute.



**d. Aeration Stage:** in this stage, the  $H_2O_2$  will be removed from the cabinet. The BioVap™ blower will be ON to draw the  $H_2O_2$  from the cabinet to the catalytic converter in the BioVap™.

Set the BioVap™ hose valves to open position during this stage.

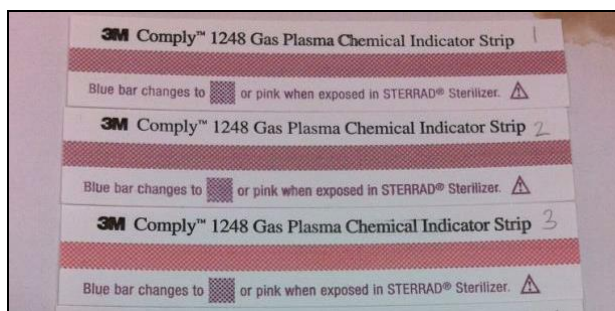


**c. Dwell Stage:** in this stage, the  $H_2O_2$  will be settled on the cabinet surface for microbial killing.



11. During decontamination cycle, monitor the concentration of  $H_2O_2$  in the room using low concentration sensor.  $H_2O_2$  concentration in the room should be under PEL (Permissible Exposure Limit) value of the country, 0.5 or 1 ppm for 8 hours, and 2 or 3 ppm for 15 minutes.

After the aeration stage is completed, check the concentration inside the cabinet. When the  $H_2O_2$  concentration is already under 1 ppm, press 'Confirm' button on the BioVap™.



12. Open the BSC sash glass and top box. Remove BI and CI and label it in accordance with the location. Check visually and record the color change of the CI



13. Inoculate the decontaminated BI and 1 untreated BI as positive control to soy broth medium. Incubate all BI and 1 broth medium as negative control at 55-60°C for 7 day. Observe and record the result daily for the evidence of the growth.

### Decontamination Acceptances

The decontamination cycle with hydrogen peroxide is considered to be successful if:

1. H<sub>2</sub>O<sub>2</sub> concentration in the room is under PEL (Permissible Exposure Limit) value of the country, 0.5 or 1 ppm for 8 hours, and 2 or 3 ppm for 15 minutes.
2. Change color of CI from blue/violet to pink (depend on the CI used, please refer to the manufacturer instruction)
3. No growth indicated by no turbidity on TSB medium of negative control and decontaminated BI
4. Growth indicated by turbidity on the TSB medium of positive control

### BSC Material Compatibility

Materials resistance to the exposure of vaporized and atomized H<sub>2</sub>O<sub>2</sub> has been validated. Here is the list of BSC parts exposed by H<sub>2</sub>O<sub>2</sub> during decontamination cycle using Bioquell and Mobile BioVap™:

- |                        |                                 |
|------------------------|---------------------------------|
| 1. Sash and side glass | 8. Filters and filter gasket    |
| 2. Inner liner         | 9. Downflow and exhaust blowers |
| 3. Port cover          | 10. Cable                       |
| 4. Work tray           | 11. PAO port                    |
| 5. Electrical outlet   | 12. Plenum                      |
| 6. Drainpan            | 13. Red cover                   |
| 7. Diffuser            |                                 |

All of above parts material has been proved to be resistant to the vaporized and atomized H<sub>2</sub>O<sub>2</sub> with this procedure. Therefore, this decontamination cycle procedures does not affect the appearance or function of the BSC parts.

**Any changes applied on the procedure may results differences in the effectiveness, safety, and material compatibility. It is user responsibility to re-validate the new procedure.**

## 2.2. Further Information

- A Guide to Biosafety and Biological Safety Cabinets can be downloaded from <http://escoglobal.com/resource.php?id=13>
- An educational video on “Working Safely in your Biological Safety Cabinet” is available for viewing at <http://www.youtube.com/watch?v=ZnUW1N-JJz8>

## Chapter 3 - Troubleshooting

### 3.1. Electrical and Mechanical Troubleshooting

This guide addresses the most common service issues. Unless there is a note to limit the applicability of the points raised, the point applies to all AC2 series. For more troubleshooting or service information contact your local Esco Distributor.

#### Hardware:

- DVM (Digital Voltage Meter).
- **Note:** An analog meter can be used for troubleshooting, but cannot be used for motor voltage measurement.
- Phillips screwdriver.
- Insulated jumper cables.

#### The Electrical Panel and Component Layout:

Open the front panel, the electrical panel is located on the back of the panel. The component layout is as followed (please note that the layout is the same regardless of the power rating).

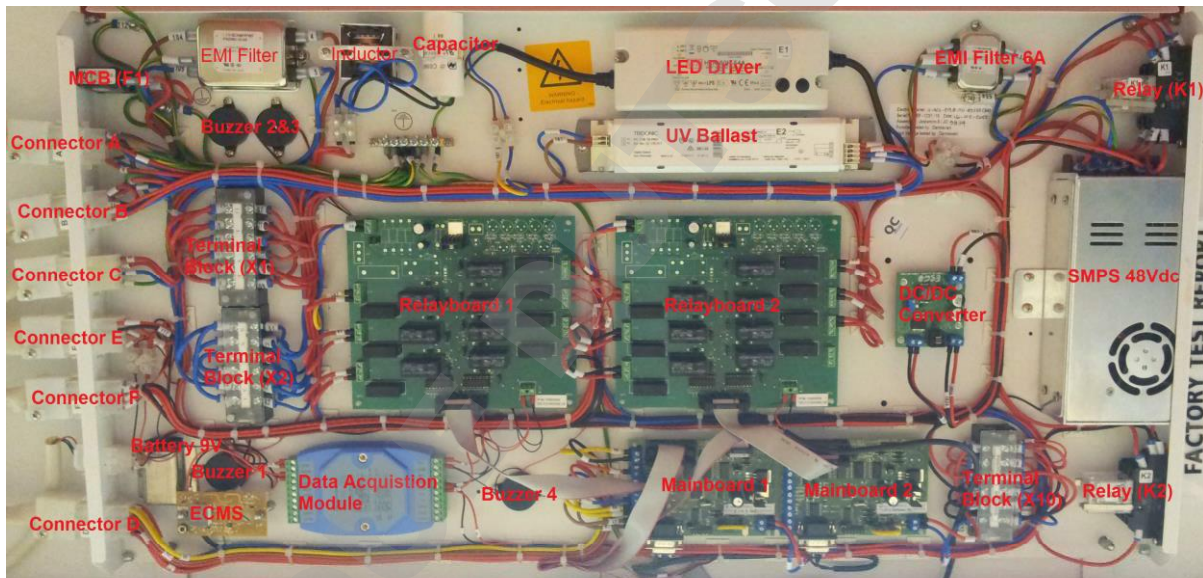
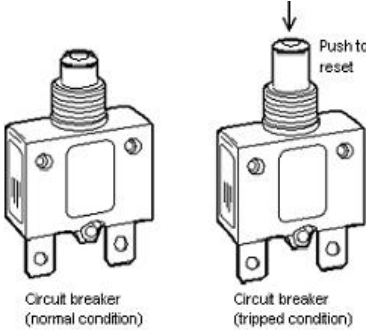
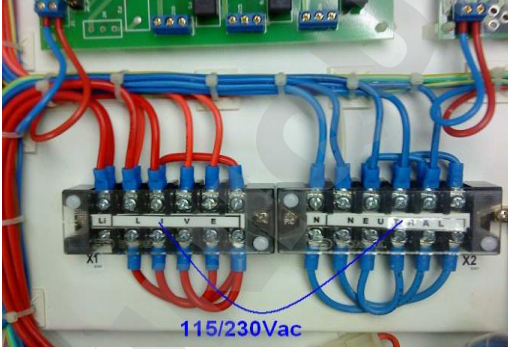
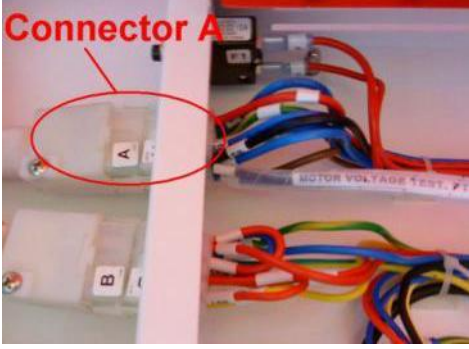


Figure 3.1. Layout Electrical Box

#### Problem 1: Cabinet does not start (LCD, button, fan light, and socket are inoperative)

Cause	Corrective Action
Power Failure	<ul style="list-style-type: none"> <li>• Check wall outlet for power.</li> <li>• If the outlet has a switch make sure it is turned ON.</li> </ul>
Power cord is not connected properly or faulty	<ul style="list-style-type: none"> <li>• Ensure the power cord is connected correctly to the wall outlet.</li> <li>• <b>NOTE:</b> Some cabinets have 2 cordsets.</li> <li>• Disconnect the power cord at the cabinet and measure the AC voltage between the live and the neutral terminal of the cord.</li> <li>• If the voltage is not within <math>\pm 2\%</math> of the wall socket voltage, replace the cordset; otherwise Proceed to the next step.</li> </ul>
Circuit breaker has tripped	<ul style="list-style-type: none"> <li>• Check the circuit breaker (F1) inside the electrical panel.</li> <li>• <b>NOTE:</b> If circuit breaker has tripped, do not reset the breaker before checking all electrical components and wiring connections. (See Figure 1-1).</li> </ul>

