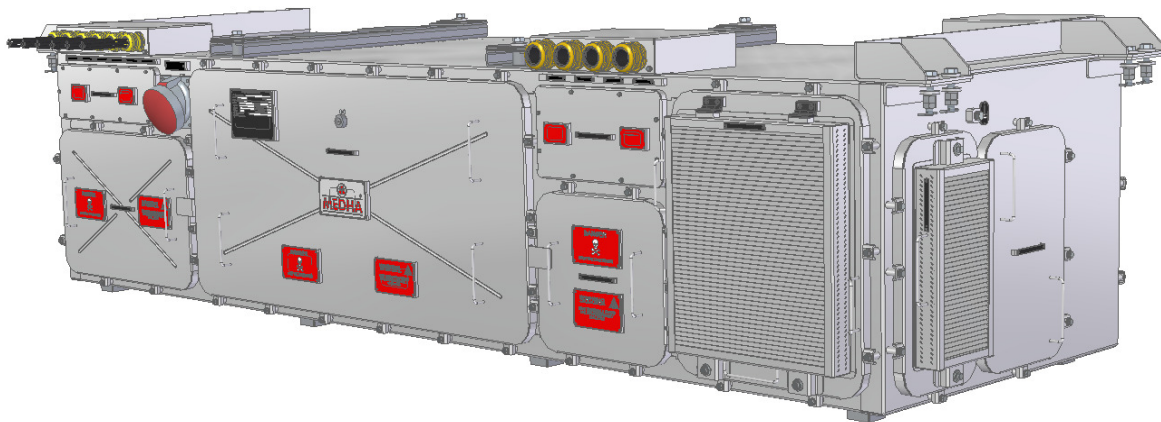




Maintenance Manual

AUXILIARY CONVERTER FOR TRAIN18-V2

TYPE MAE675UV2



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AUXILIARY CONVERTER UNIT (ACU)

1.1 Introduction

Auxiliary Converter is used to supply power for 3-phase 415V loads and 110V DC loads.

ACU is mounted at under frame of TC coach of each basic unit and consists of 2nos. 415Vac 3phase Inverter modules and 1no. 110V DC Converter module.

1.2 Technical Data & Description of the Interface

1.2.1.1 Mechanical Data

Converter Size	3000 (L) X 1000 (W) X 700 (H)
Cabinet	SS-304
Mass	1200 kg (approx.)
Degree of protection	a) ELECTRONICS ZONE: IP68 UP TO FLOOD LEVEL ELECTRONICS ZONE: IP65 ABOVE FLOOD LEVEL b) COOLING ZONE: IP20

1.2.2 Electrical Data

AC1:

Requirements	Parameters
Input Voltage	Single phase 285V AC to 450V AC input from Auxiliary secondary winding of Main transformer
Control Supply	77 V to 137.5 V DC from battery (110 V DC nominal)
Output capacity	Output: 186kVA, 415V±5% (L-L), 50Hz±3%, 3Phase, Sine wave (at >19kVac OHE) At <19kVac OHE, output voltage shall drop by maintaining V/F ratio constant.
Short time rating	For 415Vac output: 150% of rated current for 10 Seconds without increasing active power.
Efficiency	> 94%
Noise Level	< 80dB(A) at 1 meter away from the unit
Voltage-THD	≤8%

AC2 & DC Converter:

Requirements	Parameters
Input Voltage	Single phase 285V AC to 450V AC input from Auxiliary secondary winding of Main transformer
Control Supply	77 V to 137.5 V DC from battery (110 V DC nominal)
Output capacity	Output-1: 186kVA, 415V±5% (L-L), 50Hz±3%, 3Phase, Sine wave (at >19kVac OHE) At <19kVac OHE, output voltage shall drop by maintaining V/F ratio constant. Output-2: 110V to 125VDC (It is varying as per DC load sharing current requirement) DC Power: 30.5kW at 110V DC (BN, BD & Battery Charger loading on this).

Short time rating	For 415Vac output: 150% of rated current for 10 Seconds without increasing active power. For 110Vdc output: 37.5kW for 20 seconds
Efficiency	> 94%
Noise Level	< 80dB(A) at 1 meter away from the unit
Voltage-THD	≤ 8%

1.3 External Interface

1.3.1 Input/Output Terminals and connections

S. no.	Connection Name	Terminal	Ferrule no.	Recommended wire size
1	AC1 Input Phase	AC1 I/P Ph	031005.700	1wire, 185mm ²
2	AC1 Input Neutral	AC1 I/P N	031006.700	1wire, 185mm ²
3	AC2 Input Phase	AC2 I/P Ph	031007.700	1wire, 185mm ²
4	AC1 Input Neutral	AC2 I/P N	031008.700	1wire, 185mm ²
5	AC1 Output R-Phase	AC1-O/P-Rph	033001.700 033001.701	2wires, 50mm ²
6	AC1 Output Y-Phase	AC1-O/P-Yph	033002.700 033002.701	2wires, 50mm ²
7	AC1 Output B-Phase	AC1-O/P-Bph	033003.700 033003.701	2wires, 50mm ²
8	AC2 Output R-Phase	AC2-O/P-Rph	033004.700 033004.701	2wires, 50mm ²
9	AC2 Output Y-Phase	AC2-O/P-Yph	033005.700 033005.701	2wires, 50mm ²
10	AC2 Output B-Phase	AC2-O/P-Bph	033006.700 033006.701	2wires, 50mm ²
11	DC Output (BN) +Ve	BN +VE	082001.700 082001.701	2wires, 70mm ²
12	DC Output(BN) -Ve	BN -VE	082002.700 082002.701	2wires, 70mm ²
13	DC Output (BD) +Ve	BD +VE	081001.700 081001.702	2wires, 25mm ²
14	DC Output(BD) -Ve	BD -VE	081002.700 081002.702	2wires, 25mm ²

CON3 is used for 415V Shed supply connection.

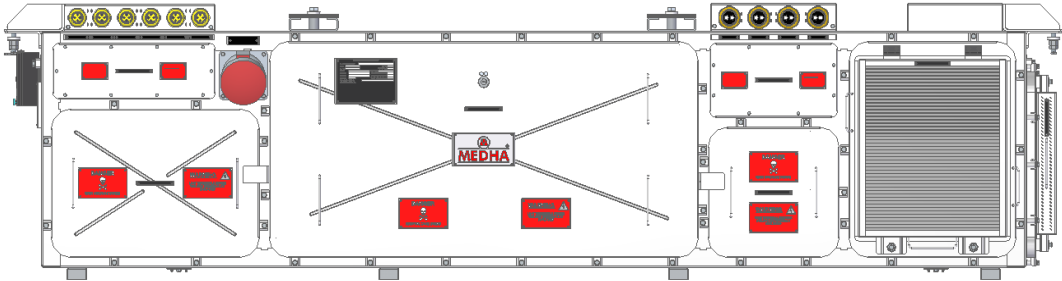
1.3.2 Control connectors (CON1 & CON2)

There are two control connectors (CON1 & CON2). CON2 is used for 110 V DC control supply and for digital signals and CON1 is used for interface between TCMS and ACU with Ethernet communication.

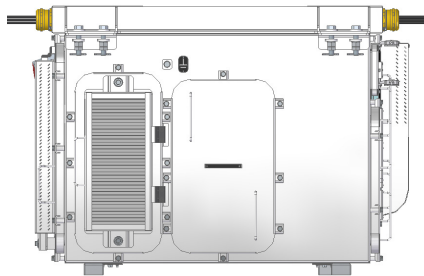
1.4 Design

1.4.1 Structural Design

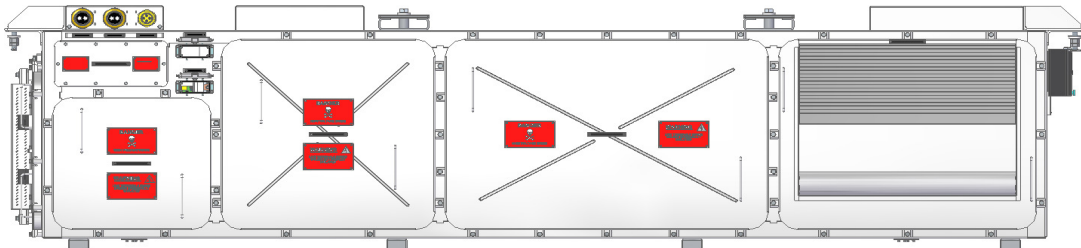
ACU Cabinet is designed to be installed in under slung of TC coach .
LHS, RHS, front and rear views are shown below.



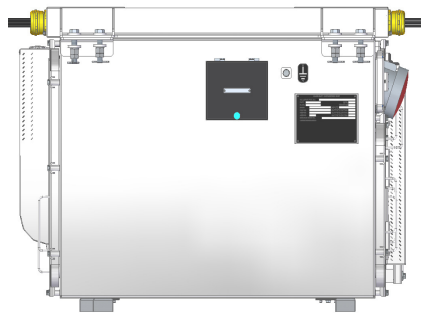
Front View



Right Side View



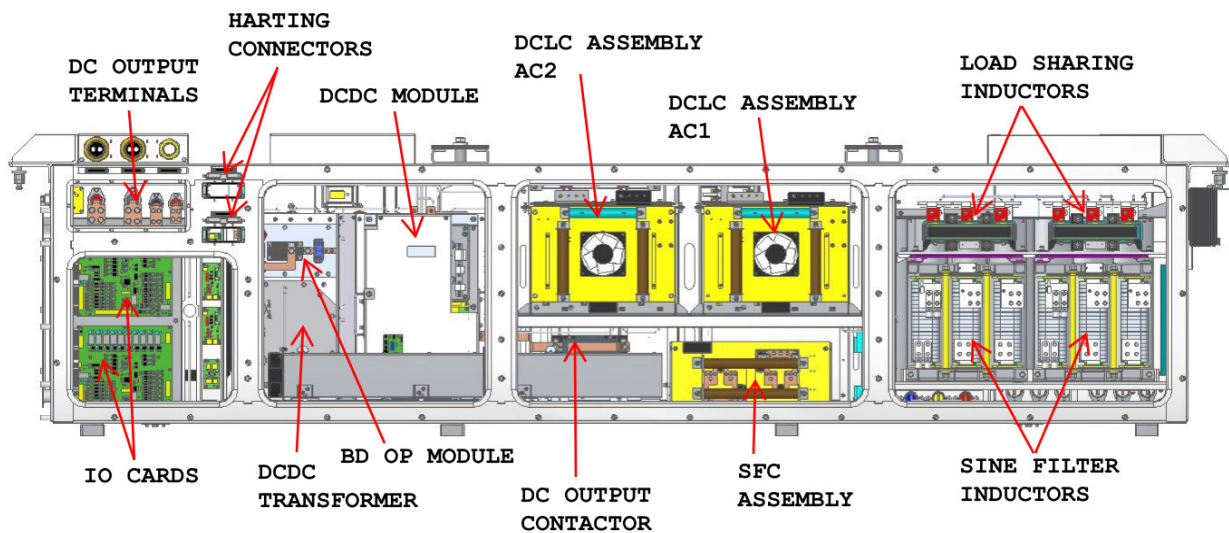
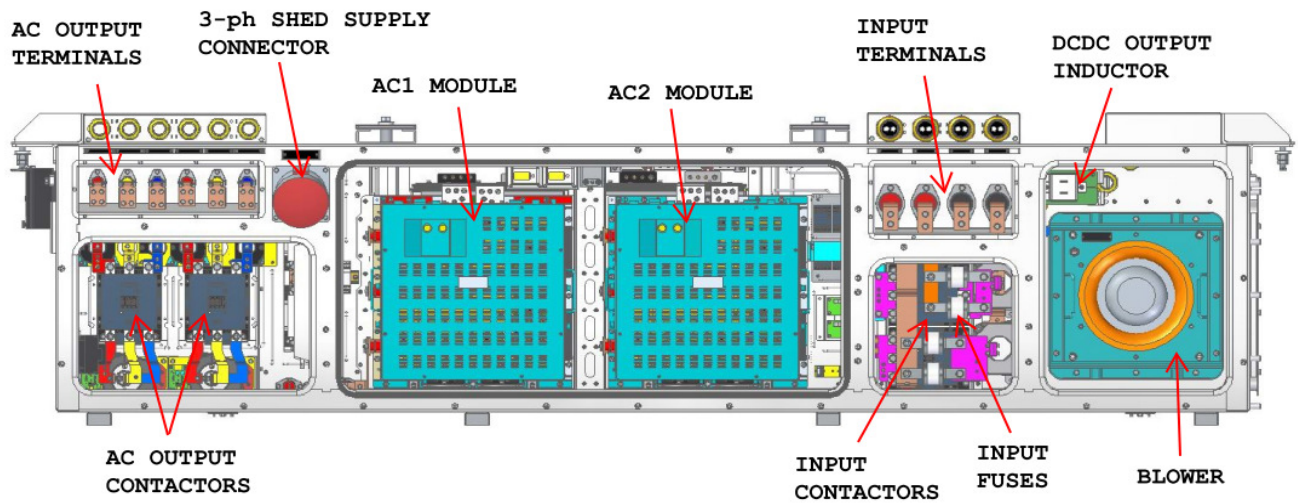
Rear View



