AMIT ENGINEERS
Smart Solution for Better Future

OPERATION AND MAINTENANCE MANUAL

FOR ROOF MOUNTED AIR-CONDITIONING UNIT MADE FOR TRAIN-18 DRIVER CAB

AMIT ENGINEERS

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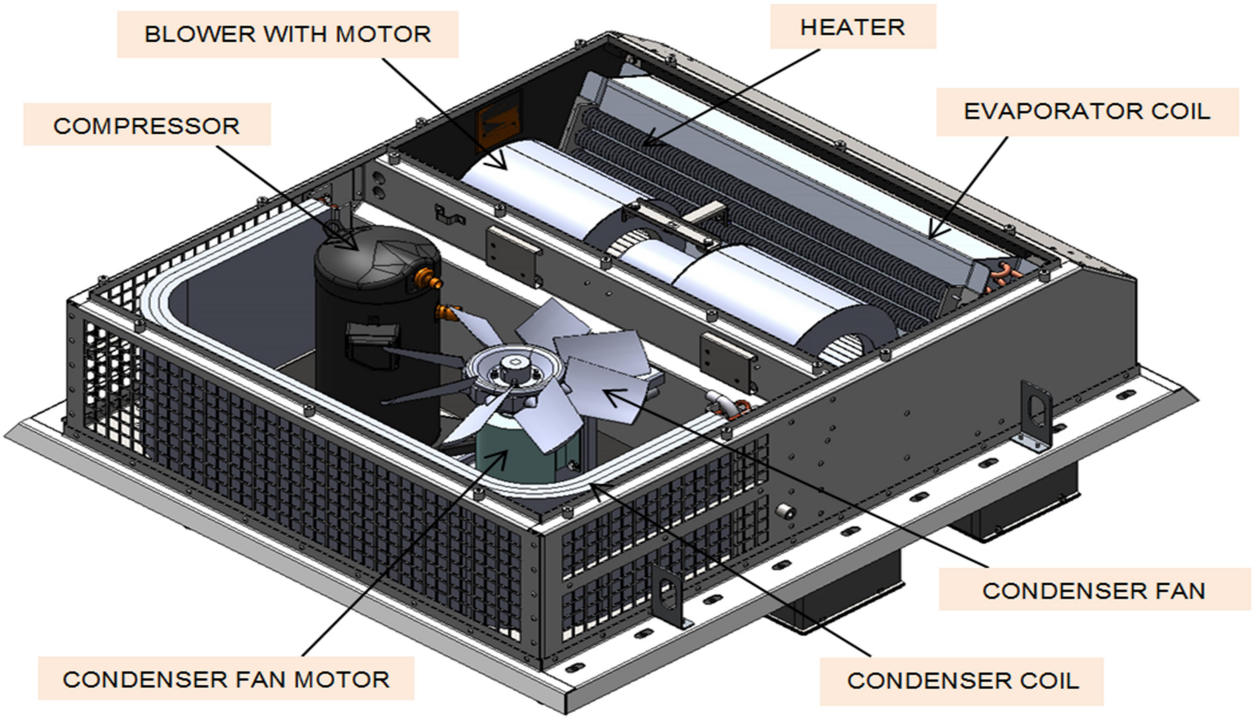
ABOUT US

Amit Engineers is an IRIS (International Railway Industry Standards) certified company based on ISO/TS 22163:2017, established in 2001. Its manufacturing unit is situated at Baddi (Himachal Pradesh). It has state-of-the-art Design & Manufacturing facilities to ensure product quality for greater customer satisfaction. It is one of the leading manufacturers of Rail Coach Components. It also provides PAN India Services Support to Indian Railways for the HVAC, Mechanical, Electro-Mechanical and Electrical & Electronics products.

It has developed a Roof Mounted Driver's Cab Air Conditioning Unit with capacity of 1.5 TR as per the requirements of the Indian Railways. The Roof Mounted Driver's Cab Air Conditioning unit design is reliable, which gives low-maintenance operations and keeps the atmosphere under control of Driver's cab, hence this product is a long-term asset to Indian Railways.

CONTENTS

1 MAJOR COMPONENTS



Control Panel

Switch Board

2 WORKING PRINCIPLE

The Amit make heating and air conditioning unit for driver cabin is direct expansion type packaged unit. When the roof mounted cab air conditioning unit is switched on and temperature is kept at desired set point, the thermostat senses the cabin temperature. If cabin temperature is more than the desired set point, cooling circuit starts.