Cause	Corrective Action
	<ul style="list-style-type: none"> <li>Does the cabinet operate correctly after resetting the circuit breaker? If it does not Proceed to the next step.</li> </ul>
	<div style="text-align: center;">  <p>Figure 1-1</p> </div>
Improper connection	<ul style="list-style-type: none"> <li>Measure AC voltage between LIVE (RED) and NEUTRAL (BLUE) terminal blocks inside electrical box. See Figure 1-2.</li> <li>Voltage must be within <math>\pm 10\%</math> of the rated voltage.</li> <li>Refer to cabinet Serial Number Tag for required voltage.</li> <li>If the voltage is out of the range or there is no voltage, check cable connection on both sides of connector A. See Figure 1-3. <ul style="list-style-type: none"> <li>230 VAC at Connector A pin 1 and 2. Pin 3 is ground.</li> <li>115 VAC Connector A pin 1 and 2. Pin 3 is ground.</li> </ul> </li> <li>If there is voltage at Connector A but no voltage is measured at the RED (LIVE) and BLUE (NEUTRAL) terminal blocks, the problem is between connector A and the terminal strips.</li> <li>If voltage is not present at connector A, but voltage is measured at the female connector for the line cord at the top of the cabinet that the power cord is plugged into, the problem is between the female connector and the pins on Connector A.</li> </ul>
 <p>Figure 1-2</p>	 <p>Figure 1-3</p>
Defective power supply – Switch Mode Power supply (SMPS)	<ul style="list-style-type: none"> <li>On the SMPS, measure the DC voltage between Red (+V) and Black (-V) Measure on the side away from the SMPS. Figure 1-4</li> <li>The voltage should be in range of <math>+48\text{ VDC} \pm 10\%</math>.</li> <li>If out of range or no voltage, check AC incoming power to the SMPS – check terminal (L) and (N). The input of SMPS should be <math>230\text{V} \pm 10\%</math> of the cabinet incoming voltage.</li> <li>If input voltage exists but there is no output voltage, please replace the SMPS.</li> <li>If input and output voltage is correct, please Proceed to the next step.</li> </ul>

Cause	Corrective Action
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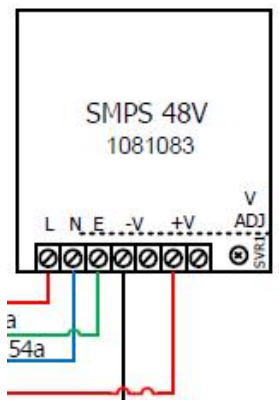


Figure 1-4

Defective DC/DC converter	<ul style="list-style-type: none"> <li>On the SMPS, measure the DC voltage between Red (wire no. 401) and Black (wire no. 402) Measure on the side away from the DC/DC converter. Figure 1-5</li> <li>The voltage should be in range of +12 VDC <math>\pm</math> 10%.</li> <li>If out of range or no voltage, check incoming power to the DC/DC converter. The input of SMPS should be 48Vdc <math>\pm</math>10% of the cabinet incoming voltage.</li> <li>If input voltage exists but there is no output voltage, please replace the DC/DC converter.</li> </ul> If input and output voltage is correct, please Proceed to the next step.
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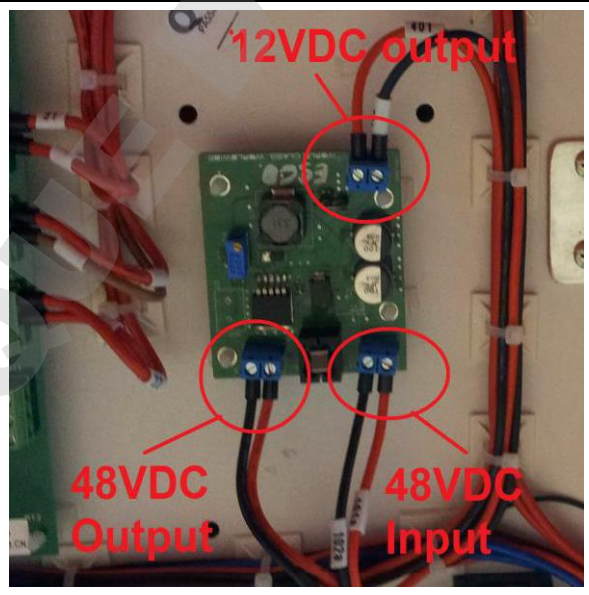
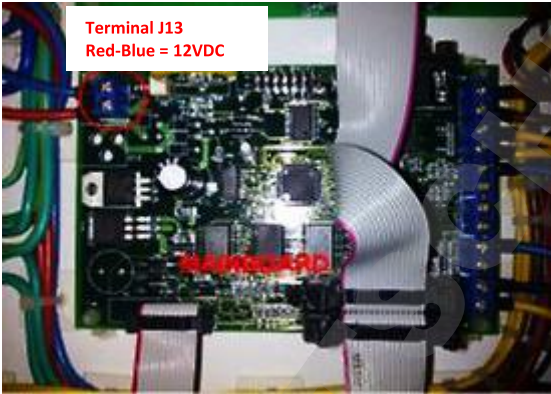

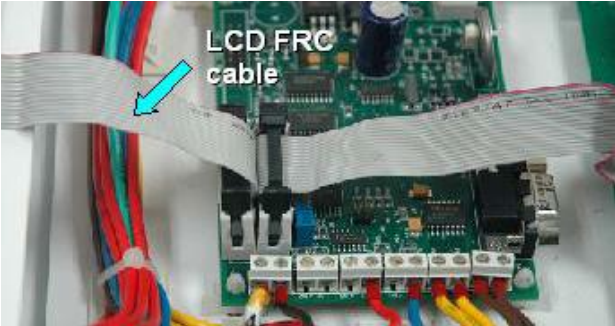
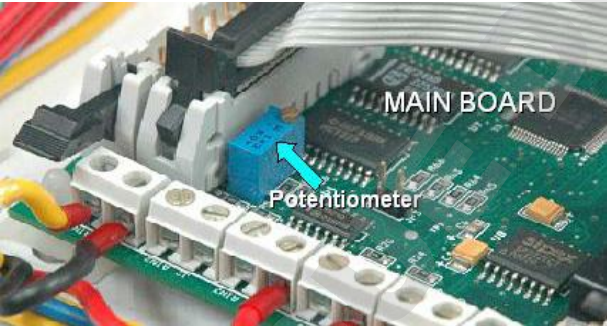


Figure 1-5

Connection problem to main board or from main board to display	<ul style="list-style-type: none"> <li>Measure the incoming voltage on the main board at terminal J 13 (Note polarity, blue cable closest to edge is negative -). See Figure 1-6.</li> <li>Voltage should be between 10.8 – 13.2VDC.</li> <li>If voltage is out of range or no voltage, ensure adequate connection between SMPS and main board.</li> <li>Ensure adequate connection between flat ribbon cable from main board to</li> </ul>
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Cause	Corrective Action
	<p>LCD/keypad membrane.</p> <p><b>NOTE:</b> There are two ribbon cables from the main board and the display and key pad. The larger flat cable is for the Display. The smaller flat cable is for the LEDs/keypad membrane.</p> <ul style="list-style-type: none"> <li>• If the LCD Display is on, but not the LEDs in keypad membrane, check connection on the smaller Flat Ribbon cable.</li> <li>• If the incoming voltage at J13 is of right voltage and flat ribbon cable are connected adequately but the LEDs on the keypad membrane and LCD display are still not turned on, please proceed to the next step.</li> </ul>
	<div data-bbox="518 600 1072 992" style="text-align: center;">  </div> <p style="text-align: center;">Figure 1-6</p>
Defective main board	<ul style="list-style-type: none"> <li>• The main board is defective if the main board incoming supply is between 10.8 – 13.2VDC if 12 VDC SMPS is installed and: <ul style="list-style-type: none"> <li>○ All LED's on the control panel are off.</li> <li>○ The LCD is blank.</li> <li>○ No buzzer sound.</li> </ul> </li> <li>• If these conditions exist replace the main board, otherwise Proceed to the next step</li> </ul> <p><b>Note:</b> when replacing main board, reconnect all wires correctly, any wrong wiring may result in damage.</p>
Keyswitch is at OFF position or keyswitch is faulty	<ul style="list-style-type: none"> <li>• Check the keyswitch located at the edge of the blue panel.</li> <li>• If it is in the OFF position, switch it ON.</li> <li>• If it is in the ON position, check the AC voltage at connector B pin 12 to NEUTRAL terminal on electrical box. See the Layout B drawing at the end of this section to locate the connector B and NEUTRAL terminal block.</li> <li>• If the voltage is less than 230 V AC <math>\pm</math> 10% (for 230 V AC cabinet) or 115 V AC <math>\pm</math> 10% (for 115 V AC cabinet), the keyswitch is spoiled. Replace the keyswitch.</li> <li>• If the voltage is 230 V AC <math>\pm</math> 10% (for 230 V AC cabinet) or 115 V AC <math>\pm</math> 10% (for 115 V AC cabinet), the relay K1 is spoiled. Replace the relay K1. See Figure 8-1 to locate the relay K1.</li> </ul>
	<div style="text-align: center;">  </div>

**Problem 2: Blank LCD**

Cause	Corrective Action
Connection problem	<ul style="list-style-type: none"> <li>• Ensure LCD large Flat Ribbon Cable adequately connects the main board with the display at the main board end.</li> <li>• Ensure that the cable has been inserted adequately into its socket on the main board. This is a Keyed connector with locking arms. The arms should point to the same direction as the cable. See Figure 2-1 below.</li> <li>• If the LCD Display is not on, check power to main board as detailed in Problem 1.</li> </ul>
 <p data-bbox="906 741 1007 768">Figure 2-1</p>	
Contrast problem	<ul style="list-style-type: none"> <li>• Adjust the potentiometer on main board by rotating the top metal part using flat screw driver to achieve the best LCD contrast. Rotating the part in the counter clockwise direction will increase the contrast. See Figure 2-2.</li> <li>• If the LCD remains blank, replace it.</li> </ul>
 <p data-bbox="818 1267 919 1294">Figure 2-2</p>	
Defective LCD	<ul style="list-style-type: none"> <li>• Connect a new LCD to the LCD port on main board.</li> <li>• If the new LCD functions properly, this indicates the old one is defective.</li> <li>• If the new LCD does not work, replace the large Flat Ribbon Cable.</li> <li>• If the LCD still does not work replace, the main board.</li> </ul>

**Problem 3: Inoperative buttons**

Cause	Corrective Action
Connection problem	<ul style="list-style-type: none"> <li>• Does the LCD display work? If it does not, please refer to Problem 1 and ensure that the main board is powered.</li> <li>• Ensure that the small Flat Ribbon Cable is connected to the main board – See figure 3-1. The triangle sign on the female connector of the cable indicates PIN number 1.</li> <li>• Interface board and membrane/keypad are located behind the blue panel, underneath the metal light deflector.</li> <li>• Turn off the cabinet and then remove the LED light. See Figure 3-2.</li> <li>• Ensure adequate connections between the cable from the main board and the</li> </ul>