Left Side View

1.5 Component Layout in the Cabinet

The following diagram show the position of the major components in the ACU.

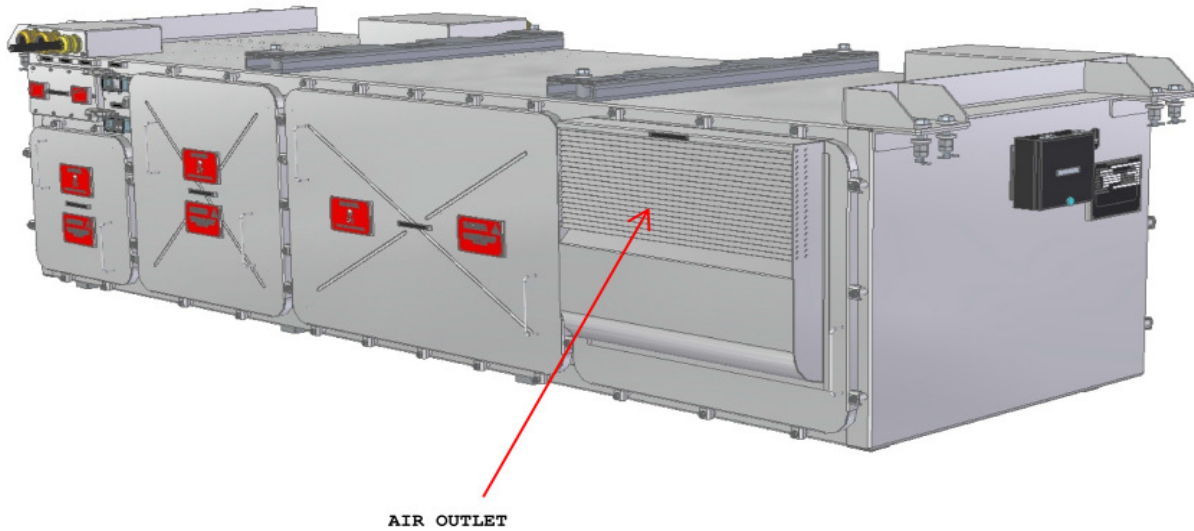
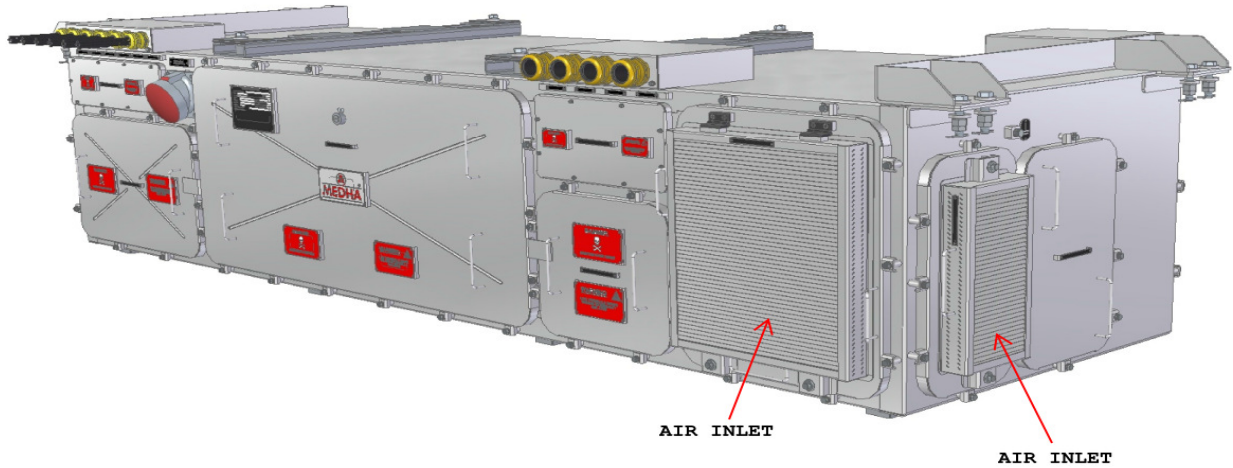


1.6 Accessibility

The Auxiliary Converter's modular system can be accessed and serviced quickly and easily.

1.7 Cooling

Auxiliary converter cooling is achieved by means of forced convection. Inside the auxiliary converter one blower is used for cooling the modules and magnetics, it draws air from the inlet air filter on front and right side of unit and forces it over module heat sinks, the air then flows over the magnetics and finally leaves outside through louvered door.



1.8 Safety Instructions

To prevent accidents follow these steps:

- Put the train in duty position
- Verify that there is no voltage remaining between DC+ and DC- by measuring with a voltmeter.
- Ensure that adequate cooling time has been allowed, if train has recently been running.
- Use appropriate depot Personal Protective Equipment (PPE) when working with hot components and dusty environment.
- Always wear a dust mask when working in dusty environment.

1.8.1 Personal safety

- Before commencing any work on the vehicle the personnel shall always: Set the vehicle to the correct operating position for the task to be performed
- Study the necessary safety precautions within the documentation and on the vehicle

1.8.2 Work on vehicle

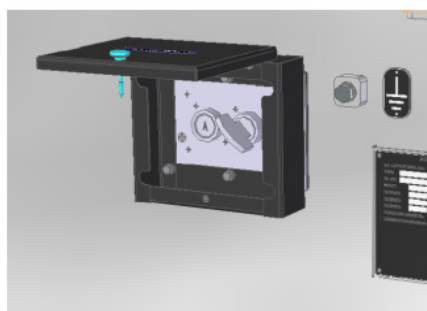
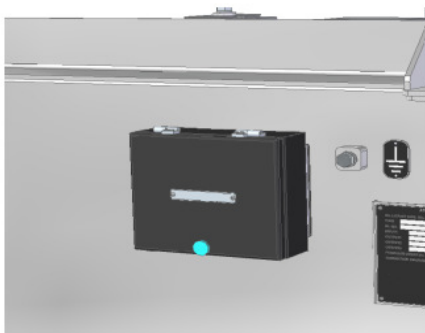
When carrying out maintenance work on the vehicle, the instructions should be followed carefully.

- Always use protective clothing and protective equipment.
- Make sure you have worn the safety shoes, gloves
- Set the placard "Work in progress" or follow the employer instruction.
- Before commencing work on the vehicle, ensure that all voltage is disconnected.

1.9 Interlocking

Interlocking System: The propulsion equipment is secured by the key interlock system. It ensures that the high voltage supply is always earthed before it is possible to get in contact with the equipment.

1. Open the isolation switch guard cover by unscrewing the knob.
2. Place the key-A in to the isolation switch and rotate clockwise for accessing key-B. Rotate the key-B anti-clockwise and remove it. With Key-B Main door lock to be opened.



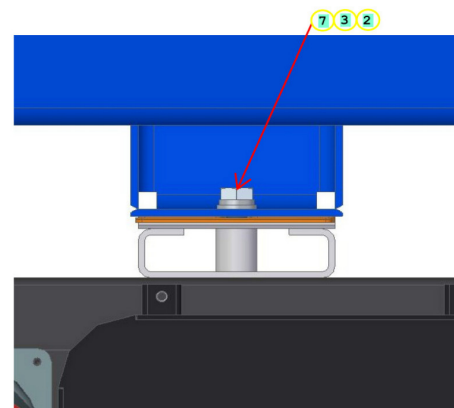
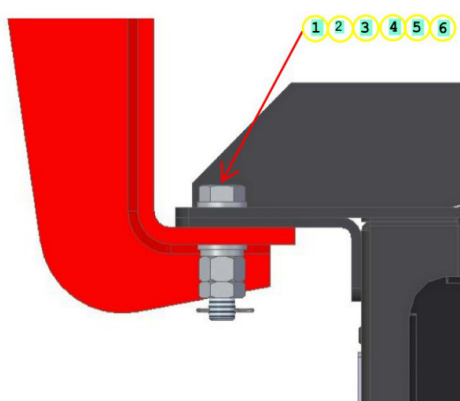
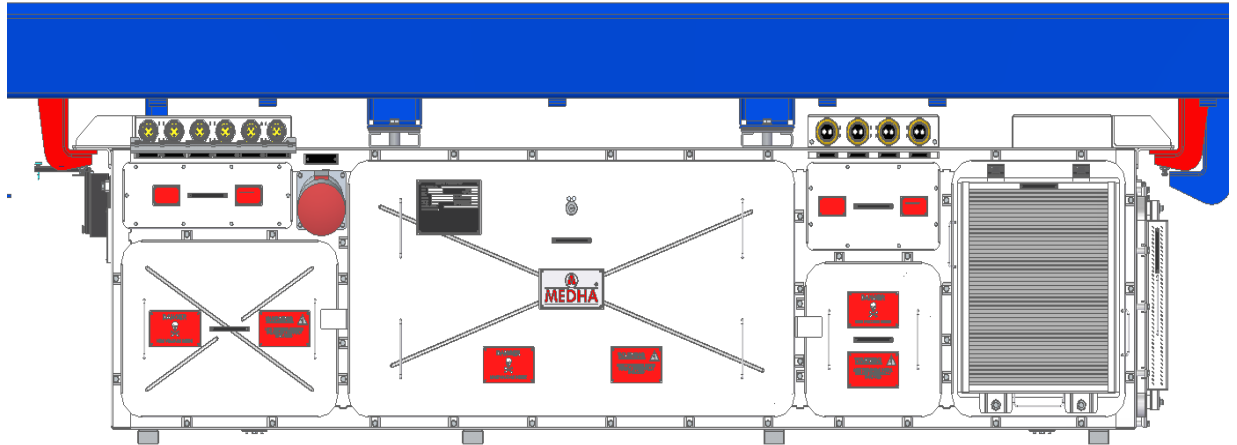
1.10 Maintenance Schedule Check list