The warm cabin air is drawn in through a return air grill located at bottom of the HVAC unit. This warm air is then passed over the cooling coil (fin & tube type heat exchanger). The fluid (refrigerant) inside the tube absorbs the heat from hot air, evaporating itself. This also results in cooling of warm air passing over it. While cooling the temperature of the cabin air passing through the heat exchanger falls below the dew point temperature and results dehumidification of air. Thus, during cooling both temperature and humidity of air inside the cabin decrease, which helps in maintaining the comfort condition for the driver.

The evaporated refrigerant from the cooling coil (evaporator) is the compressed into compressor to raise its saturation temperature above the outdoor temperature. After that this high pressure superheated vapors refrigerant is passed through another heat exchanger (condenser), where it cooled below its saturation temperature to convert it in to liquid.

This condensed liquid refrigerant is then passed though the expansion valve where the pressure of the refrigerant decreases along with temperature. The state of the refrigerant is returned to its initial state, completing the vapour compression refrigerant cycle. This cycle continues until the desired temperature is achieved.

Being the packaged air conditioning unit, all refrigeration components at enclosed within the single shell only, and it is supplied at ready to installed condition.

3 INTERFACE REQUIREMENTS

3.1 POWER SUPPLY

Auxiliary supply 415 Volts AC 50 Hz 3 phase and 110 Volts AC single phases are available for the power and control supply feeding to air-conditioning unit.

4 FUNCTIONAL DESCRIPTION OF CAB HVAC SYSTEM

The roof mounted cab heating and air conditioning units can be controlled by user with the help of the rotary switches mounted in the switch gear panel. Unit can be run in to 3 modes based on the selection using rotary switch.

4.1 OPERATIONAL MODES

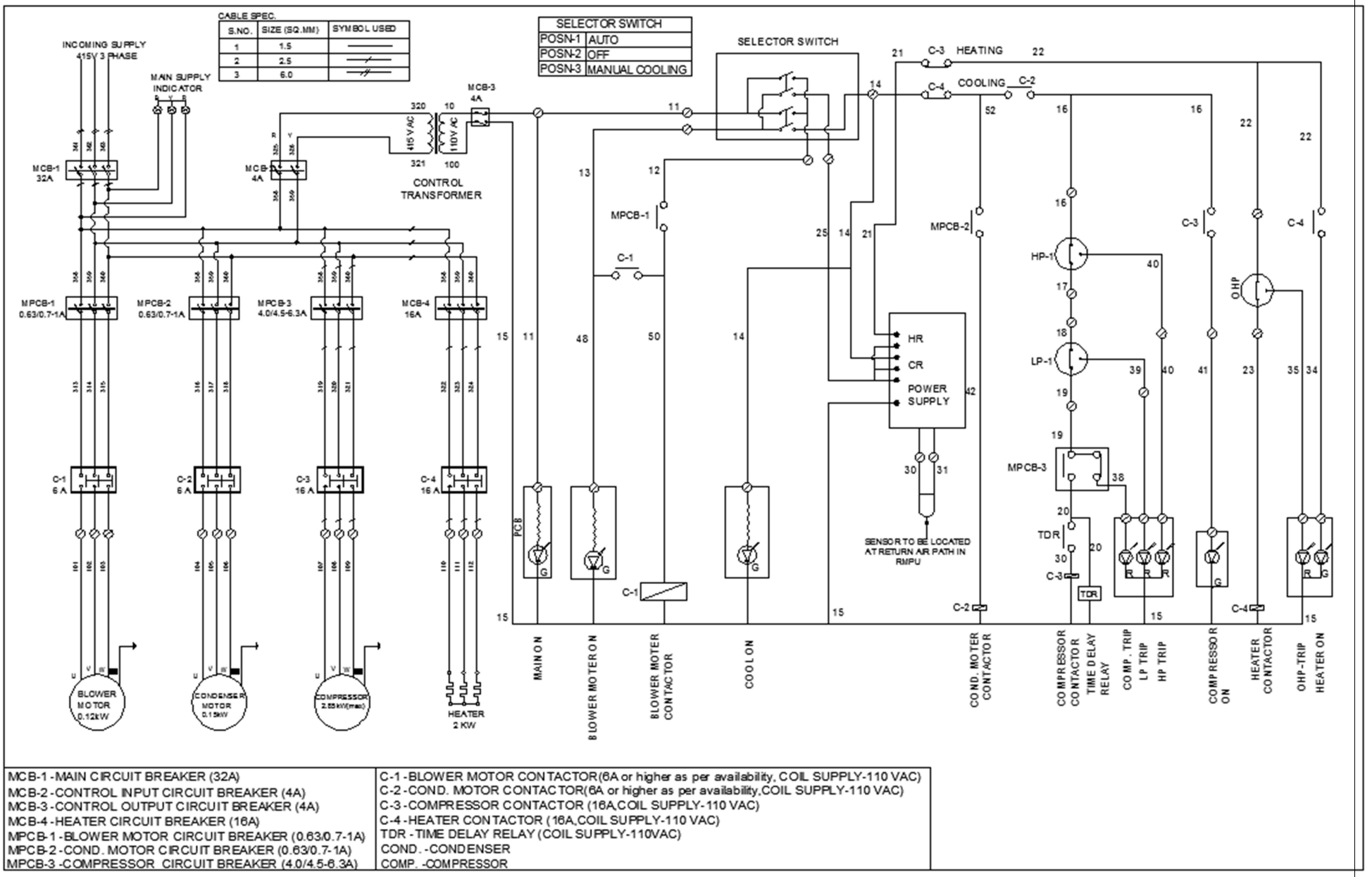
POSITION	MODES		WHAT IS ON/OFF
1	AUTO	AUTO COOLING	Blower Motor + Condenser Fan Motors + Compressor will be ON according to Room Temperature.
		AUTO HEATING	Blower Motor + Heater will be ON according to Room Temperature.
2	OFF		AC OFF
3	MANUAL COOLING		Blower Motor + Condenser Fan Motors + Compressor will be ON without any Temperature control.