Cause	Corrective Action
	<p>Interface board. See Figure 3-3.</p> <ul style="list-style-type: none"> <li>Ensure adequate connections between the green plastic cable from the Interface board and the Display board. Figure 3-4.</li> </ul>

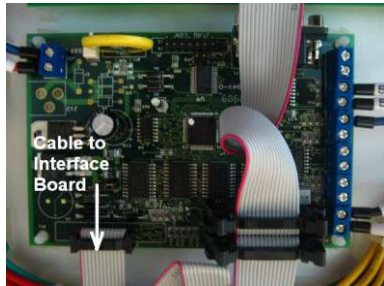


Figure 3-1



Figure 3-2

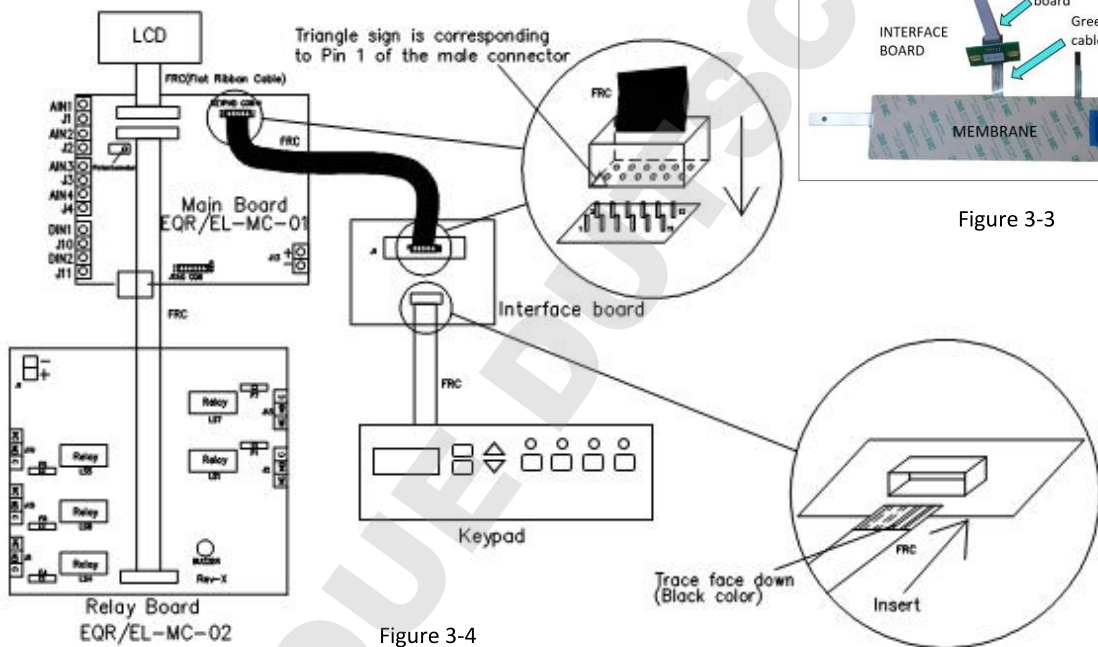


Figure 3-4

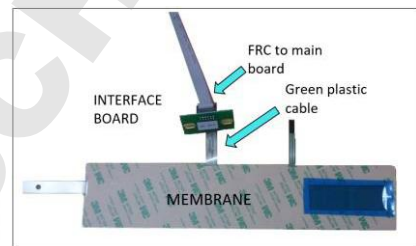
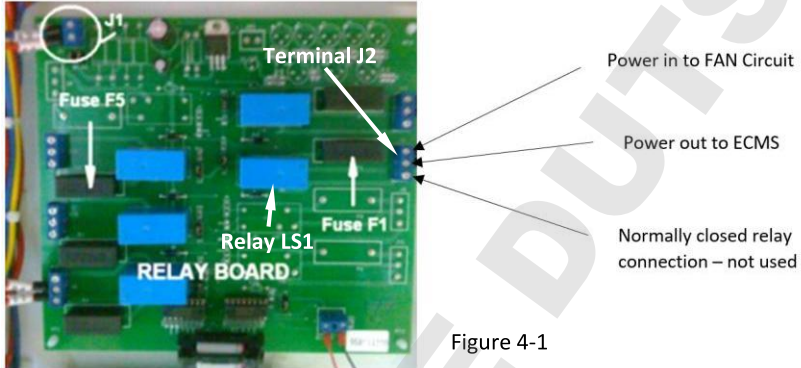



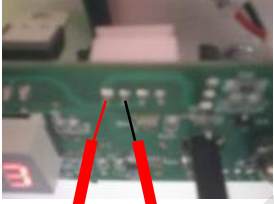

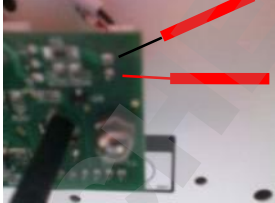

Figure 3-3

Defective Cable and / or Interface Board and / or keypad	<ul style="list-style-type: none"> <li>Replace them one by one, to check which one(s) is/are Defective.</li> <li>Replace the Defective part(s).</li> </ul>
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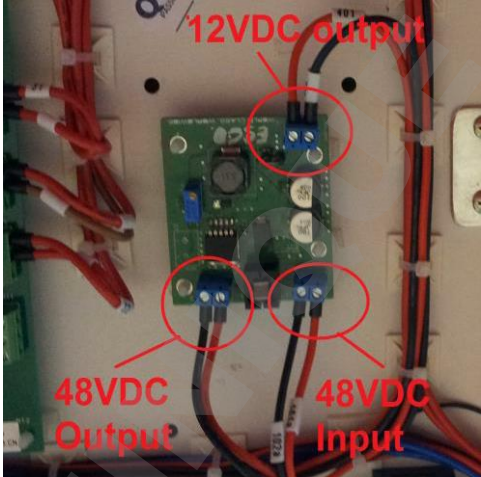
**Problem 4: Blower does not function**

Cause	Corrective Action
Motor Blower Fan is not running	<ul style="list-style-type: none"> <li>Switch on the Fan by pressing Fan button on control panel.</li> <li>Enter the Fan PIN number if required (default is 0001).</li> <li>The Exhaust blower and main blower must start. If mode on normal or quickstart there is a warm up timer for 3 minutes by default.</li> <li>If the both of blower does not operate, proceed to the next step.</li> </ul>
DC Voltage Connection	<ul style="list-style-type: none"> <li>Measure the incoming voltage on the Relay Board at terminal J 1 (Note polarity, BLUE cable closest to edge is negative -). See Figure 4-1.</li> <li>Voltage should be between 10.8 – 13.2VDC.</li> </ul>

Cause	Corrective Action
problem to relay board	<ul style="list-style-type: none"> <li>• If voltage is out of range or no voltage, check connection between SMPS (power supply) and relay board.</li> <li>• If voltage is correct, Proceed to the next step.</li> </ul>
Fuse F1 is blown or circuit is not energized	<ul style="list-style-type: none"> <li>• Check that AC voltage is supplied to the Relay board.</li> <li>• Ensure the Motor Blower FAN button and LED is energized.</li> <li>• Locate LS1 circuit and measure DC voltage between large BLACK (Negative X10) terminal block and the end terminal (with Red cable) on the three terminal strips (J2 on relay board). See Figure 4-1.</li> <li>• If there is voltage to the end terminal (Terminal with cable) check the central terminal (Normally Open Circuit) to the BLACK (Negative X10) terminal block.</li> <li>• Should there be no voltage detected at the central terminal, the fuse could have been blown or the circuit is not energized.</li> <li>• Check Fuse F1 on relay board. See Figure 4-1.</li> <li>• If fuse F1 is blown, replace F1.</li> <li>• If fuse F1 is good, check the voltage between the BLACK (Negative X10) terminal block and the end terminal on the LS1 circuit (J2 on relay board)</li> <li>• Detection of voltage at the end terminal with no cable indicates that the F1 fuse is good and the circuit is not energized.</li> </ul>
 <p data-bbox="639 1240 743 1267">Figure 4-1</p>	
Defective DC ECMS motor speed controller	<ul style="list-style-type: none"> <li>• Switch on the FAN blower by press FAN button.</li> <li>• Check Voltage supply to the ECMS, check from DC supply that one pin must be 12 volt.</li> <li>• If there is no voltage supplied to the ECMS, check the cable conection.</li> <li>• If cable conection is fine, check voltage output of the DC power supply.</li> <li>• If there is no DC Power supply output, the DC power supply is faulty and needs replacement.</li> <li>• If there is voltage supplied to ECMS, proceed to the next step.</li> <li>• Check the display of ECMS whether or not there is any reading. If not, ECMS is defective and need replacement.</li> <li>• If ECMS display value randomly, please check Data Acquisition Module.</li> <li>• If ECMS display stable and produces PWM output, ECMS is likely not defective.</li> <li>• If ECMS does not produce PWM output, ECMS is defective and needs replacement.</li> <li>• If ECMS does not respond after adjustment the speed, please check Data Acquisition Module.</li> <li>• When the standby mode is activated, the ECM blower should work at a lower speed. If the ECM blower increases in speed (measured or through displayed value) or drops lower than low than the expected speed, the ECMS is defective and need to be replaced.</li> </ul>

Cause	Corrective Action
	<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;">  <p>Figure 4-2. ECMS</p> </div> <div style="text-align: center;">  <p>Figure 4-3. Measure ECMS Supply</p> </div> </div> <div style="display: flex; justify-content: space-around; margin-top: 20px;"> <div style="text-align: center;">  <p>Figure 4-4. ECMS no Display</p> </div> <div style="text-align: center;">  <p>Figure 4-5. Measure PWM Output</p> </div> </div>
<p>Defective Data Acquisition Module</p>	<ul style="list-style-type: none"> <li>• Check Voltage supply to the Data Acquisition Module, check on VIN and GND terminal. See Figure 4-6</li> <li>• If there is no voltage supplied to the Data Acquisition Module, check the cable conection.</li> <li>• If cable conection is fine, check voltage output of the Data Acquisition Module. AO0+ and AGND for exhaust blower, AO1+ and AGND for main blower. Make sure exhaust blower speed and main blower speed not set on 0%.</li> <li>• If voltage output change based of setting speed blower, the data aquisition is not devective.</li> </ul> <p>If there is no output on both, the Data Acquisition Module is faulty and needs replacement.</p>
	<p>Figure 4-6</p>
<p>Motor failure</p>	<p><b>WARNING:</b> <i>The cabinet MUST be decontaminated before opening the plenum cover.</i></p> <ul style="list-style-type: none"> <li>• Check for physical damage.</li> <li>• Will the motor rotate?</li> <li>• Check wiring.</li> <li>• Replace the blower.</li> </ul>