S. no.	Connection Name	Every 15 Days	Every 30 Days	Every 90 Days	Every 180 Days
1	Inspection of unit mounting hardware as per chapter 1.11.1	√	√	√	√
2	Inspection of converter unit as per chapter 1.11.2	√	√	√	√
3	Ensure isolation switch box cover is properly closed when accessed.	√	√	√	√
4	Ensure 3-ph shed supply connector cap is properly closed when accessed.	√	√	√	√
5	Air inlet & outlet openings inspection as per chapter 1.11.3	√	√	√	√
6	Inspection of air inlet louver frames snap locks as per chapter 1.11.7	√	√	√	√
7	Air filter cleaning with forced air as per chapter 1.12.1.1		√	√	√
8	Inspection of unit doors hardware as per chapter 1.11.10			√	√
9	External name plates & outer surfaces cleaning as per chapter 1.12.4			√	√
10	Inspection of external electrical connections and ground connections as per chapter 1.11.9				√
11	Intumescent seal inspection as per chapter 1.11.4				√
12	Inspection of silica gel as per chapter 1.11.5				√
13	Inspection of door gasket as per chapter 1.11.6				√
14	Air filter cleaning with forced water as per chapter 1.12.1.2				√
15	Inspection of blower as per chapter 1.11.11				√
16	Blower cleaning as per chapter 1.12.3				√
17	Magnetics cleaning as per chapter 1.12.2				√
18	Inspection of internal mounting hardware as per chapter 1.11.8				√
19	Inspection of internal components and cables as per chapter 1.11.12				√
20	Inspection of excessive temperature and arcing (Voltage flash overs) as per chapter 1.11.13				√
21	Inspection of cable ties as per chapter 1.11.14				√
22	Inspection of all internal electrical connections as per chapter 1.11.15				√
23	While doing maintenance if any abnormality / damage found, it should be addressed on need (issue severity) basis.				√

1.11 Inspection

1.11.1 Inspection of unit mounting hardware

- Ensure that the converter unit bolted tightly, There should not be any slackness in mounting fasteners and also split pin should be intact with lock nut. If any hardware is loose, Re-tight the hardware, apply the torque & mark with nail paint.
- If any hardware is missing, Assemble new hardware & apply the torque.



1.11.2 Converter unit inspection

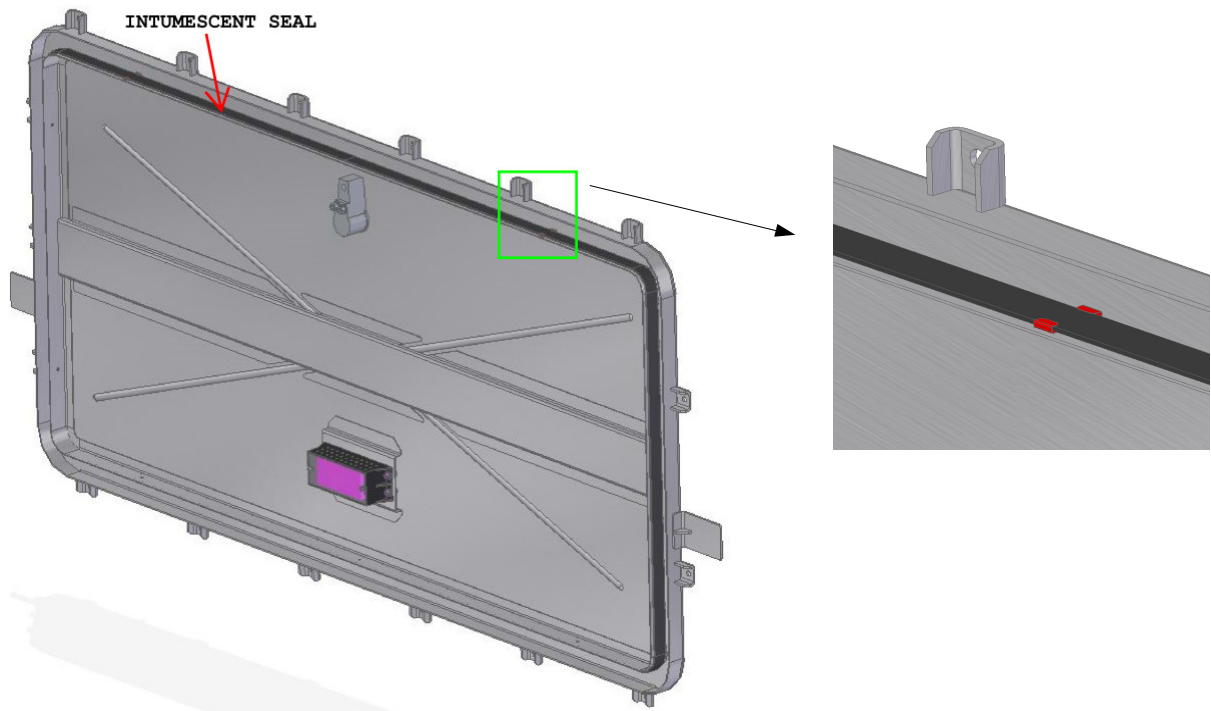
- Visually verify the converter unit for any damages.

1.11.3 Air inlet & outlet openings inspection

- Ensure that the air inlet and outlet openings are not obstructed by papers, covers or any other large foreign objects etc.

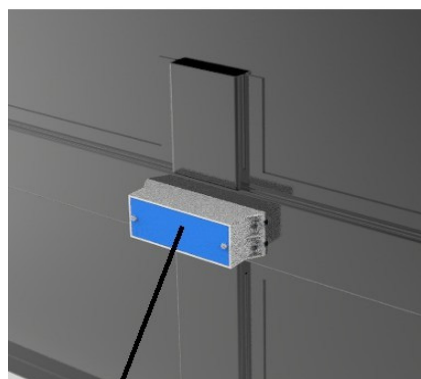
1.11.4 Inspection of intumescent seal

- Ensure Intumescent seals are free from cut marks and physical damages, If found replace with new one.

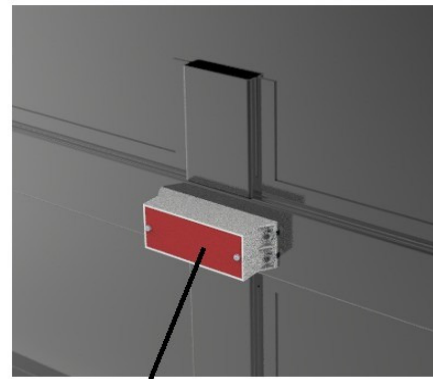


1.11.5 Inspection of silica gel

- Check the color of silica gel inside the doors AC MODULES CHAMBER, AC OUTPUT CONTACTORS CHAMBER, IO CARDS CHAMBER, DC MODULE CHAMBER & DC LINK CHAMBER. They should be blue, Replace silica gel if found pink.



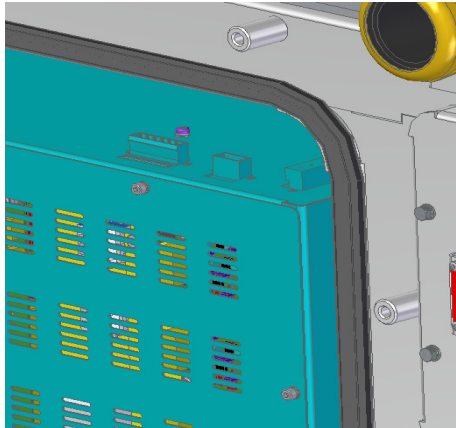
BLUE
COLOR
(HEALTHY)



PINK
COLOR
(UN-HEALTHY)

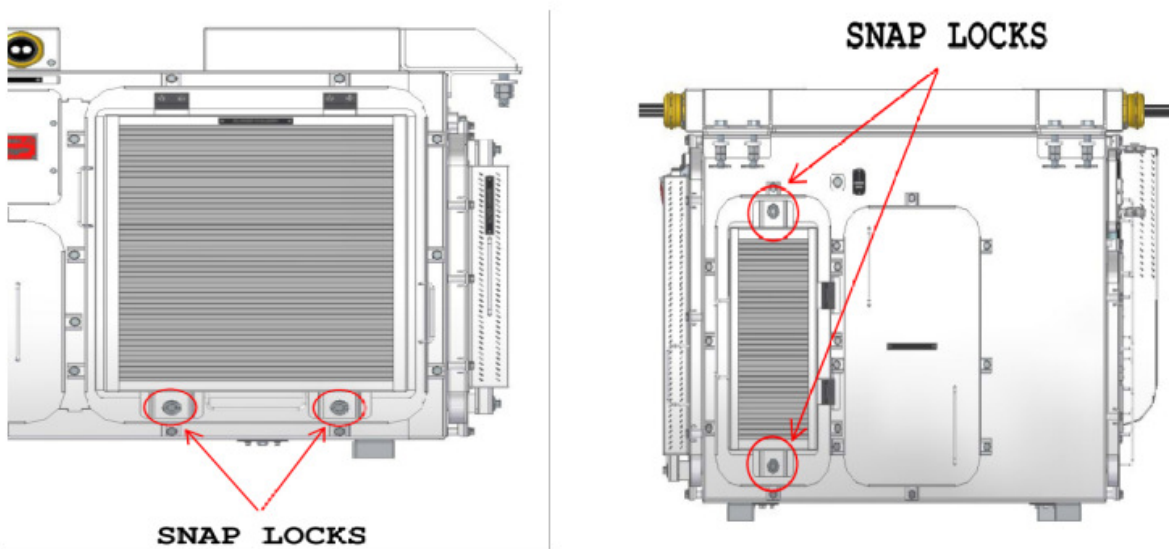
1.11.6 Inspection of door gasket

- Ensure that all door sealing gaskets are free from cut marks and physical damages, If found replace with new one.



1.11.7 Inspection of air inlet louver frame snap locks

- Ensure air inlet louver frames are properly snapped.