4.2 SOLID STATE TEMPERATURE CONTROLLER TEMPERATURE SETTING

There are two Setting in Solid state Temperature Controller.

MODE	CUT IN	CUT OFF
Cooling	26 ℃	24 ℃
Heating	19 ℃	21 ℃

5 ELECTRICAL DIAGRAM



MCB-1 - MAIN CIRCUIT BREAKER (32A)	C-1 - BLOWER MOTOR CONTACTOR (6A or higher as per availability, COIL SUPPLY-110 VAC)
MCB-2 - CONTROL INPUT CIRCUIT BREAKER (4A)	C-2 - COND. MOTOR CONTACTOR (6A or higher as per availability, COIL SUPPLY-110 VAC)
MCB-3 - CONTROL OUTPUT CIRCUIT BREAKER (4A)	C-3 - COMPRESSOR CONTACTOR (16A, COIL SUPPLY-110 VAC)
MCB-4 - HEATER CIRCUIT BREAKER (16A)	C-4 - HEATER CONTACTOR (16A, COIL SUPPLY-110 VAC)
MPCB-1 - BLOWER MOTOR CIRCUIT BREAKER (0.63/0.7-1A)	TDR - TIME DELAY RELAY (COIL SUPPLY-110VAC)
MPCB-2 - COND. MOTOR CIRCUIT BREAKER (0.63/0.7-1A)	COND. - CONDENSER
MPCB-3 - COMPRESSOR CIRCUIT BREAKER (4.0/4.5-6.3A)	COMP. - COMPRESSOR

6 MAINTENANCE SCHEDULE

Sr. No.	Equipment / Fittings	Activities	Trip / Weekly	Monthly	Six Monthly	IOH 18 Months	POH 36 Months
1.	General	a) Check the log sheet maintained in each AC coach and attained the defects recorded by escorting staff during run.	√	√	√	√	√
		b) Clean all dust by vacuum or compressed air from the switch board cabinet and tighten the cable terminals, if found loose.	√	√	√	√	√
		c) Replace/connect defective/by passed components.	√	√	√	√	√
		d) Remove fresh and return air filters by opening the access doors of the unit. Clean these filters with vacuum or compressed air taking out the filters and place them gently in their place or replace with pre-cleaned/new filter/filter media and close the doors properly. A cleaning jig should be available with AMC holder/Railways for this activity. Note: After this activity, the service doors shall be latched properly in case of return air filter.	√	√	√	To be replaced	To be replaced
		e) Check working of rotary switches by rotating forward and backward, provided on switch panel for temperature selection and Air. Co. ON. Replace if required.	√	√	√	√	√
		f) Check working of set point generator rotary switch provided for temperature setting.	√	√	√	√	√
		g) Check the tripping of Heaters i.e., OHP. The OHP setting is 65°C. The testing of OHP setting shall be done by switching off the blower. During testing, the probe of digital thermometer shall be placed near the sensor of OHP & the display shall be kept outside. NOTE: It shall be checked twice a year. In addition, it shall also be checked as a pre-winter precaution before the onset of winter season.			√	√	√
		h) Run the CAB AC for half an hour and then check the current drawn by various equipment's with the help of clamp tester (tongue tester) duly calibrated. Normal currents for various equipment's and mode of operation are as under: • CAB AC in cooling mode. 8.5 Amps Max. • Compressor 7 Amps Max. • Condenser fan motor 1.1 Amps Max. • Blower motor 1.1 Amps Max.			√	√	√