**Problem 5: Airflow Failure (AIRFAIL) – alarm is triggered**

Cause	Corrective Action
External air interference	<ul style="list-style-type: none"> <li>• Ensure that there are no external sources of airflow disturbance close to the sensor. Check vents, lights, ceiling too close, etc.</li> <li>• If there is no external air interference, Proceed to the next step.</li> </ul>
Blocked cabinet grille	<ul style="list-style-type: none"> <li>• Ensure that the air grilles inside the cabinet are not blocked and that the cabinet is not excessively loaded.</li> <li>• If there is no blockage in air grilles, Proceed to the next step.</li> </ul>
Low building supply voltage (if new cabinet, check this first)	<ul style="list-style-type: none"> <li>• Refer to the electrical layout and find motor voltage Test Point shown in Figures 4-2 and 4-3.</li> <li>• <b>NOTE:</b> <i>The voltage adjustments should only be carried out by a qualified Certifier.</i></li> <li>• For a new cabinet, if the motor voltage is lower than the Nominal Voltage value recorded in the factory test report, adjust the speed controller to get output voltage to blower as specified in the Test Report – Test Conditions Documentation Sheet.</li> <li>• For cabinet that has been used for more than 1 year, refer to last motor Nominal Voltage from last certification report or if not available, measure the actual airflow on cabinet and increase motor voltage accordingly to achieve nominal airflow velocity.</li> <li>• If supply voltage is same as Nominal voltage, proceed to the next step.</li> </ul>
Defective DC/DC converter	<ul style="list-style-type: none"> <li>• On the SMPS, measure the DC voltage between Red (wire no. 401) and Black (wire no. 402) Measure on the side away from the DC/DC converter. Figure 5-1</li> <li>• The voltage should be in range of +12 VDC <math>\pm</math> 10%.</li> <li>• If out of range or no voltage, check incoming power to the DC/DC converter. The input of SMPS should be 48Vdc <math>\pm</math>10% of the cabinet incoming voltage.</li> <li>• If input voltage exists but there is no output voltage, please replace the DC/DC converter.</li> </ul> <p>If input and output voltage is correct, please Proceed to the next step.</p>
<div style="display: flex; align-items: center;">  <div style="margin-left: 20px;"> <p>Figure 5-1</p> </div> </div>	
Cabinet requires the air flows to be set	<ul style="list-style-type: none"> <li>• Refer to the Test Report for this model and set the air flow values to the required values. This information is also contained on the label at the bottom of the BLUE front panel.</li> </ul>
Filter loaded or wrong speed controller setting	<ul style="list-style-type: none"> <li>• Measure the actual airflow velocity using anemometer or flow hood. If actual airflow is good but LCD still shows AirFail:NO!, Proceed to the next step. If actual airflow is not good, please adjust motor speed controller accordingly until alarm is turned off and the LCD shows nominal airflow reading. After this, if LCD still shows AirFail:NO!, proceed to the next step.</li> <li>• The sensor will take about 2-3 minutes before it can register a new airflow setting.</li> </ul>

Cause	Corrective Action
	<p><b>Note:</b> <i>The cabinet must be certified at least annually.</i></p> <ul style="list-style-type: none"> <li>If the blower is already operating at maximum value and the airflow alarm is still triggered due to filter loaded, it's time to change the filter.</li> <li>If filter is not loaded, Proceed to the next step.</li> </ul>
Faulty/ inaccurate calibration	<ul style="list-style-type: none"> <li>Re-calibrate the microprocessor. Follow the calibration procedure in the test report. <b>Warning:</b> <i>To be carried out only by an authorized person.</i></li> </ul> <p><b>CHECKING CALIBRATION DATA</b></p> <ul style="list-style-type: none"> <li>After calibration is done, go to main display by pressing MENU button twice.</li> <li>Press SET/Diagnostic button, will display the mode and software version that is currently being used on the cabinet. Example: <b>DIAGNOSTIC MODE: MAINTENANCE CP109G VERSION 1.0 TEMPERATURE:25°C</b></li> <li>Press DOWN button until you find the following: <ul style="list-style-type: none"> <li><b>ADC IF0:</b> Shows ADC value at zero inflow point calibration.</li> <li><b>ADC IFN:</b> Shows ADC value for Nominal Point Inflow.</li> <li><b>ADC IFA:</b> Shows ADC value for Actual Inflow – showing real time sensor reading.</li> <li><b>ADC DF0:</b> Shows ADC at zero downflow point calibration.</li> <li><b>ADC DFN:</b> Shows ADC at nominal downflow point calibration.</li> <li><b>ADC DFA:</b> Shows ADC value for actual downflow.</li> <li><b>ADC TEMP:</b> ADC value for temperature.</li> </ul> </li> </ul> <p><b>Note:</b> <i>Depending on preset unit at SETTINGS&gt;MEASUREMENT UNIT&gt; (Metric or Imperial), the units for temperature and velocity will change accordingly. For Metric-°C, m/s while for Imperial-°F, fpm. Factory setting is at Metric.</i></p> <ol style="list-style-type: none"> <li>In order to prevent any AIRFAIL or unstable velocity displayed on LCD problem, please ensure the following is done after the calibration: <ol style="list-style-type: none"> <li>TEMPERATURE shows room temperature. Please maintain the environment temperature between 5° to 35°C. If not, refer to next possible cause, part B.</li> <li>ADC IF0 &lt; ADC IFN. If not please re-do calibration in correct sequence: ZERO SENSOR → CALIBRATE SENSOR. If CALIBRATION ERROR is encountered, please refer to next possible cause, part A.</li> <li>ADC DF0 &lt; ADC DFN. If not please re-do calibration in correct sequence: ZERO SENSOR → CALIBRATE SENSOR. If CALIBRATION ERROR is encountered, please refer to next possible cause, part A.</li> </ol> </li> <li>Just after calibration, ADC IFA value should be close to ADC IFN value. If not, please adjust the speed controller to make both values closer by at least ± 20 units.</li> </ol>
Sensor Failure / Sensor Misalignment	<p><b>A. Air Flow Sensor failure / misalignment</b></p> <ul style="list-style-type: none"> <li>There are two airflow sensors. The exhaust sensor place on top of the cabinet and downflow sensor inside the unit below the top filter. See Figure 5-4 below.</li> </ul> <p><b>Important to check:</b></p> <ol style="list-style-type: none"> <li>Ensure that the sensor area is not blocked at all and that its through-holes are perpendicular to the filter's surface.</li> <li>Exhaust sensor is attached tightly to the box / housing.</li> <li>If sensor box is used, there is no gap between sensor box and filter surface. If doughnut housing is used, the installation direction is in accordance with the airflow direction.</li> <li>Sensor housing is installed tightly to the cabinet.</li> </ol>

Cause	Corrective Action
	<ul style="list-style-type: none"> <li>• Open the front panel and locate electrical panel behind it.</li> <li>• Refer to the Component Layout at the beginning of this section to locate the main board in the electrical box.</li> <li>• Using multimeter, check the exhaust sensor's output voltage (DC) at channel AIN1(+) and J1(-), AIN2(-) and J2(+) on main board (See Figure 5-5 below).</li> <li>• The exhaust sensor voltage must increase if exhaust blower speed is increased and will decrease if exhaust blower speed is decreased.</li> <li>• The downflow sensor voltage must increase if main blower speed is increased and will decrease if main blower speed is decreased.</li> <li>• If your observations are different, check airflow sensor connection at connector D pin 11, 12 (exhaust), pin 3 (downflow) on electrical panel for any bad/loose connection.</li> <li>• If connections are good but sensor is still not working properly, replace it.</li> <li>• If airflow sensor is working properly, Proceed to the next step.</li> </ul> <p><b>B. Temperature Sensor Failure</b></p> <ul style="list-style-type: none"> <li>• Temperature sensor is located on top of the unit, close to exhaust airflow sensor. See Figure 5-4.</li> <li>• Using multimeter, check the temperature sensor's output voltage (DC) at channel AIN4(-) and J4(+) on main board See Figure 5-5.</li> <li>• 0.01VDC should represent one degree Celsius. For example, if output is 0.25 VDC, it indicates temperature of 25 °C. Tolerance of <math>\pm 1^{\circ}\text{C}</math> is acceptable.</li> <li>• Replace temperature sensor if the reading is wrong.</li> <li>• If temperature sensor is working properly, Proceed to the next step.</li> </ul>



Figure 5-3



Temperature Sensor

Figure 5-4

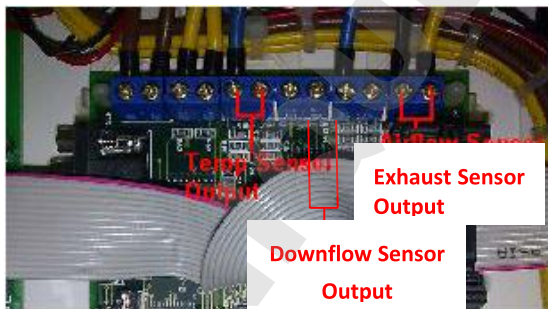


Figure 5-5

**Problem 6: Excessive Blower Noise**

Cause	Corrective Action
Resonance	<p><b>Note:</b> Requires a Certifier or qualified personnel</p> <ul style="list-style-type: none"> <li>• Locate the motor speed controller.</li> <li>• Measure the motor voltage and record this number</li> <li>• Increase the motor speed by 5 – 10 VAC. Does the noise change or go away?</li> <li>• If the noise is gone, measure the actual airflow velocity. Requires a Certifier               <ul style="list-style-type: none"> <li>○ If the velocity is still in the acceptable range, maintain it.</li> <li>○ If velocity is out of acceptable range, or if noise persists, go to next step.</li> </ul> </li> </ul>
Loose motor or impeller wheel mounting	<p><b>Note:</b> Decontaminate cabinet first before accessing the blower</p> <ul style="list-style-type: none"> <li>• Open the blower access panel and check if the blower mounting bolts are tight</li> <li>• Does the motor rotate freely without noise?</li> <li>• If motor is physically damaged, replace it.</li> </ul>