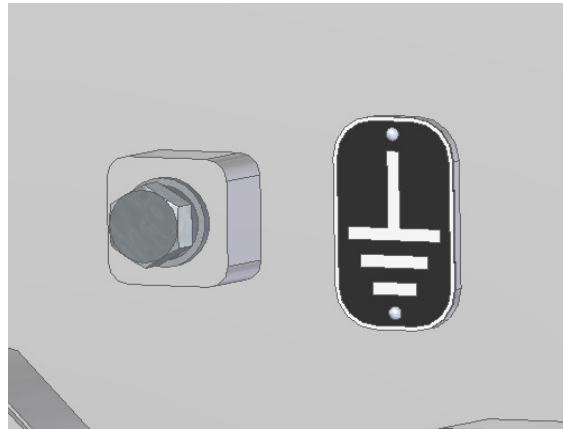


1.11.8 Inspection of internal mounting hardware

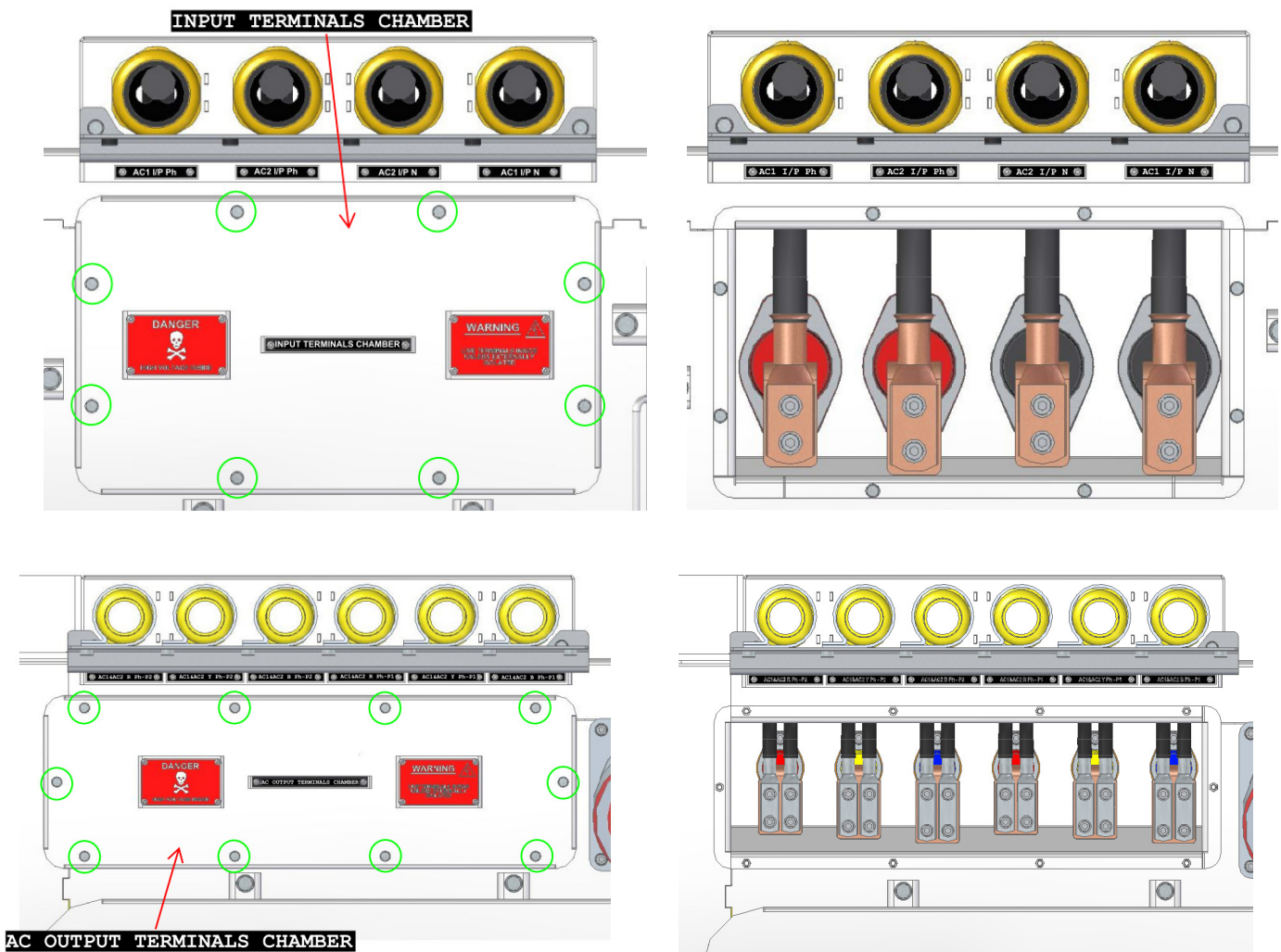
- Visually inspect mounting hardware of modules, sub assemblies & their electrical connections for any slackness by seeing changes in torque markings, if any disturbance found in torque markings, re-tight the hardware & mark with nail paint.
- If any hardware is missing, Assemble new hardware & apply required torque.

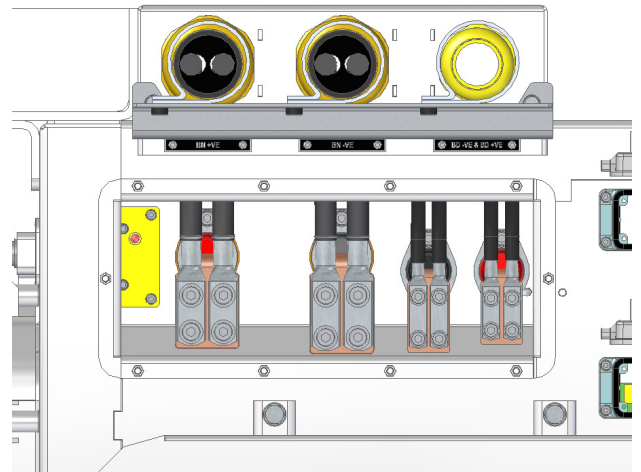
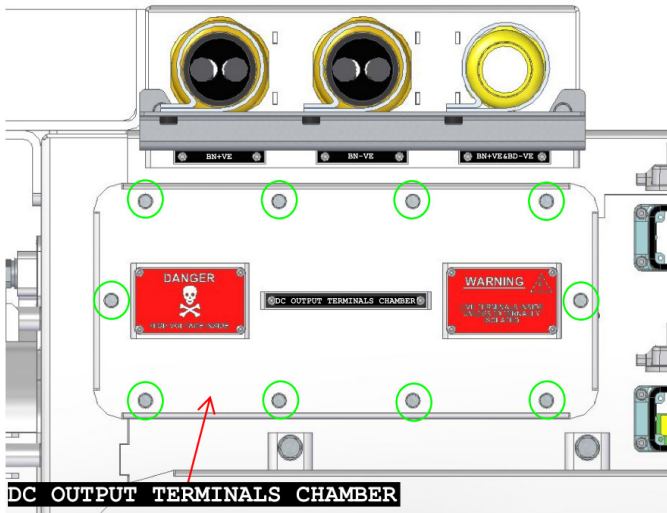
1.11.9 Inspection of external electrical & ground connections

- Check all external electrical connections and ground connections for corrosion to resolve. Ensure connections are tight.



- For accessing external electrical connections, Open the Input terminal chamber, AC output terminals chamber & DC output terminals chamber.
- Open the terminal cover mounting hardware as shown below.



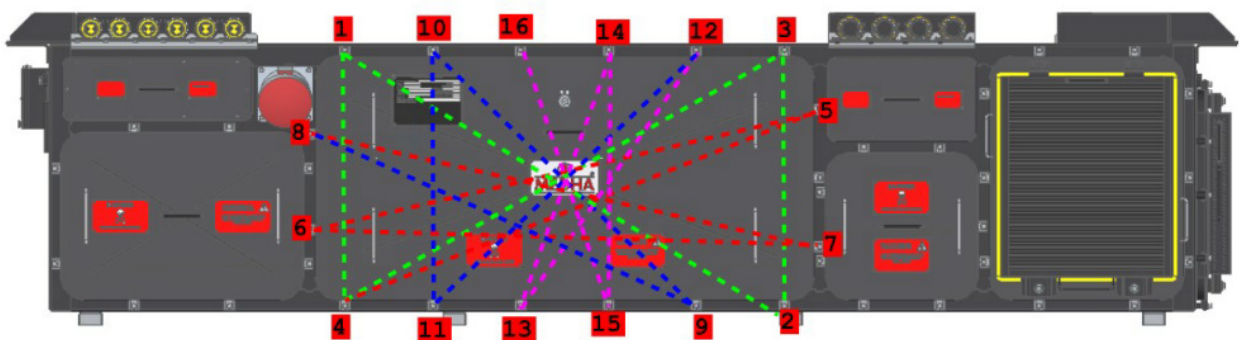


- Visually inspect lug mounting hardware for any slackness by seeing changes in torque markings, If any disturbance found in torque markings, re-tight the hardware, Apply required torque & mark with nail paint.
- Close the terminal cover, assemble the hardware & apply the required torque

1.11.10 Inspection of unit doors hardware

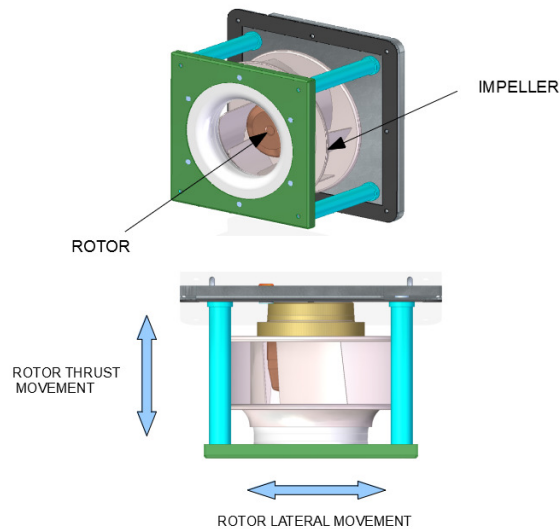
- Check all unit doors hardware are tight & intact with the unit. If any hardware is missing, assemble new hardware & Apply the torque.
- If hardware is loose, Tight it & apply torque.

Note: Follow below mentioned sequence for tightening door hardware & applying torque.



1.11.11 Inspection of blower

- Open blower service chamber door by following chapter 1.16.
- Ensure that thrust moment of the Rotor to be examined by pushing the rotor towards the stator, thus any abnormal action / loose moment (weak spring action) will be found.
- Relative lateral movement of Rotor over the Stator to be verified by moving the Rotor assembly To and Fro (or) left to right direction, thus any abnormal action / loose moment, (Increased Bearing clearance / Bearing deterioration action) will be found.
- After examining the above points, If any occurrences are noticed then replace with new blower.



- Clean the blower by following chapter 1.12.3.
- Collect the accumulated dust from the blower service chamber.
- Close blower service chamber door by following chapter 1.16.

1.11.12 Inspection of components & cables

- Ensure all components & cables are free from damage. If found, replace them.

1.11.13 Inspection of excessive temperature and arcing (Voltage flash overs).

- Do visual inspections for evidence of excessive temperature, burns and arcing (Voltage flash overs) and resolve it.

1.11.14 Inspection of cable ties

- Ensure all cables ties are tight & intact. If any cable tie found loose, replace it with new one.