		• CAB AC in heating mode 1.4 Amps Max. NOTE: The current also depends on the ambient temperature.					
		i) Check visually condenser fan blade and ensure that there is no crack on the blade or hub.		√	√	√	√
		j) Check and tighten mountings of blower, compressor and blower motor and ensure that they are in good condition.			√	√	√
		k) Ensure that no capillary tubes are in hanging position.		√	√	√	√
		l) Check capillary tubes provided for HP/LP cutout for proper support/clamping. Their nuts should be properly tightened.		√	√	√	√
		m) Check for proper tightening of cover provided over evaporator compartment.			√	√	√
		n) Check the earthing shunts in CAB AC are provided. Earthing shunts should be earthed with coach body.			√	√	To be replaced
		o) Check mountings of compressor in position.			√	√	
		p) If less cooling is noticed, check the leakage of refrigerant from the system by using soap solution or leak detector. If leak is detected, it should be attended and re-charging of refrigerant in the system shall be made as per RDSO SMI No. ELPS/AC/SMI/14. Filter drier must be replaced during this activity.	√	√	√	√	√
		q) Check insulation resistance of all the motors & compressors by the duly calibrated 1000 V megger, Attend the motors, if insulation resistance of motor is found less than 2 M ohm. IMPORTANT: Disconnect control devices during this activity.				√	√
		r) Check for physically damaged/jointed cables. Replaced if needed.				√	√
		s) Check for the physically damaged conduits. Replace them, if needed.				√	To be replaced
2.	Refrigerant pipe line/ capillary checks	a) Check for proper clamping/support				√	√
		b) Rubbing of capillary with SS sheet/channel or other parts of CAB AC.				√	√
		c) Leakage from the flare nut of HP/LP conduits with soap solution			√	√	√
		d) Leakage from Feeler tube of OHP				√	√

3.	Compressors checks	a) Holding clamps from top are properly tightened.			√	√	√
		b) Mounting fasteners are properly tightened.			√	√	√
		c) Leakage from suction and discharge port.			√	√	√
		d) Accumulators holding/mounting, if provided.			√	√	√
		e) Condensing area covers are properly tightened & not touching top of compressor body.			√	√	√
		f) Electrical terminal box is properly tightened & cables are terminated with lugs.			√	√	√
4.	Condenser fans motor / blades and Blower motor / impeller checks	a) Mounting fasteners are properly tightened.			√	√	√
		b) Electrical terminal box of motors is properly tightened & cables are terminated with lugs.			√	√	√
		c) Double earthing shunts are provided.			√	√	To be replaced during POH
		d) Condition of blade for its fixing/cracking/damage or touching with its cover. Rectify/replace, if needed.			√	√	√
		e) Ensure proper clamping of cable conduits.			√	√	√
		f) Overhauling of Blower and condenser fan motors shall include the following during POH. • The incoming motors shall be checked for abnormal noise and vibration. • Check bearing make and replace with specified make, if found defective. • The IR value of Motor stator shall be measured between motor terminal and frame before and after overhauling. The value of IR shall not be less than 10 M ohm, when measured with 1000-volt megger. • Winding resistance of motors shall be measured between RY, YB & BR phases. The winding resistance shall be ±10% of resistance declared by OEM in cold condition. • Check closely terminal block and connecting lead for any physical damage or any flash mark over it. Replace the same, if not satisfactory. • Perform HV (Di-electric test) on stator by applying 1.5 kV ac supply for one minute. During test the leakage current shall not be more than 1.0 mA. • Run motor on no load for 15 minutes and check for following:					√