**Problem 7: Light always OFF**

Cause	Corrective Action
Sash in SASH ALARM state	<ul style="list-style-type: none"> <li>• Is the Light LED on the front panel ON?</li> <li>• If the light does not turn on, press the Light button and make sure the sash is in the Normal operating position (Ready Position Normal Operating height). <b>Note:</b> The sash must be at the Normal Operating position.</li> <li>• Is the cabinet in Warm Up period? <b>Note:</b> The fluorescent light will not light if the cabinet is in Warm Up period unless the cabinet is in Quick Start Mode.</li> <li>• Move the sash to Ready position (normal operating height).</li> <li>• Switch on the light by pressing LIGHT button on the membrane.</li> <li>• If the LED is ON the keypad and main board are functioning correctly.</li> <li>• If fluorescent light does not light with the window in the proper position Proceed to the next step</li> <li>• If the LIGHT LED still does not light, skip to <b>Ready magnetic switch Issues</b> in this table.</li> </ul>
Faulty LED light	<ul style="list-style-type: none"> <li>• Check the LED light voltage input (50-57 VDC).</li> <li>• If there is voltage but LED is not on, replace the faulty LED light.</li> <li>• LED light located inside the blue panel.</li> </ul>
Defective LED Driver or Relay Board Issues	<ul style="list-style-type: none"> <li>• Check incoming voltage to the Relay board.</li> <li>• Locate LS5 circuit and measure AC voltage between BLUE (NEUTRAL) terminal block and the end terminal (with Red cable) on the three terminal strip (J13 on relay board).</li> <li>• If there is voltage to the end terminal (Terminal with cable), check the central terminal (Normally Open Circuit) to the BLUE (NEUTRAL) terminal block.</li> <li>• No voltage at the central terminal indicates a blown fuse or the circuit is not energized.</li> <li>• Check Fuse F5 on relay board. See Figure 7-1 below.</li> <li>• If fuse F5 is blown, replace F5.</li> <li>• If fuse F5 is good, check the voltage between the BLUE (NEUTRAL) and the BROWN (LIVE) on input terminal terminal, Should be 230V ±10%.</li> <li>• Check output LED driver, should be 230VAC. See Figure 7-2 below.</li> <li>• If the LED driver has power and the light not ON, check LED light input</li> </ul>

Cause	Corrective Action
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	<ul style="list-style-type: none"> <li>If there is voltage, replace the LED driver.</li> </ul>
--	--

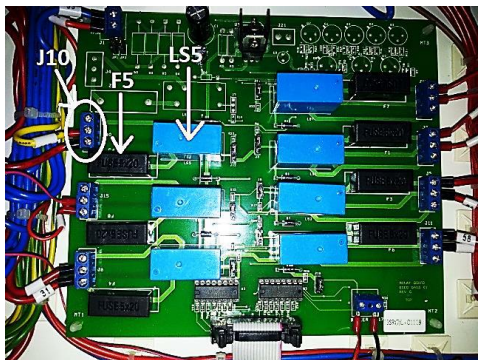


Figure 7-1

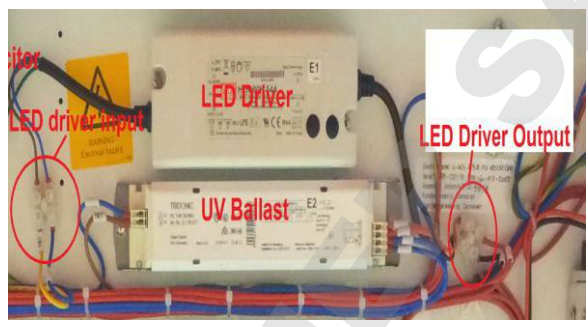


Figure 7-2

Ready magnetic switch Issues

- With the LIGHT LED ON and the sash at the Normal operating position (Ready)
- Does the Display indicate “SASH: OK” or “SASH: NO!”
- “SASH: NO!” indicates the sash is not at the proper position and the LIGHT LED should not be on. This indicates a main board problem or a magnetic switch detection problem.
- To access the magnetic switches for the sash positions, remove the right sash window profile cover as you face the cabinet.
- There are 3 magnetic switches inside the right profile. See Figure 7-3 below. The one in the middle is for Ready position.
- There is a magnet attached to the glass to activate the magnet.
- Shift the switch or magnet position so the distance between them is between 10-13mm (3/8 to 1/2”) as explained in Figure 7-2 below. If the distance is too far, the switch may not be able to detect the magnet.
- If the LCD still displays “SASH: NO!”, the switch may be defective or there is a wiring connection problem. To check the connections proceed to the next step.

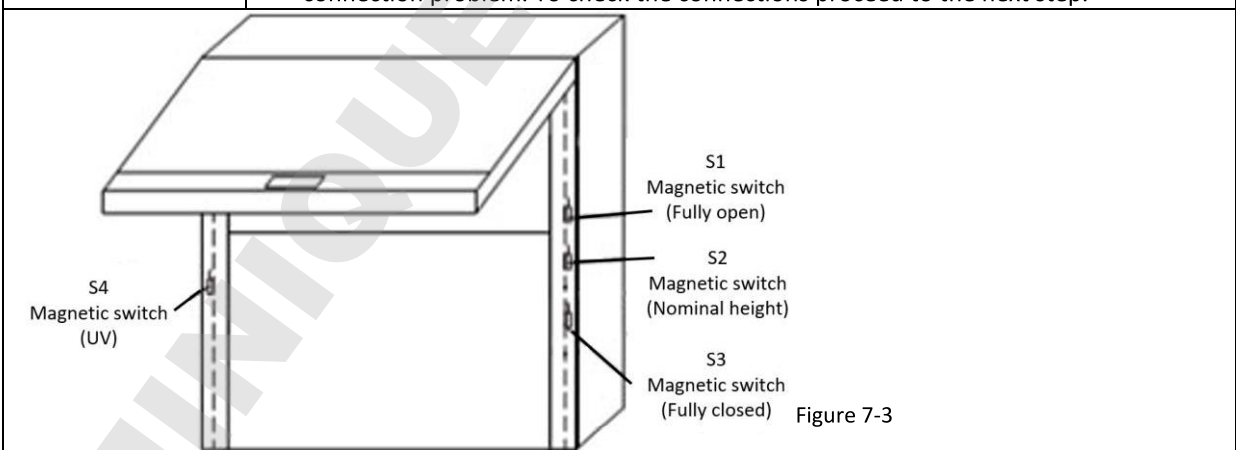


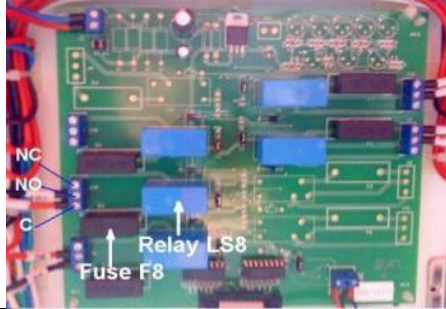
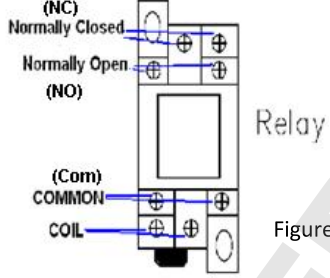
Figure 7-3

Connection Problem

- Locate Connector C and D and check male and female side for any bad connection.
- If the fluorescent lamp still does not light with the LIGHT LED ON return to start of Problem 7 and repeat the troubleshooting process.