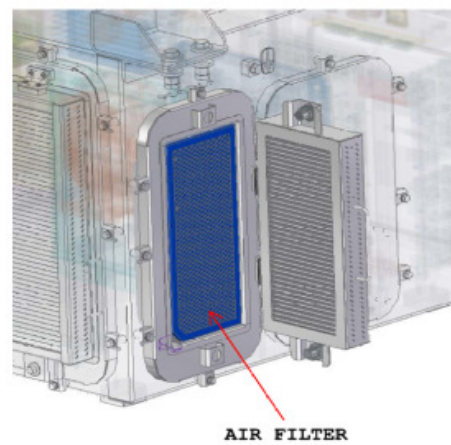
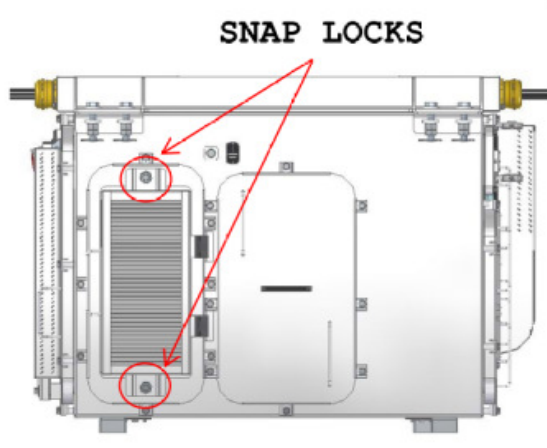
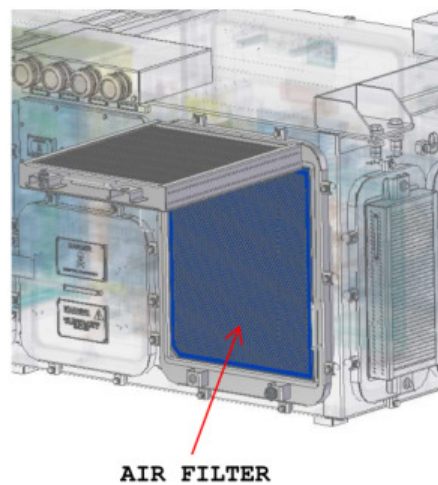
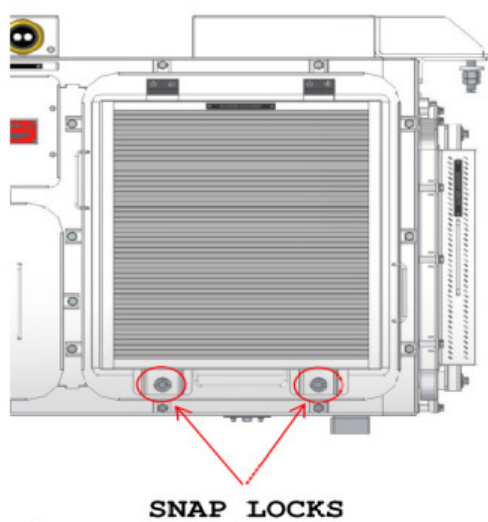
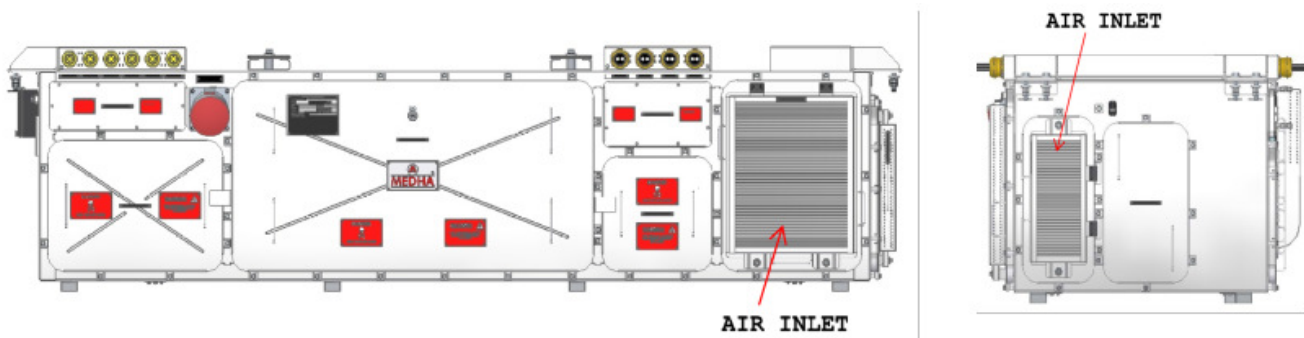
1.11.15 Inspection of all internal electrical connections

- Ensure all internal electrical connections (Terminals, lugs) are tight & intact. If found, tight them & apply required torque.

1.12 Cleaning

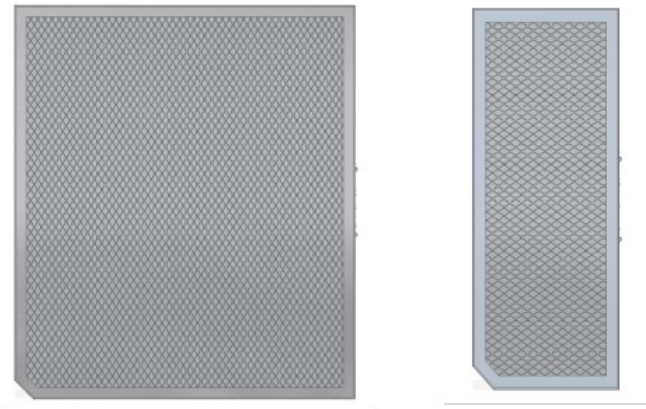
1.12.1 Filters cleaning procedure

- For accessing filters, Press the snap locks shown below & open the louver assembly doors.
- Remove the filters from the unit.
- Ensure inlet air filters are not torn out or damaged. If found damaged, replace with new one.
- If filters are OK, Clean the filters.

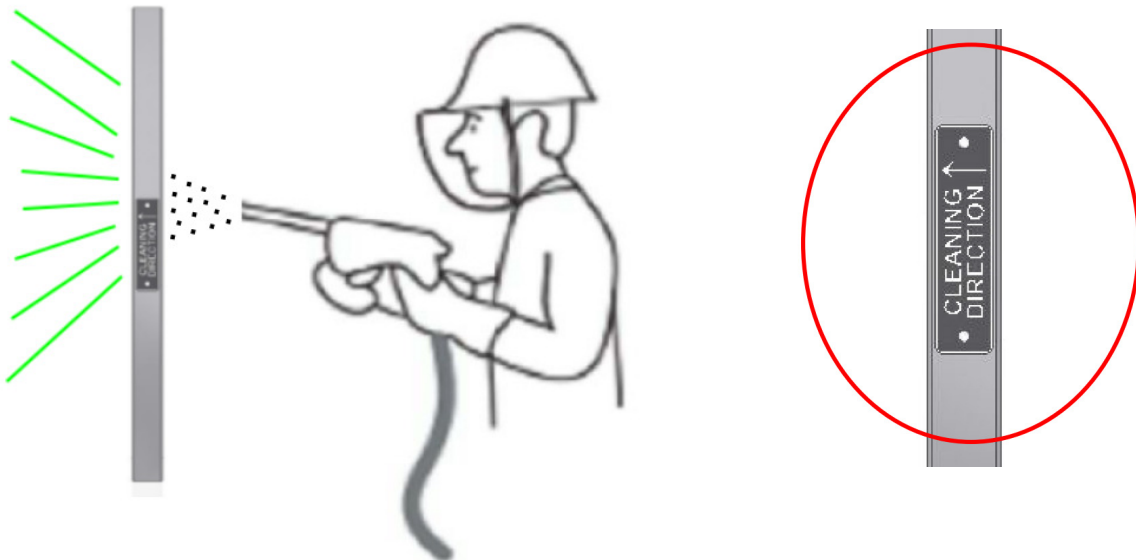


1.12.1.1 Cleaning with forced air

Note: Ensure electronics zone is closed while cleaning of filters.



- For every 30 days clean the inlet filters with forced air as shown below
Note: Cleaning direction should be as shown below otherwise it will choke the filter further.



- After cleaning, Place the filters in the door pockets, close the louver assembly & push it till the snap locks gets engaged with the door properly.

1.12.1.2 Cleaning with forced water

Note: Ensure electronics zone is closed while cleaning of filters.

- For every 180 days clean the inlet filter with pressurized water in the direction shown below, till the filter is free from dirt, dust & other debris. Apply pressurized air on to filter to remove entrapped water particles.

Note: Cleaning direction should be as shown below otherwise it will choke the filter further.



- After cleaning, Place the filters in the door pockets, close the louver assembly & push it till the snap locks gets engaged with the door properly.

1.12.2 Magnetics cleaning procedure

- Clean the magnetic surface (i.e., outer surface, terminals and other accessible dust deposited surfaces) with soft brush only.
- Remove the accumulated dust with vacuum cleaner.

Note: Ensure electronics zone is closed with door while cleaning of magnetics.

1.12.3 Blower cleaning procedure

- Open blower service chamber door by following chapter 1.16.
- Clean the Impeller blades, Rotor surface and cone assembly with soft brush.
- Collect the accumulated dust from the blower chamber.
- Take lint free cloth dipped in isopropyl alcohol & wipe the Impeller blades, Rotor surface and cone assembly.
- Close blower service chamber door by following chapter 1.16.

1.12.4 Name plates & external cleaning

- Clean all doors, name plates & all external components.

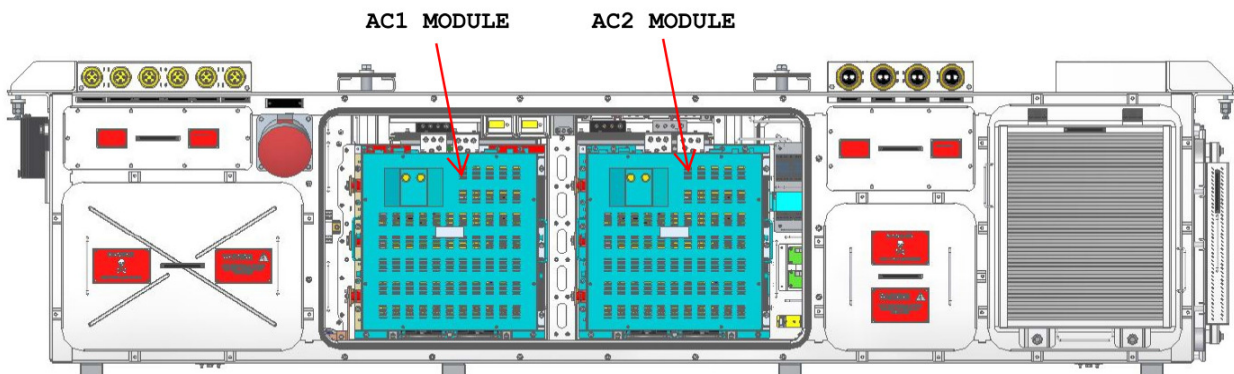
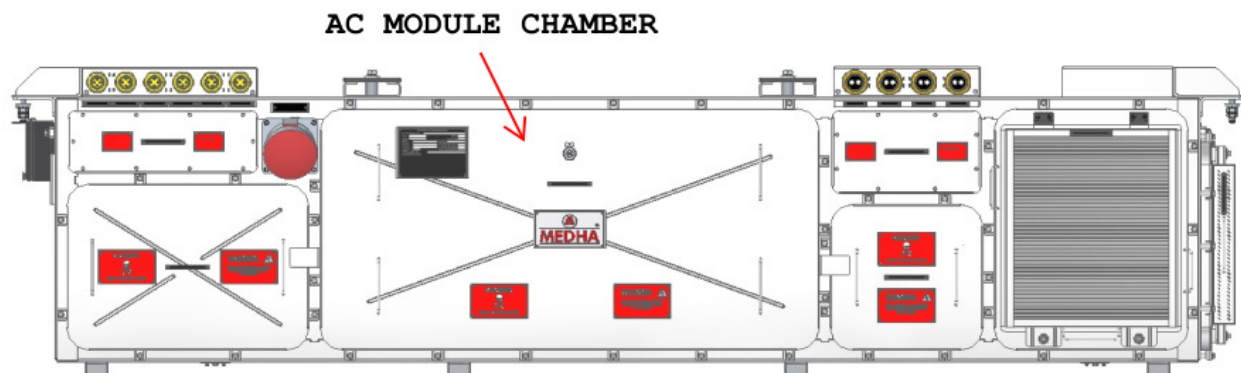
1.13 List of Line Replaceable Units (LRU's)

1. AC module
2. DC-DC module
3. Blower
4. Load sharing inductor
5. Sine filter inductor
6. DC-DC transformer
7. DC output inductor
8. IO cards

1.13.1 AC module

1.13.1.1 AC module replacement procedure

- For accessing key-B refer Interlocking section 1.9
- Open the door lock with key-B.
- Open the door mounting hardware and Place the door aside (AC module chamber door is shown in below image.)