		I. Bearing noise – Normal noise II. Bearing temperature rise above ambient - 10°C III. SPM reading - 20 dBN max. (Green zone)					
		• Measure starting current of motors on no load. It shall not be more than 10 times of normal running current. Similarly, the running current of motors shall be measured and it shall not be more than 1.1 A.					√
		• Ensure that impellers are properly tightened.			√	√	√
		• Electrical terminal box is properly tightened & cables are terminated with lugs.			√	√	√
5.	A) Return Air filters	a) Ensure that filters are not damaged.	√	√	√	√	√
		b) Ensure that there is a provision to avoid wrong fitment in the filter as well as in CAB AC.				√	√
	B) HP/LP/OHP cutout switch	a) Check that the mounting fasteners are properly tightened.			√	√	√
		b) Ensure proper clamping/support of capillary tube connected to HP/LP/OHP cutout switch.			√	√	√
		c) Ensure that flare nuts are properly tightened.			√	√	√
		d) Ensure that control wires to HP/LP/OHP cutout switches are properly clamped.			√	√	√
		e) Ensure that covers of these HP/LP/OHP cutouts switches are properly screwed.	√	√	√	√	√
		f) Ensure proper clamping of feeler tube of OHP switch.				√	√
		g) Remove the accumulated dust over feeler tube of OHP switch.			√	√	√
		h) There should be cover (canopy) on top HP/LP switch (provided with capillary tubes) to prevent water entry.		√	√	√	√
	C) Heater	a) Ensure proper mounting of heater.			√	√	√
		b) Ensure proper clamping of electrical wires to heater.			√		√
		c) Check dust accumulation on heating element. Remove gently, if required.			√	√	√
	D) NTC sensors	a) Ensure that the sensors provided at return air path and supply air are firmly mounted.			√	√	√
		b) Ensure sensor wires are properly clamped.			√	√	
		c) Remove the dust accumulated over sensor gently.			√	√	√
	E) Expansion Valve /	a) Ensure that the bulb is mounted in the suction line just after evaporator coil and in a position corresponding to between 1 O'clock and 4 O'clock.		√	√	√	√

	capillary tubes	Ensure that it is properly insulated.					
		b) Ensure that the equalizing line is connected in the suction line immediately after the bulb.			√	√	√
		c) Ensure that the bulb is not connected at the bottom of the pipe line.			√	√	√
		d) Ensure that bulb/equalizing line/capillary tubes are not chocked.		√	√	√	√
	H) Evaporator coil	a) Ensure that there is no damage to fins.				√	√
		b) Ensure that capillaries of distributors to evaporator coil are not having any sharp bend or kinks. They should also be clamped properly.				√	√
		c) Ensure that air passes only through evaporator coils and no air is bypassed directly to blower chamber.				√	√
		d) Clean the coil, if found dirty.				√	√
		e) Check that the mounting fasteners are properly tightened.				√	√
	I) Filter drier & sight glass	a) Ensure that drier is installed with flow in the direction of the arrow marked on the filter drier label.			√	√	√
		<u>NOTE:</u> 1) Never use 'antifreeze liquids' like methyl alcohol together with a filter drier. Such liquid can damage the filter. 2) Never re-use a filter drier. 3) To avoid chances of moisture ingress in the system. Filter drier & compressor should be installed immediately after evacuation and charging the system.			√	√	√
	J) Access Doors	a) Insulate service doors, lower portion and side wall from inside of the evaporator compartment.				√	√
		b) Ensure that latches to lock the service doors are not defective / damaged.	√	√	√	√	√
	K) Drip tray	a) Ensure that there is no leakage of condensate water from drip tray to electrical box & blower housing area.			√	√	√
		b) Ensure free flow of condensate water		√	√	√	√
	L) Condenser area	a) Clean the condenser coil from inside with compressed air/water jet after opening the cover of condenser area.		√	√	√	√
		b) Ensure that there is no damage to fins.			√	√	√
		c) Check that the mounting fasteners are properly tightened.				√	√

		d) Provide fire retardant thermal insulation over suction line.				√	√
		e) Ensure that there is no damage/crack in structure frame of RMPU.				√	√
		f) Ensure proper clamping of electrical conduit.				√	√

7 **FAULTS**

ABBREVIATIONS

1. BLR ON - Blower ON
2. COMP. ON - Compressor ON
3. HTR ON - Heater ON
4. COOL ON - Cooling ON
5. HP TRIP - High Pressure Trip
6. LP TRIP - Low Pressure Trip
7. OHP TRIP - Over Heat Protection Trip
8. COMP. TRIP - Compressor Trip

8 MAINTENANCE PROCEDURE

Maintenance work on the refrigerating circuit should be completed before the summer season.