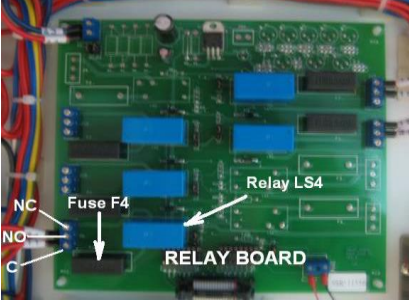
**Problem 8: UV Light always OFF**

<b>Cause</b>	<b>Corrective Action</b>
Sash not in Full Close State	<ul style="list-style-type: none"> <li>• Lower the sash to full close position.</li> <li>• If “<b>SASH FULLY CLOSED</b>” is not displayed on the LCD, please refer to the Magnetic Switch troubleshooting section.</li> <li>• Switch on the UV lamp by pressing the UV button.</li> <li>• If “<b>SASH FULLY CLOSED</b>” is displayed on LCD but UV is not ON after pressing UV button, refer to the Magnetic Switch troubleshooting section.</li> </ul>
Faulty UV tube	<ul style="list-style-type: none"> <li>• Replace the faulty UV tube.</li> </ul>
Faulty UV ballast	<ul style="list-style-type: none"> <li>• Check incoming voltage to the Relay board.</li> <li>• Locate LS8 (J15 Terminal) circuit and measure AC voltage between large BLUE (Neutral) terminal block and the end terminal (with Red cable) on the three terminal strip (J15 on relay board).</li> <li>• If there is no incoming voltage to the end terminal (Terminal with cable), refer to the next step <b>NO power to UV Relay circuit LS8</b>.</li> <li>• If voltage to the end terminal (Terminal with cable) exists, check the central terminal (Normally Open Circuit) to the BLUE (Neutral) terminal block.</li> <li>• Absence of voltage at the central terminal indicates a blown fuse or the circuit is not energized.</li> <li>• Check Fuse F8 on relay board. See Figure 8-1 below.</li> <li>• If fuse F8 is blown, replace F8.</li> <li>• If fuse F8 is good, check the voltage between the BLUE(NEUTRAL) terminal block and the end terminal on the LS8 circuit (on J15 terminal of relay board).</li> <li>• Voltage at the end terminal with no cable indicates the F8 fuse is good and the circuit is not energized.</li> <li>• Make sure the UV LED is on.</li> <li>• If the ballast has power and the UV lamp is new, the problem is either cable connections or the UV ballast.</li> <li>• Check Connector B cable connections. If there are no loose terminals, replace the UV ballast.</li> </ul>
No Power to UV Relay circuit LS8 and K2 relay	<ul style="list-style-type: none"> <li>• Absence of voltage at LS8 indicates K2 Relay is open.</li> <li>• Check magnetic UV interlock switch on Left side (as you face the cabinet) of sash.</li> <li>• Check the AC voltage to and from the K2 relay.</li> <li>• Absence of voltage indicates a wiring issue between the RED (Live) power in and the K2 relay.</li> <li>• If voltage to the K2 relay is present, but no voltage out of the K2 relay, this indicates the relay is not energized or defective.</li> <li>• Check the DC voltage to the coil of the K2 relay. Voltage should be 12VDC <math>\pm</math> 10%.</li> <li>• No voltage indicates the magnetic switch on the Left side is not closed. Check the wiring to the switch Connector D-6 and D-3.</li> <li>• To simulate a closed switch, set the jumper between connector D-6 and D-3 at Connector D.</li> <li>• If the relay does not energize, check the wiring from the K2 coil to Connector D and the neutral wiring from K2 to the DC Power supply.</li> <li>• If wiring connections are OK, visually inspect K2 relay for any burnt or flash marks.</li> <li>• If burnt or flash marks are present, replace the relay.</li> <li>• If no burnt or flash marks are found, turn off the cabinet.</li> <li>• Disconnect relay cables and check for the continuity at K2 relay terminals. See figure 8-2. NC to COM has continuity while, NO to COM does not have continuity. Replace the relay if any of the terminals are found with wrong continuity configuration.</li> </ul>

Cause	Corrective Action
 <p>Figure 8-1</p>	 <p>Figure 8-2</p>
<p>UV magnetic switch is defective or misaligned</p>	<ul style="list-style-type: none"> <li>• Move sash to Fully Closed position. The LCD should show <b>SASH: FULLY CLOSED</b>.</li> <li>• If the LCD display shows “<b>SASH: NO!</b>” the sash is not fully closed.</li> <li>• Check the magnetic switches. There are 3 magnetic switches behind the right sash profile cover. See Figure 7-2 above. The bottom one is for UV Mode position.</li> <li>• There is a magnet attached to the glass to activate the magnetic switch.</li> <li>• Shift the switch or magnet position so the distance between them is between 10-13mm (3/8” to 1/2”) as explained in Figure 7-2 above. If the distance is too far, the switch may not be able to detect the magnet.</li> <li>• If the LCD still showing “<b>SASH: NO</b>” check the connections at Connector D pins D-4 and D-5</li> <li>• To simulate a closed U/V Switch, connect the jumper between Connector D pins D-5 and D-4.</li> <li>• If this does not turn on the UV, return to the first step and repeat the procedures.</li> </ul>
<p>Watchdog failure</p>	<ul style="list-style-type: none"> <li>• User cannot operate UV lamp during watchdog failure because UV ballast controlled by watchdog board.</li> </ul>

**Problem 9: Electrical socket always OFF**

Cause	Corrective Action
<p>Connection Problem</p>	<ul style="list-style-type: none"> <li>• Is the OUTLET LED illuminated? If not press the Outlet button at the keypad membrane in front panel.</li> <li>• Check voltage coming to the Relay board.</li> <li>• Locate LS4 (J6 Terminal) circuit and measure AC voltage between Large BLUE (Neutral) terminal block and the end terminal (with Red cable-COM) on the three terminal strip (J6).</li> <li>• If there is voltage to the end terminal (with Red cable-COM), check the central terminal (Normally Open circuit) to the BLUE (Neutral) terminal block.</li> <li>• No voltage at the central terminal (Normally Open circuit) indicates a blown fuse or the circuit is not energized.</li> <li>• Check Fuse F4 on relay board. See Figure 9-1 below.</li> <li>• If fuse F4 is blown, replace with F5 fuse.</li> <li>• If fuse F4 is OK, check the voltage between the BLUE (NEUTRAL) terminal block and the end terminal (COM) on the LS4 circuit (J6 on relay board).</li> <li>• Voltage at the end terminal (Normally Closed circuit) with no cable indicates the F4 fuse is good and the circuit is not energized. Make sure the OUTLET LED is on.</li> <li>• If there is power to the relay and it is energized Check voltage across Connector B pin 1 to 2 and pin 4 to 5.</li> <li>• If there is power through Connector B pins, remove socket outlets from wall.</li> <li>• Check incoming power to the plug in the cable to the outlet</li> <li>• No power indicates a wiring issue. Recheck voltage from Connector B pins.</li> <li>• Check for loose or faulty connection between the power cord, IEC inlet and Connector B.</li> </ul>

Cause	Corrective Action
 <p data-bbox="655 577 756 607">Figure 9-1</p>	
Faulty electrical socket	<ul style="list-style-type: none"> <li>• Socket(s) is(are) located inside the work zone.</li> <li>• Check electrical socket connection.</li> <li>• If connection is correct but socket has no output, replace electrical socket.</li> </ul>
Watchdog failure	<ul style="list-style-type: none"> <li>• User cannot operate socket outlet during watchdog failure because the socket controlled by watchdog board.</li> </ul>

#### Problem 10: Contaminated Sample/Lab

Cause	Corrective Action
Blocked air grille/ Cabinet overloaded with too many items	<p data-bbox="435 913 1185 943"><b>Note:</b> Contaminated samples are normally the result of any of the following:</p> <ul style="list-style-type: none"> <li>-Poor Technique of the user or lack of training.</li> <li>-Samples being contaminated in the incubator or somewhere other than the BSC.</li> </ul> <p data-bbox="435 1010 727 1039">Items to check on the BSC:</p> <ul style="list-style-type: none"> <li>• Make sure that the front and back air grilles are not blocked.</li> <li>• Remove all equipment and other items from the cabinet and surface decontaminate the cabinet including the area under the work surface.</li> <li>• Surface decontaminate everything that is returned to the BSC.</li> <li>• If the contamination problem persists, recertify the cabinet.</li> </ul>

### 3.2. Software Troubleshooting

Error Code	Corrective Action
Sash: Error Position	<ul style="list-style-type: none"> <li>Magnetic switches are located inside right profile cover. See drawing B-1 below.</li> </ul>

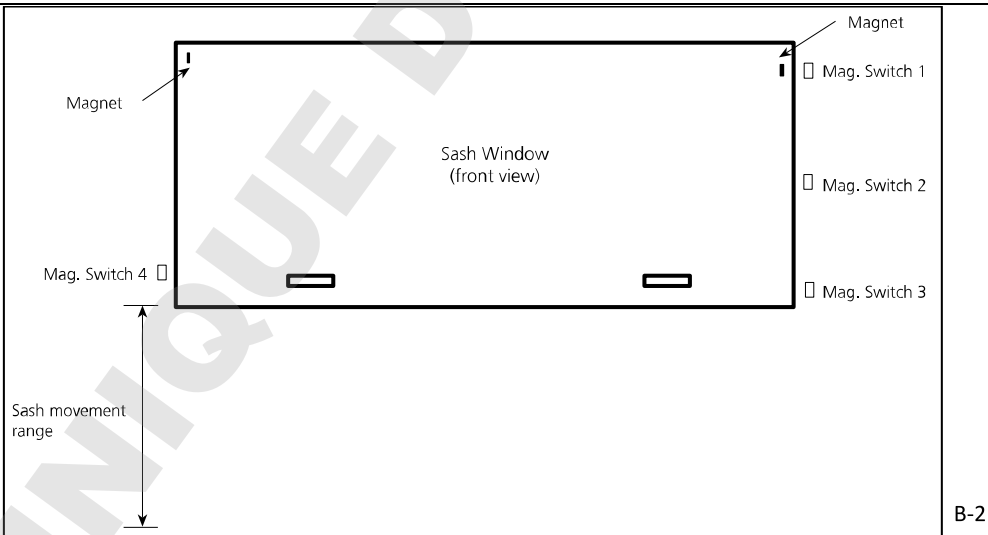
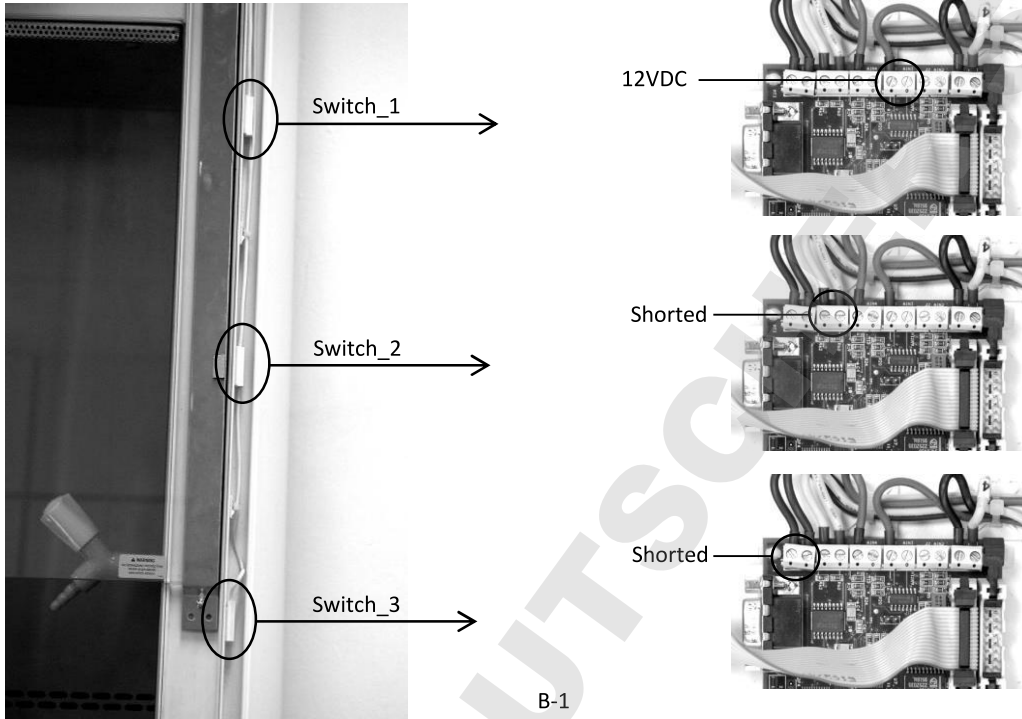