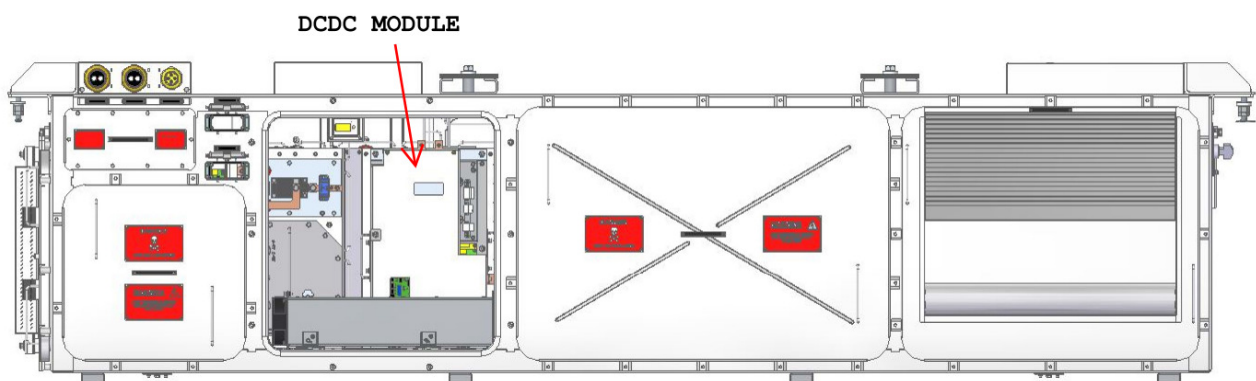
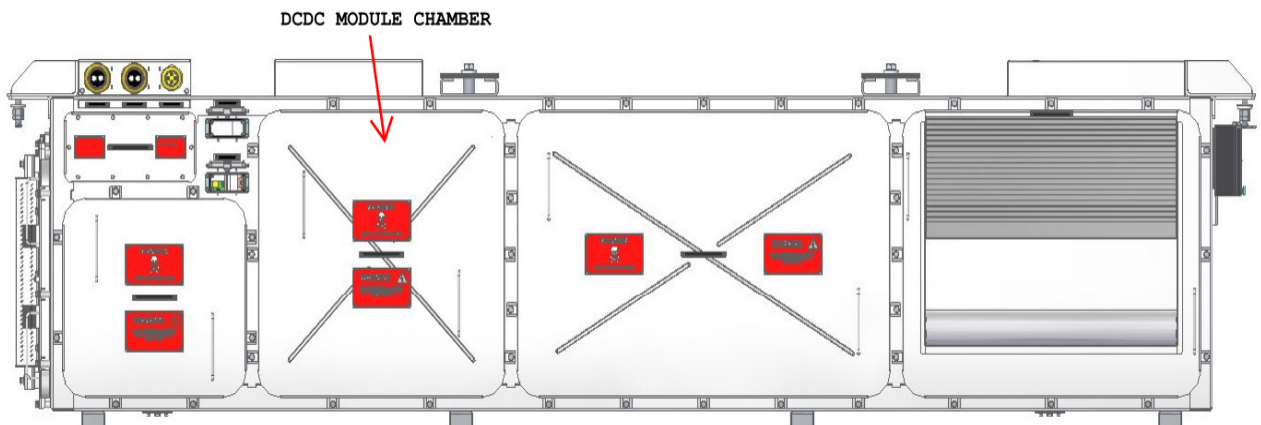


- a) Unplug the electrical connectors
- b) Remove electrical busbar connections
- c) Remove earth connection
- d) Remove the module mounting hardware (M8 socket screws) using extended Allen key
- e) Remove the module mounting stays hardware & remove the stays.
- f) Remove the module and replace with the new module
- g) Mount the module mounting hardware & apply required torque.
- h) Plug all electrical connectors.
- i) Mount all electrical bus-bar & earth connections & apply torque.
- j) Do the inspection of door gasket as per chapter 1.11.6
- k) Do the inspection of intumescent seal as per chapter 1.11.4
- l) Do the inspection of silica gel as per chapter 1.11.5
- m) Clean & assemble the AC module chamber door & apply required torque.
- n) Do the inspection of unit doors hardware as per chapter 1.11.10

1.13.2 DC-DC Module

1.13.2.1 DC-DC Module replacement procedure

- Open the door mounting hardware and Place the door aside (DCDC module chamber door is shown in below image.)
- Disconnect the churning fan wires & open the churning fan duct assembly hardware & remove churning fan duct assembly from the unit.

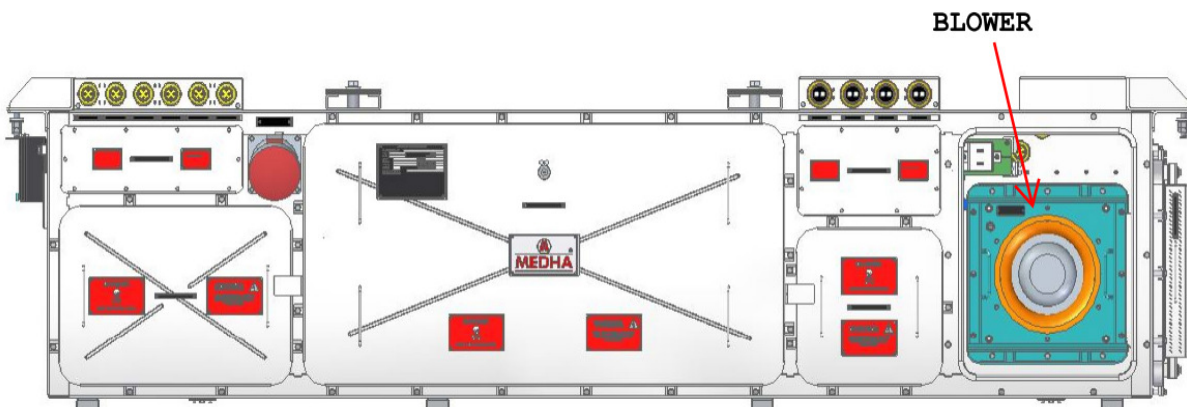
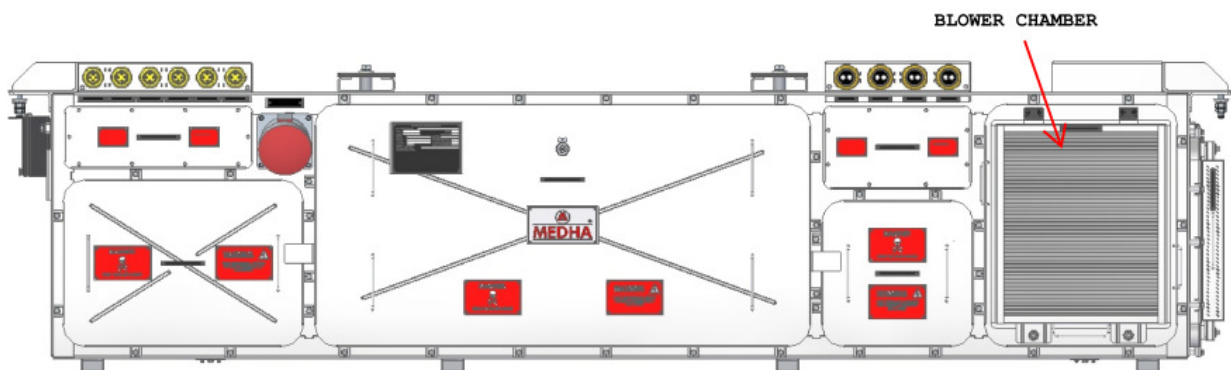


- a) Unplug the electrical connectors
- b) Remove electrical bus-bar connections
- c) Remove earth connection
- d) Remove the module mounting stays hardware & remove the stays.
- e) Remove the module mounting hardware using extended allen-key.
- f) Remove the module and replace with the new module
- g) Mount the module mounting hardware & apply required torque.
- h) Mount module mounting stays, its hardware & applied required torque.
- i) Plug all electrical connectors.
- j) Mount all electrical bus-bar & earth connections & apply torque.
- k) Mount the churning fan duct assembly, its hardware & apply required torque.
- l) Connect the churning fan wires.
- m) Do the inspection of door gasket as per chapter 1.11.6
- n) Do the inspection of intumescent seal as per chapter 1.11.4
- o) Do the inspection of silica gel as per chapter 1.11.5
- p) Assemble the DCDC module chamber door & apply required torque.
- q) Do the inspection of unit doors hardware as per chapter 1.11.10

1.13.3 Blower

1.13.3.1 Blower replacement procedure

- Open the door mounting hardware and Place the door aside (Blower chamber door is shown in below image.)

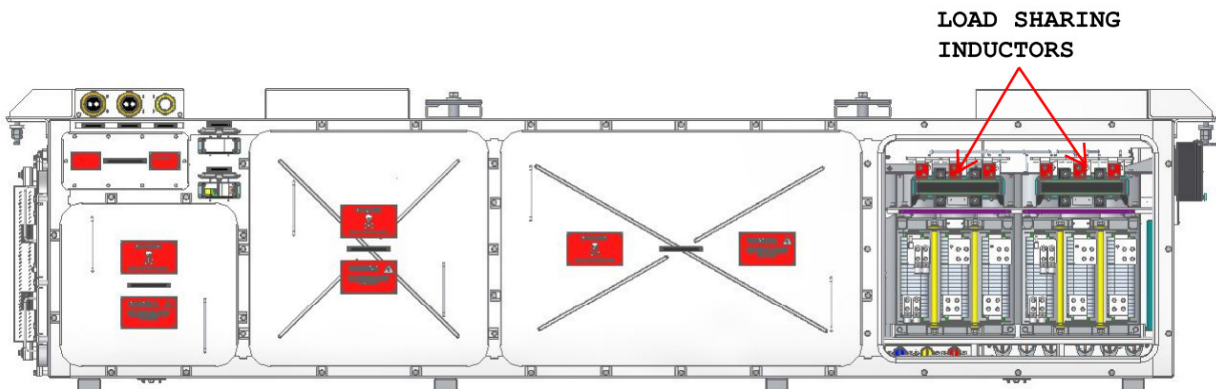
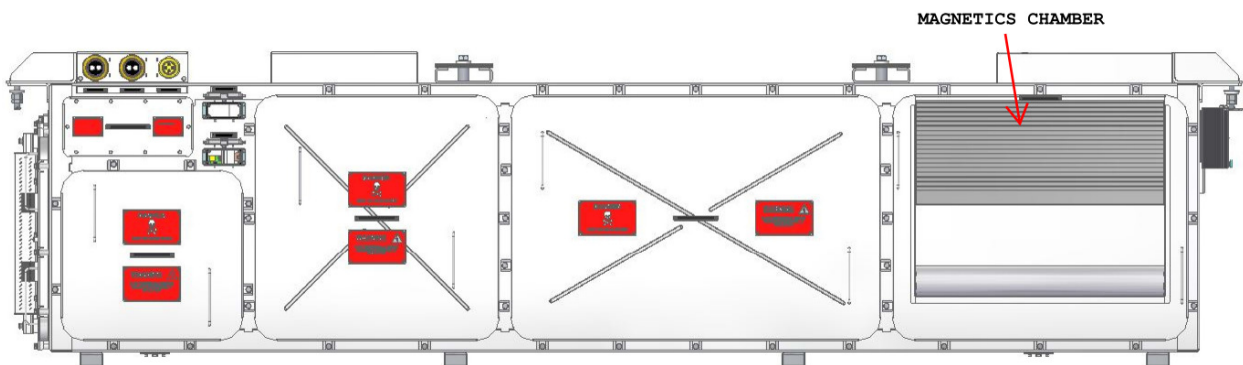


- a) Disconnect the blower cables from the TB.
- b) Open the blower mounting hardware using extended allen-key.
- c) Remove the blower from the unit & replace with new one.
- d) Assemble the mounting hardware of blower & apply necessary torque.
- e) Connect the blower cables at their respective locations.
- f) Clean & collect the accumulated dust from the blower chamber.
- g) Do the inspection of door gasket as per chapter 1.11.6
- h) Clean & assemble the blower chamber door & apply necessary torque.
- i) Do the inspection of unit doors hardware as per chapter 1.11.10

1.13.4 Load sharing inductor

1.13.4.1 Load sharing inductor replacement procedure

- Open the door mounting hardware and Place the door aside (magnetics chamber door is shown in below image.)