Caution

Before starting any inspection or maintenance work on components working with power supply, turn off the main power supply and ensure again turning on once the maintenance is done.

Caution

If the coach is running in servicing areas with heavy air pollution, the filter requires more frequent inspection and cleaning.

Most components of the compact air conditioner unit will be replaced when defective.

Sr. No.	Equipment	Maintenance Procedure
1	Condenser fan motor	- Open Top Cover. - Remove CD fan blade. - Remove electrical connection. - Open mounting nuts & bolts. - Change motor with same rating.
2	Compressor	- Open Top Cover. - Loosen compressor clamp. - Remove power connection - Drain refrigerant. - DE brazes refrigerant piping and cap them properly to avoid entering of moisture and foreign particles inside the system. - Open mounting base nut. - Change compressor as per recommended procedure. - Use same rating of compressor.
3	Filter Drier	- Open Top Cover. - Pump down system using service valve provided in liquid line of Refrigeration circuit. - DE braze filter drier and cap refrigerant pipelines properly to avoid Entering of moisture and foreign particles inside the system. - Change filter drier with same size.
4	Hand Shut Off Valve	- Open Top Cover. - Remove Hand shut off valve. - Drain refrigerant. - DE braze Hand shut off valve and cap refrigerant pipelines properly to Avoid entering of moisture and foreign particles inside the system. - Change Hand shut off Valve with same size.
5	Return air filter	Open Top Cover. Take out filter. Clean filter media, replace if necessary.

6	Blower motor	- Open Top Cover. - Remove blower runners. - Open electrical connections. - Open mounting base nut & bolts. - Change blower motor with same rating.
7	Heater	- Open Top Cover. - Take out heater bank. - Inspect the safety element.
8	Evaporator Coil	- Open Top cover. - De-Braze evaporator coil from the refrigerant line. - Avoid entering of moisture and foreign particles inside the system. - Remove Evaporator coil from the unit carefully. - Change Evaporator coil with same specifications. - After proper Brazing and leak testing, close all the covers of the unit.
9	Condenser Coil	- Open Top cover. -De-Braze Condenser coil from the refrigerant line. -Avoid entering of moisture and foreign particles inside the system. -Remove Condenser coil from back side after loosen the mut bolts. -Change Condenser coil with same specifications. -After proper Brazing and leak testing, close all the covers of the unit
10	Blower Fan	- Open Top cover. - Loosen nut bolts and remove Blower fan. - Replace the Blower fan with new one having same model/specifications.
11	Condenser Fan	- Open Top Cover. - Loosen nut bolts and remove Condenser fan. - Replace with new one having same model.

8.1 SAFETY DEVICES

All current-carrying components such as Motors, Heaters and Compressor etc. should be positively earthed.

8.2 OVERLOAD AND SHORT CIRCUIT PROTECTION OF MOTORS

Power Supply provided to all Motors and Compressor through suitable Amperage Motor protection Circuit Breaker (MPCB) according to device power ratings, for protection against Overload, short circuit and grounding. (Kindly refer to Electrical Diagram for proper ratings of MPCB)

8.3 THERMAL PROTECTION FOR HEATERS

The electric heaters are protected with OHP against over temperature. If the supply air temperatures reach 65°C, O.H.P. switches Off the Heater via control Circuit.

8.4 COOLING CIRCUIT PRESSURE PROTECTION

To prevent from High pressure or Low pressure in the refrigerant circuits of an air conditioning unit-, High- and Low-pressure switches are used.

8.4.1 Cause of HP tripping in refrigeration circuit. (Higher Activ. pressure [psi] 450±15)

1. Condenser motor defective / not working.
2. Condenser fan motor running in reverse direction. Air should be sucked through condenser coils.

3. Condenser fan blade defective / broken.
4. Condenser coil clogged with dirt & dust.

8.4.2 Cause of LP tripping in refrigeration circuit. (Lower Activ. Pressure [psi] 30±5)

1. Blower motor defective / not working.
2. Blower motor running in reverses direction. Air should be sucked through Evaporator coils.
3. Blower runner defective / broken.
4. Evaporator coil clogged with dirt & dust.
5. Air filters clogged with dirt, dust or any other obstructions in evaporator Section.
6. Less refrigerant or leakage in the refrigeration circuit.
7. Drier filter or Capillary chocked.