Table 2

Magnetic Switch 1	Magnetic Switch 2	Magnetic Switch 3	Magnetic Switch 4	Description
Close	Open	Open	Open	Sash is fully opened, ALARM is given. ALARM can be muted.
Open	Close	Open	Open	Cabinet sash is at nominal height, ready to use.
Open	Open	Close	Close	Sash is fully closed; UV can be operated.
Open	Open	Open	Open	SASH is at unsafe state, ALARM is given. ALARM cannot be muted.
Rest Conditions				Sash:Error Position detected

Sensor Uncalibrated	<ul style="list-style-type: none"> <li>Calibrate the controller. Refer to test report to calibrate.</li> </ul>
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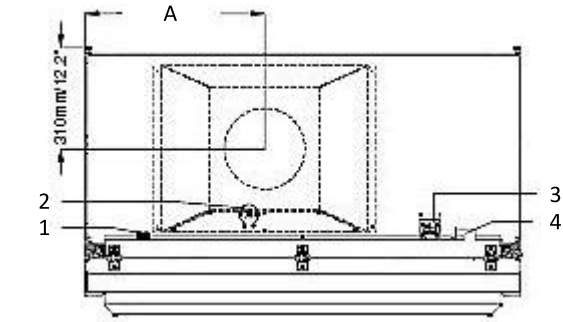
Watchdog Failure	<ul style="list-style-type: none"> <li>• Please check cable connection (DB9 connector) between mainboard and watchdog board.</li> <li>• If problem still occur check voltage supply on J13 watchdog board. If there is no voltage, please check the DC power connection.</li> <li>• If no problem on voltage input, please try to reset the watchdog board then mainboard by press SW1 (white button beside board battery).</li> <li>• If the problem still occur then replace watchdog board with new one.</li> </ul> <p><i>Note: During this condition problem. Access output for UV lamp, socket outlet, gas valve and free relay contact will be ignored. Regarding those outputs controlled by watchdog board.</i></p>
AMB.:HIGH or AMB.:LOW	<ul style="list-style-type: none"> <li>• This problem happen if actual ambient temperature detected by temperature sensor below 5°C or above 35°C.</li> <li>• If these problems still happen even temperature maintain on 5°C until 23°C. Please refer on Problem 5 temperature sensor failure.</li> </ul>

Sash Position	Function Available	Normal Or Quickstart Mode and Airfail Alarm On	Normal Or Quickstart Mode and Airfail Alarm Off	Maintenance Mode
READY	Sash Position Detection	Yes	Yes	Yes
	Fan Control	Yes, with WARM UP & PURGING time, FAN PIN required	Yes, with WARM UP & PURGING time, FAN PIN required	Yes, without WARM UP & PURGING time, no PIN required
	Light Control	Yes	Yes	Yes
	Socket Control	Yes	Yes	Yes
	UV Control	Interlocked	Interlocked	Interlocked
	Gas valve Control	Yes. if no airflow failure	Yes	Yes
	Up Motor Control	Yes. If sash cycle less than 16000	Yes. If sash cycle less than 16000	Yes. If sash cycle less than 16000
	Down Motor Control	Yes. If sash cycle less than 16000	Yes. If sash cycle less than 16000	Yes. If sash cycle less than 16000
	MENU Access	Yes, USER or ADMIN PIN required	Yes, USER or ADMIN PIN required	Yes, no PIN required
	Pressing Set button	Diagnostic Message. Mute the alarm if any airflow failure or during warm up.	Diagnostic Message. Mute the alarm during warm up.	Diagnostic Message
	Timer	Yes	Yes	No
	Current Time Display	Yes	Yes	Yes
	Air Velocity Display	Yes	Yes	Yes
	If not calibrated, displaying "Sensor Uncalibrated"			
Air Velocity Display Status	Yes	Yes	No	
Air Fail checking	Yes, Alarm and display alert if air fails	No	No	
SASH ALARM	Sash Position Detection	Yes	Yes	Yes
	Current Time Display	Yes	Yes	Yes
	Sash Alarm	Yes	Yes, not mutable	Not Applicable
	Fan Control	Yes, with WARM UP & PURGING time, PIN required	Yes, with WARM UP & PURGING time, PIN required	Yes, without WARM UP & PURGING time, no PIN required
	Light Control	No	No	Yes
	Socket Control	Yes	Yes	Yes
	UV Control	Interlocked	Interlocked	Interlocked
	Gas valve Control	Interlocked	Interlocked	Yes
	Up Motor Control	Yes. If sash cycle less than 16000	Yes. If sash cycle less than 16000	Yes. If sash cycle less than 16000
	Down Motor Control	Yes. If sash cycle less than 16000	Yes. If sash cycle less than 16000	Yes. If sash cycle less than 16000
	MENU Access	No	No	Yes, no PIN required
	Pressing Set button	Can't mute the alarm	Can't mute the alarm	Diagnostic Message
Air Velocity Display	Yes	Yes	Yes	

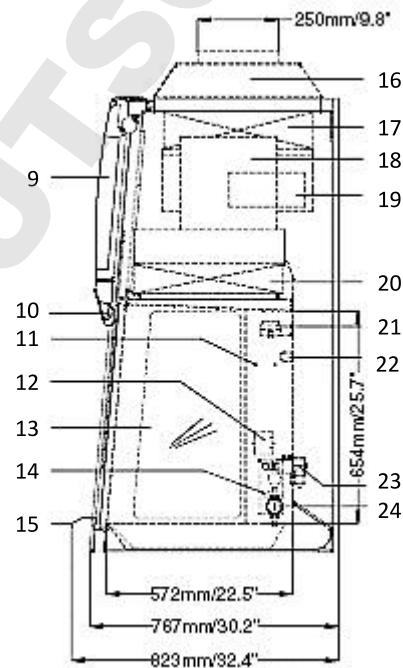
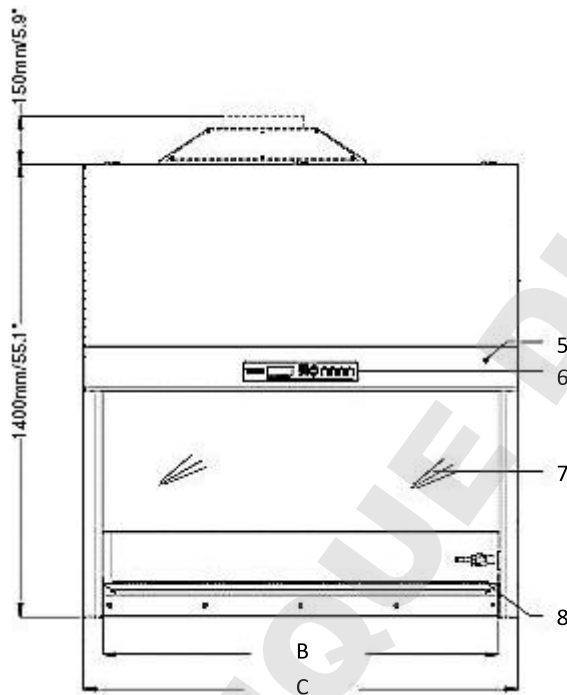
	Air Velocity Display Status	Yes	Yes	No
	Air Fail checking	Yes, display alert if air fails	No	No
FULLY OPEN	Sash Position Detection	Yes	Yes	Yes
	Current Time Display	Yes	Yes	Yes
	Alarm	Yes	Yes	No
	Fan Control	Yes, with WARM UP & PURGING time, FAN PIN required	Yes, with WARM UP & PURGING time, FAN PIN required	Yes, without WARM UP & PURGING time, no PIN required
	Light Control	Yes	Yes	Yes
	Socket Control	Yes	Yes	Yes
	UV CONTROL	Interlocked	Interlocked	Interlocked
	Gas valve Control	Interlocked	Interlocked	Yes
	Up Motor Control	Interlocked	Interlocked	Interlocked
	Down Motor Control	Yes. If sash cycle less than 16000	Yes. If sash cycle less than 16000	Yes. If sash cycle less than 16000
	MENU Access	No	No	Yes, no PIN required
	Pressing Set button	Can mute the alarm for 5 min	Can mute the alarm for 5 min	Diagnostic Message
FULLY CLOSED	Sash Position Detection	Yes	Yes	Yes
	SWITCH OFF Fan requested	Yes	Yes	No
	Fan Control	Interlocked	Interlocked	Yes
	Light Control	Interlocked	Interlocked	Yes
	Socket Control	Yes	Yes	Yes
	UV Control	Yes	Yes	Interlocked
	Gas valve Control	Interlocked	Interlocked	Yes
	Up Motor Control	Yes. If sash cycle less than 16000	Yes. If sash cycle less than 16000	Yes. If sash cycle less than 16000
	Down Motor Control	Interlocked	Interlocked	Interlocked
	MENU Access	No	No	Yes, no PIN required
Pressing Set button	Not applicable	Not applicable	Diagnostic Message	

## Chapter 4 - Engineering Details

### 4.1. AC2-TU Engineering Drawing (E series)

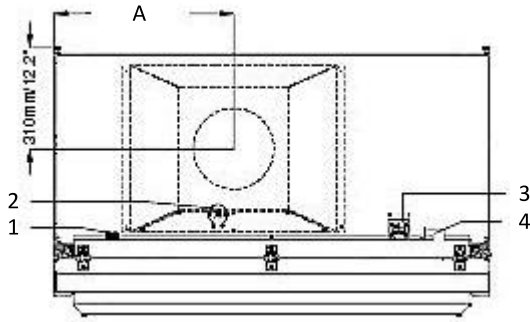


	A	B	C
3	463 mm	915 mm	1035 mm
4'	553 mm	1220 mm	1340 mm
5'	660 mm	1525 mm	1645 mm
6'	680 mm	1830 mm	1950 mm