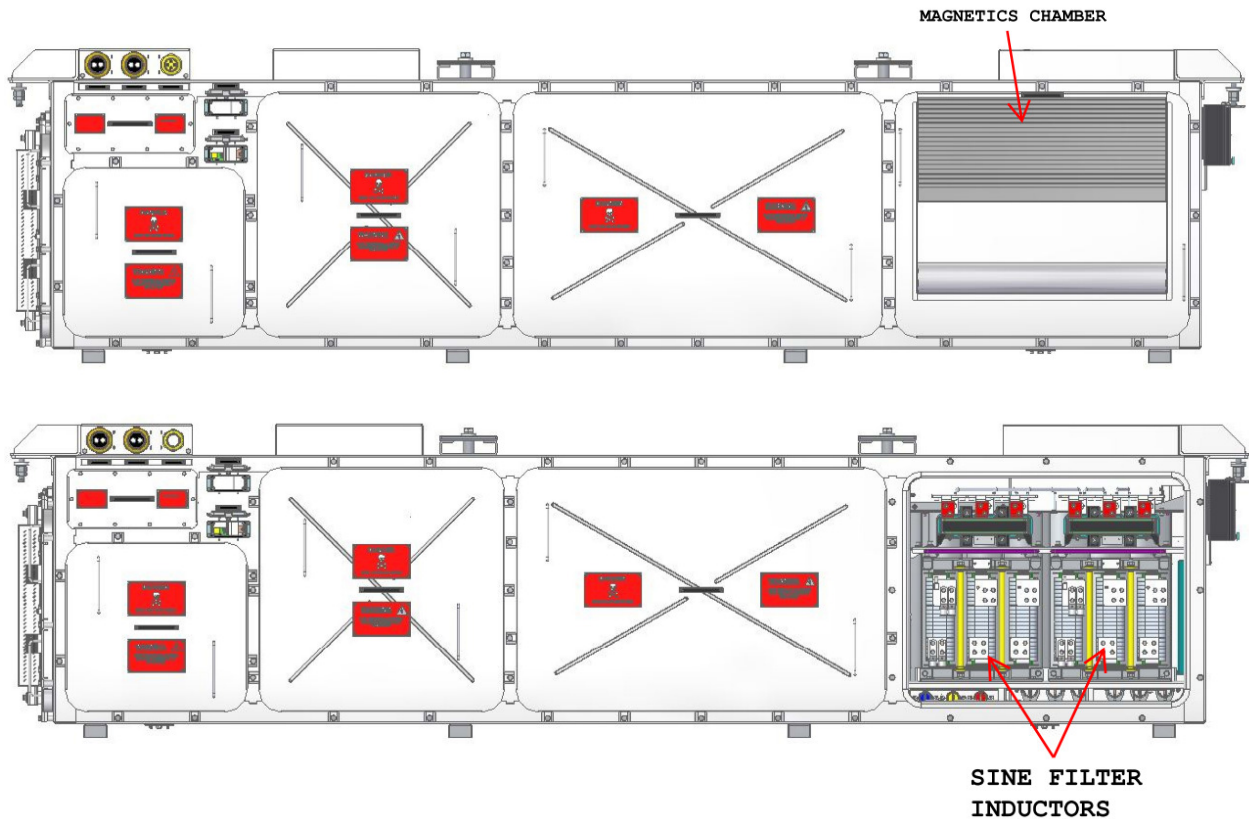


- a) Open the load sharing inductor cables hardware.
- b) Open the load sharing inductor mounting hardware.
- c) Remove the load sharing inductor from the unit & replace with new one.
- d) Assemble the mounting hardware of load sharing inductor & apply necessary torque.
- e) Assemble the cables mounting hardware of load sharing inductor & apply necessary torque.
- f) Do the inspection of door gasket as per chapter 1.11.6
- g) Clean & assemble the Magnetics chamber door & apply necessary torque.
- h) Do the inspection of unit doors hardware as per chapter 1.11.10

1.13.5 Sine filter inductor

1.13.5.1 Sine filter inductor replacement procedure

- Open the door mounting hardware and Place the door aside (magnetics chamber door is shown in below image.)

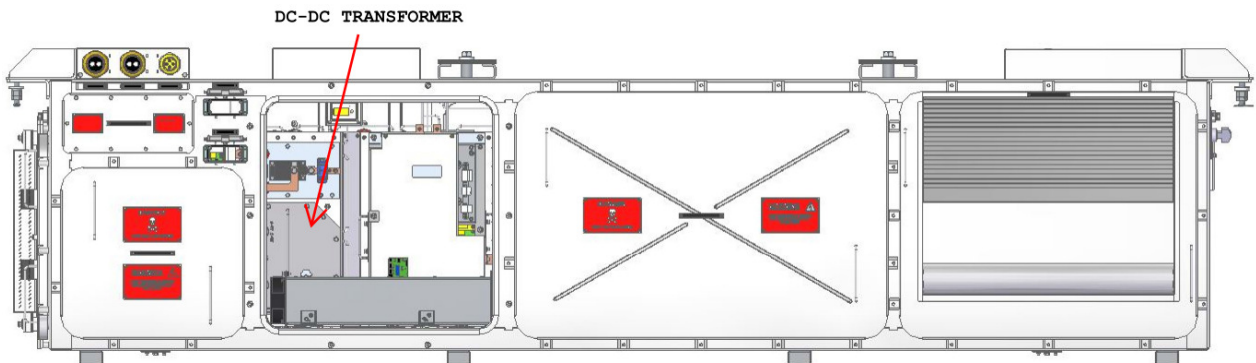
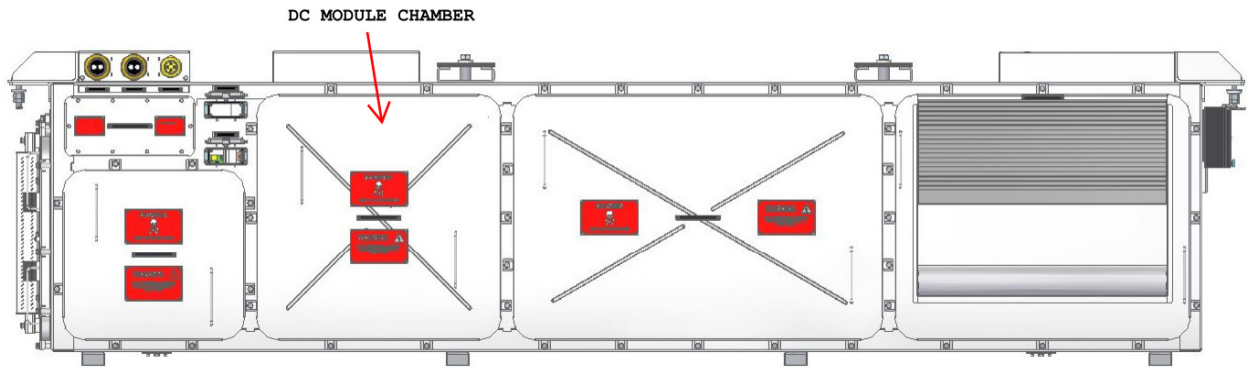


- Open sine filter inductor cables hardware.
- Open sine filter inductor mounting hardware.
- Remove the sine filter inductor from the unit & replace with new one.
- Assemble the mounting hardware of sine filter inductor & apply necessary torque.
- Assemble the cables mounting hardware of sine filter inductor & apply necessary torque.
- Do the inspection of door gasket as per chapter 1.11.6
- Clean & assemble the Magnetics chamber door & apply necessary torque.
- Do the inspection of unit doors hardware as per chapter 1.11.10

1.13.6 DC-DC transformer

1.13.6.1 DC-DC transformer replacement procedure

- Open the door mounting hardware and Place the door aside (DC chamber door is shown in below image.)

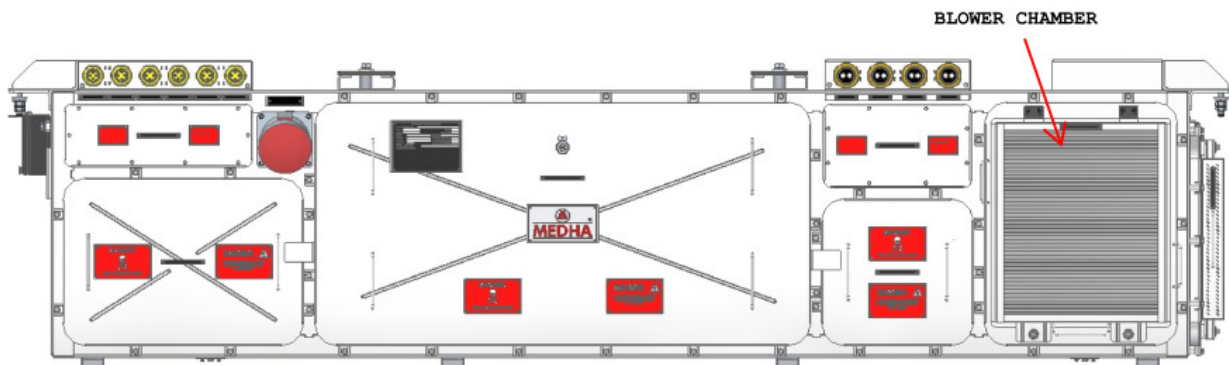


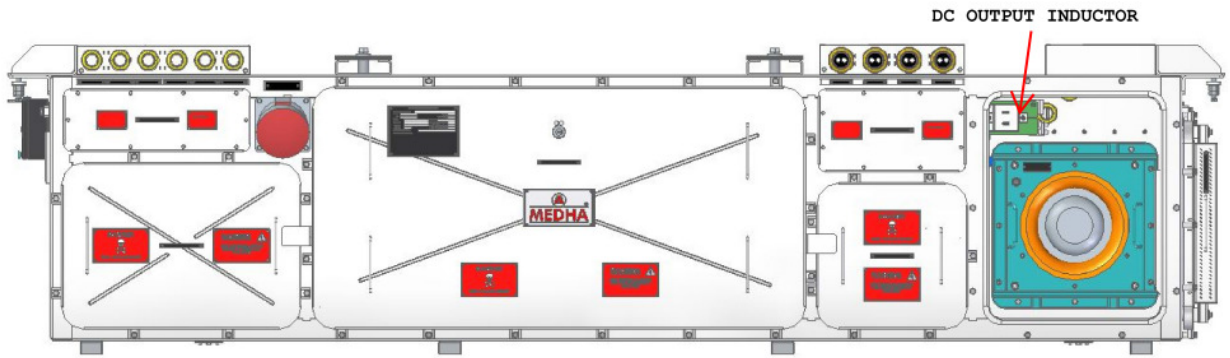
- a) Open the DC-DC transformer cables hardware.
- b) Open DC-DC transformer mounting hardware.
- c) Remove the DC-DC transformer from the unit & replace with new one.
- d) Assemble the mounting hardware of DC-DC transformer & apply necessary torque.
- e) Assemble the cables mounting hardware of DC-DC transformer & apply required torque.
- f) Do the inspection of door gasket as per chapter 1.11.6
- g) Do the inspection of intumescent seal as per chapter 1.11.4
- h) Do the inspection of silica gel as per chapter 1.11.5
- i) Clean & assemble the Blower chamber door & apply required torque.
- j) Do the inspection of unit doors hardware as per chapter 1.11.10

1.13.7 DC output inductor

1.13.7.1 DC output inductor replacement procedure

- Open the door mounting hardware and Place the door aside (Blower chamber door is shown in below image.)