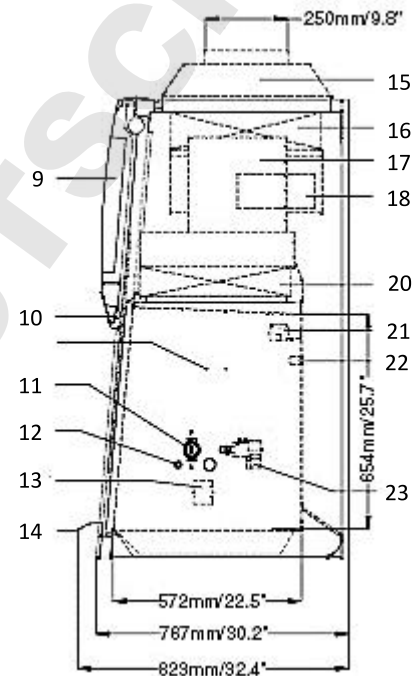
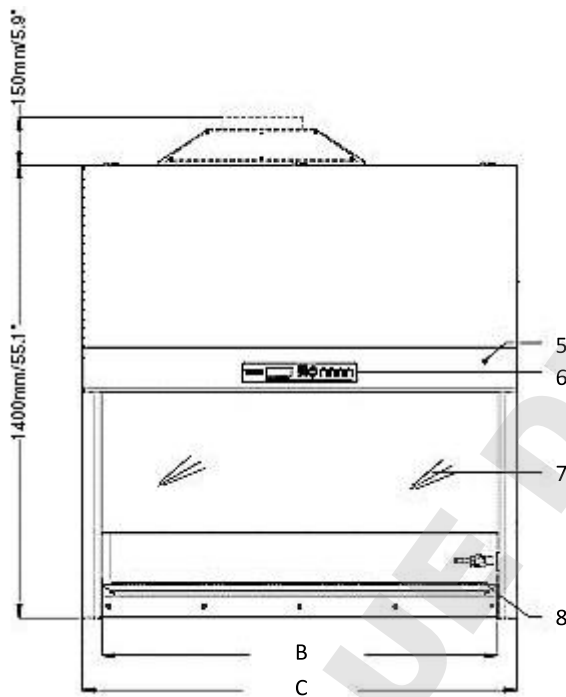


- |  |   |
|--|---|
| 1. Zero Volt Relay Contact                       | 13. Service Fixture Retrofit Kit Provision (2 on each side) |
| 2. Exhaust Sensor & Mounting Bracket             | 14. Stainless Electrical Outlet Retrofit Kit Provision      |
| 3. RS 485 Communication Port                     | 15. Stainless Steel Armrest                                 |
| 4. Power Inlet                                   | 16. Exhaust Collar (Optional)                               |
| 5. Key Switch                                    | 17. Exhaust H14 Filter (Optional U15)                       |
| 6. Esco Sentinel Gold Control System             | 18. ECM Exhaust Blower                                      |
| 7. Laminated Glass Motorized Sliding Sash Window | 19. Downflow H14 Filter (Optional U15)                      |
| 8. Stainless Steel Multi-piece Work Tray         | 20. Downflow Sensor   |
| 9. Electrical/Electronic Panel                   | 21. UV Lamp Provision                                       |
| 10. LED Lamps                                    | 22. Optional Solenoid Valve                                 |
| 11. IV Bar Retrofit Kit Provision                | 23. Steris VHP/Bioquell HPV Port                            |
| 12. Steris VHP / Bioquell HPV Port               |   |

## 4.2. AC2-TU Engineering Drawing (S series)



	A	B	C
3	463 mm	915 mm	1035 mm
4'	553 mm	1220 mm	1340 mm
5'	660 mm	1525 mm	1645 mm
6'	680 mm	1830 mm	1950 mm



- |   |   |
|---|---|
| 1. Zero Volt Relay Contact                            | 13. Side Tempered Glass                                     |
| 2. Exhaust Sensor & Mounting Bracket                  | 14. Service Fixture Retrofit Kit Provision (2 on each side) |
| 3. RS 485 Communication Port                          | 15. Stainless Steel Armrest                                 |
| 4. Power Inlet  | 16. Exhaust Collar (Optional)                               |
| 5. Key Switch   | 17. Exhaust H14 Filter (Optional U15)                       |
| 6. Esco Sentinel Gold Control System                  | 18. RBM Downflow Blower                                     |
| 7. Laminated Glass Motorized Sliding Sash Window      | 19. ECM Exhaust Blower                                      |
| 8. Stainless Steel Single-piece Work Tray             | 20. Downflow H14 Filter (Optional U15)                      |
| 9. Electrical/Electronic Panel                        | 21. Downflow Sensor   |
| 10. LED Lamps   | 22. UV Lamp Provision                                       |
| 11. IV Bar Retrofit Kit Provision                     | 23. Optional Solenoid Valve                                 |
| 12. Standard Electrical Outlet Retrofit Kit Provision |   |

### 4.3. General Specifications

AIRSTREAM CLASS II BIOLOGICAL SAFETY CABINET TECHNICAL SPECIFICATIONS					
Glass Side: 220-240 VAC, 50/60 Hz	AC2-3E8-TU	AC2-4E8-TU	AC2-5E8-TU	AC2-6E8-TU	
Stainless Steel Side: 220-240 VAC, 50/60 Hz	AC2-3S8-TU	AC2-4S8-TU	AC2-5S8-TU	AC2-6S8-TU	
Nominal Size	3 ft. / 0.9 m	4 ft. / 1.2 m	5 ft. / 1.5 m	6 ft. / 1.8 m	
External Dimensions (W x D x H) **	1035 x 825 x 1400 40.7" x 32.5" x 55.1"	1340 x 825 x 1400 (52.8" x 32.5" x 55.1")	1645 x 825 x 1400 (64.8" x 32.5" x 55.1")	1950 x 825 x 1400 (76.8" x 32.5" x 55.1")	
Gross Internal Dimensions (W x D x H)	915 x 580 x 654 (36.0" x 22.8" x 25.7")	1220 x 580 x 654 (48.0" x 22.8" x 25.7")	1525 x 580 x 654 (60.0" x 22.8" x 25.7")	1830 x 580 x 654 (72.0" x 22.8" x 25.7")	
Usable Work Area	0.42 m <sup>2</sup> (4.5 ft <sup>2</sup> )	0.56 m <sup>2</sup> (6.1 ft <sup>2</sup> )	0.71 m <sup>2</sup> (7.6 ft <sup>2</sup> )	0.86 m <sup>2</sup> (9.2 ft <sup>2</sup> )	
Tested Opening	175 mm (7.0")				
Working Opening	190 mm (7.5")				
Average Inflow Velocity	0.48 m/s (95 fpm)				
Average Downflow Velocity	0.35 m/s (69 fpm)				
Airflow Volume	Inflow	278 cmh (164 cfm)	369 cmh (218 cfm)	463 cmh (273 cfm)	553 cmh (325 cfm)
	Downflow	661 cmh (389 cfm)	876 cmh (516 cfm)	1099 cmh (647 cfm)	1314 cmh (773 cfm)
	Exhaust	278 cmh (164 cfm)	369 cmh (218 cfm)	463 cmh (273 cfm)	553 cmh (325 cfm)
	Required Exhaust with Optional Thimble Exhaust Collar	320 cmh (189 cfm)	554 cmh (326 cfm)	692 cmh (407 cfm)	830 cmh (488 cfm)
	Static Pressure for Optional Thimble Exhaust Collar	29 Pa / 0.11 in H <sub>2</sub> O	38 Pa / 0.12 in H <sub>2</sub> O	44 Pa / 0.14 in H <sub>2</sub> O	50 Pa / 0.18 in H <sub>2</sub> O
ULPA Filter Efficiency	>99.999% for particle size between 0.1 to 0.3 micron, ULPA as per IEST-RP-CC0011.3 USA; >99.999% at MPPS as per EN 1822 (H-14) EU				
Sound Emission *	EN 12469	50.7 dBA	51.7 dBA	53.4	54.8
Fluorescent Lamp Intensity	1500 Lux (139 foot-candles)	1562 Lux (145 foot-candles)	1510 Lux (140 foot-candles)	1450 Lux (134 foot-candles)	
Cabinet Construction	Main Body	1.2 mm (0.05") 18 gauge EG steel with Isocide™ oven-baked epoxy-polyester powder coating			
	Work Zone	1.5 mm (0.06")/16 gauge stainless steel, type 304, 4B Finish			
	Side Walls (E series)	UV absorbing tempered glass, 6 mm (0.2") colorless and transparent 1.5 mm (0.06") 16 gauge stainless steel, type 304, with 4B finish			
	Side Walls (S series)	1.5 mm (0.06") 16 gauge stainless steel, type 304, with 4B finish			
Electrical	Cabinet Full Load Amps (FLA)	10	10	10	10
	Heat Load (BTU/Hr)	597	682	785	938
Maximum Power (5A Electrical Outlets included)	1880	1880	1880	1880	
Nominal Power Consumption (W)	175	200	245	287	
Net Weight **	188 kg (414 lbs.)	236 kg (520 lbs.)	293 kg (645 lbs.)	351 kg (773 lbs.)	
Shipping Weight	216 kg (476 lbs.)	260 kg (573 lbs.)	331 kg (729 lbs.)	403 kg (888 lbs.)	
Shipping Dimensions, Maximum (W x D x H)	1120 x 880 x 1760	1450 x 880 x 1760	1720 x 880 x 1760	2050 x 880 x 1760	
Shipping Volume, Maximum (W x D x H)	1.73 m <sup>3</sup>	2.25 m <sup>3</sup>	2.66 m <sup>3</sup>	3.17 m <sup>3</sup>	

\* Noise reading in open field / anechoic chamber. Noise reading in normal room varies by room size, layout and background noise, but may reach roughly 3-4 dBA above these values. Noise measurement is based on the ISO 11201 while cabinet is running at normal mode with uncertainty of 2dBA.

\*\* The power and current values stated above are not including the socket outlet. The usage of the socket outlets will add in to the reading of the value above.

\*\*\* Cabinet only, excludes optional stand.