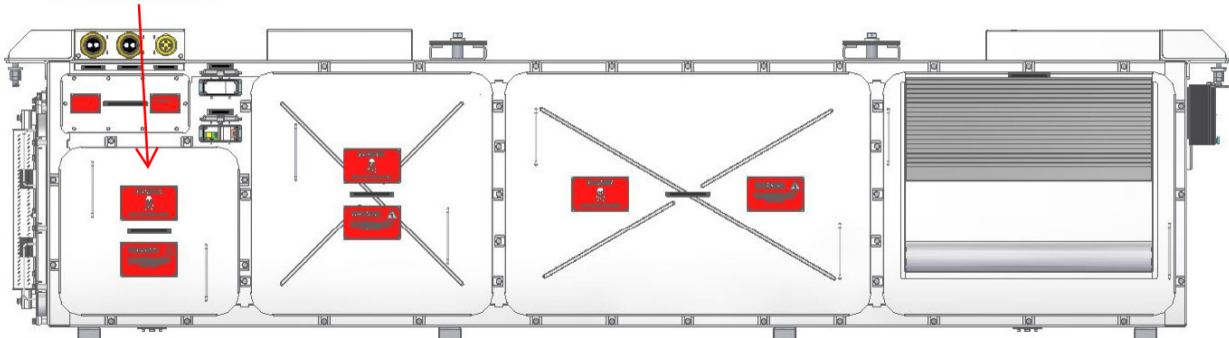
- k) Open the DC output inductor cables hardware
- l) Open DC output inductor mounting hardware.
- m) Remove the DC output inductor from the unit & replace with new one.
- n) Assemble the mounting hardware of DC output inductor & apply necessary torque.
- o) Assemble the cables mounting hardware of DC output inductor & apply necessary torque.
- p) Do the inspection of door gasket as per chapter 1.11.6
- q) Clean & assemble the Blower chamber door & apply necessary torque.

1.13.8 IO cards

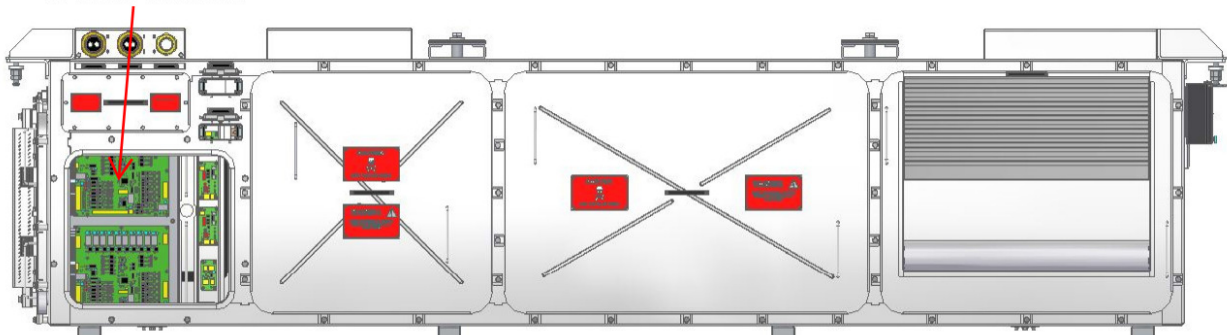
1.13.8.1 IO cards replacement procedure

- Open the door mounting hardware and Place the door aside (IO cards chamber door is shown in below image.)

IO CARDS CHAMBER



IO CARDS ASSEMBLY

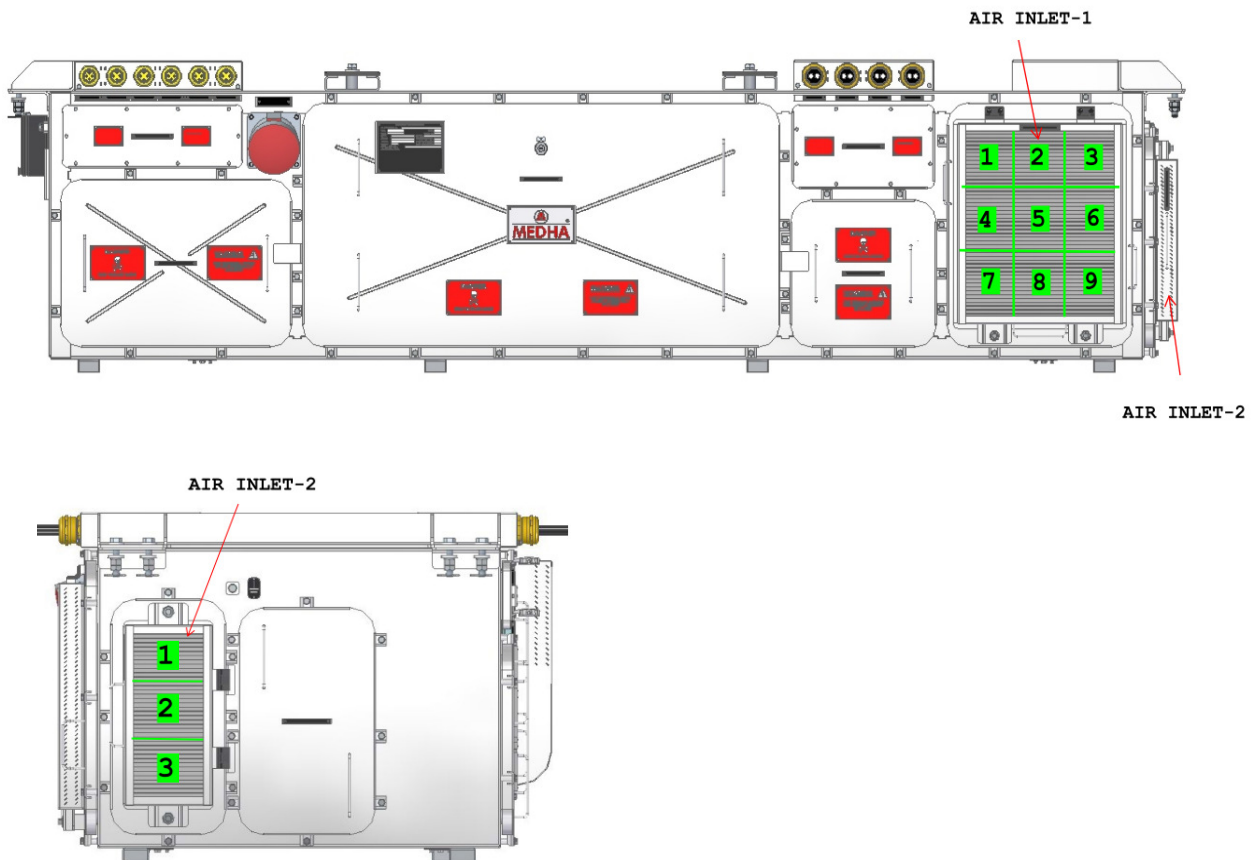


- a) Disconnect the IO cards cables, unplug connectors
- b) Remove IO cards assembly mounting hardware.
- c) Remove the IO cards assembly from the unit & replace with new one.
- d) Assemble the mounting hardware of IO cards assembly & apply necessary torque.
- e) Connect the IO cards cables & plug the connectors in their respective locations.
- f) Do the inspection of door gasket as per chapter 1.11.6
- g) Do the inspection of intumescent seal as per chapter 1.11.4
- h) Do the inspection of silica gel as per chapter 1.11.5
- i) Clean & assemble the IO cards chamber door & apply necessary torque
- j) Do the inspection of unit doors hardware as per chapter 1.11.10

1.14 Maintenance of Heat Sinks

No maintenance is required for the Heat sinks. In case if any Heat Sink thermal performance degradation is identified through temperature rise or shutdowns in the converter even if the blower motor is running in the right direction, Then measure the inlet air velocities as per below,

- Average air velocities should as follows,
- Check the inlet air velocity at 9 locations on the air inlet-1 door & ensure average velocity should be $\geq 2 \text{ m/s}$.
- Check the inlet air velocity at 3 locations on the air inlet-2 door & ensure average velocity should be $\geq 1.5 \text{ m/s}$.



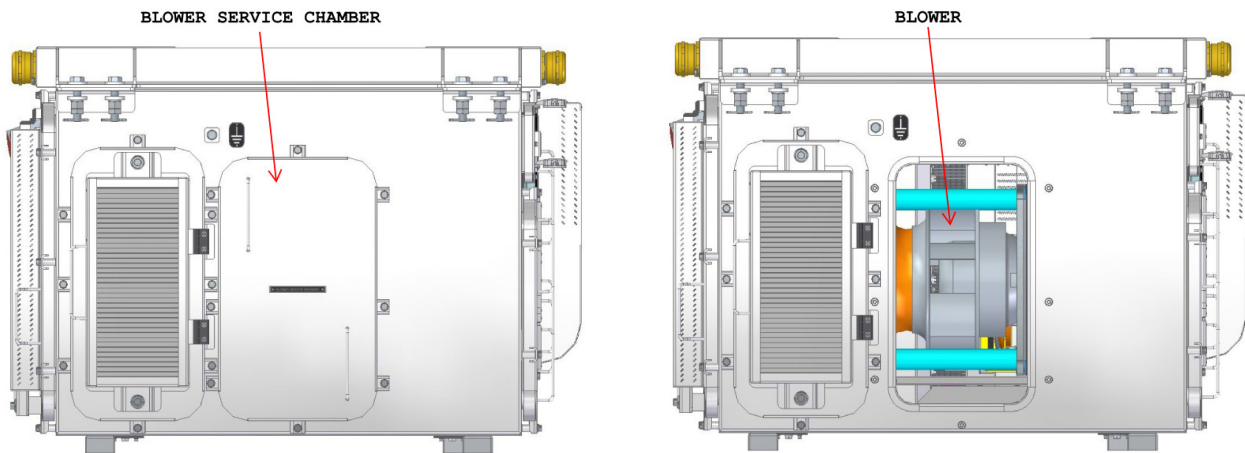
- If average inlet air velocities are less than the specified limit, Then remove the Heat Sink module and clean it as per the procedure given below.

1.15 Heat sink cleaning

- Remove the modules from the unit as per procedure mention for removing and replacing LRU's
- Clean the Heat sink fins with brush.
- Clean the fins with vacuum cleaner for removing the dirt from fins.
- Clean the fins with lint free cloth dipped in ISO-propyl alcohol. While performing this activity dust & ISO-propyl should not enter into the Electronics Zone.
- Verify all modules gaskets & intumescent seals, Replace them if any damages found.

1.16 Blower service door opening & closing procedure

- Open blower service chamber door hardware, remove the door & keep aside.



- Perform the task & ensure accumulated dust is collected.
- Clean & assemble the blower service chamber door & apply necessary torque.

AUXILIARY CONVERTER FOR TRAIN 18V2

TYPE MAE 675 UV2



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