9 PROBLEMS FACED

9.1	Filters	One of the typical reasons air conditioners don't work properly is a clogged or dirty filter. Follow the manufacturer's suggestions as to how often to change your air filter. Some are monthly, others every three months, while some are reusable and should be cleaned when they are dirty. One way to determine if a filter needs to be cleaned is to check if any light passes through it. If not, it's time to clean it. Dirty filters not only reduce the flow of air but can also cause the AC unit to freeze.
9.2	Solid State Temperature Controller	Another easy fix is to make sure your Solid-state temperature controller (which controls the temperature setting in your CAB area) is turned on, the inside is clean, its level, it's not being affected by sunlight, and it's on the correct setting. If problems persist, there may be another issue.
9.3	Refrigerant Leaks	When the coolant starts leaking in the air conditioner, the unit will not perform correctly, and the temperature will fluctuate. The location of the leak will affect the cost of the repair so having this examined yearly by a trained AC technician is advised.
9.4	Drainage	Like the filter, the drain line can become clogged with dirt, dust, and lint. If it becomes clogged, the drain pan will fill up, and water will leak out potentially causing damage to the AC unit or whatever is around your pan.
9.5	Circuit Breakers	The breakers and fuses safeguard the AC unit's motor or compressor from overheating. Often when a motor dies, one of the first parts the HVAC technician checks is the breaker.
9.6	Compressor	The compressor applies energy to the refrigerant and propels it through the coils to carry out heat exchange. If the compressor is not working, the AC unit will not cool your house. If there's not enough refrigerant, the compressor will run hot and eventually seize. If there's too much, the refrigerant will return to the compressor, which can cause it to fail.
9.7	Evaporator Coils	Evaporator coils absorb heat in the air and send it back into the cabinet as cold air using a blower fan. Coils can become corroded, but if they are located inside, they typically only require maintenance every three years.
9.8	Condenser Coils	Condenser coils are located with the compressor so they can become dirty due to the elements. They can usually be cleaned with a water hose once a year, but if they get too dirty, an HVAC technician will have to clean them with a chemical cleaner.
9.9	Worn Contactor	In a CAB AC unit, there are contactors for the compressor, the blower motor, and the condenser fan motor. They make an electrical connection that starts the motors and compressor. If there's arcing and pitting on the contactor, it becomes difficult for electric current to start the motors.

10 INSTALLATION

10.1 TRANSPORTATION / SHIPMENT

1.5 TR CAB Air Conditioners are supplied preassembled on truck frame. The air conditioning units are fastened with bolts to the truck frame. All assemblies are carefully tested and packed prior to shipment (With refrigerant charged)

Caution

For loading and unloading, overhead crane shall be used. It enables the unit to be transported safety.

10.2 STORAGE

The Roof Mounted CAB AC units shall be stored in their undamaged transport skids. Do not store them in open. Make sure that units are not damaged.

10.3 INSTALLATION

Install Roof Mounted CAB AC on the Cabin of the Driver's CAB.

Caution

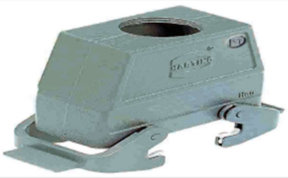
For transporting the air conditioning unit to the Driver's Cabin for the purpose of Installation, overhead crane shall be used.

Installing the Roof Mounted CAB air conditioning unit

Caution

Lift the air conditioner for the specified lifting points gently.

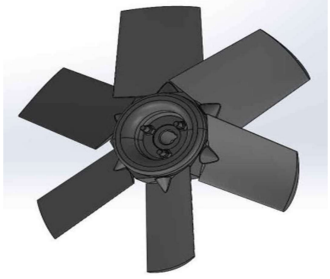
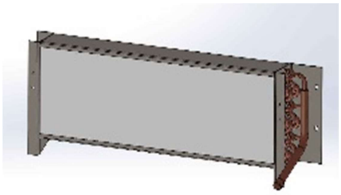
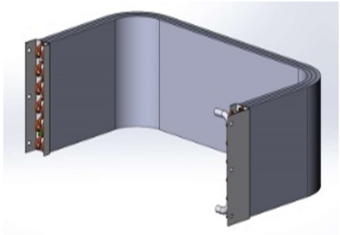
SR.NO.	COMPONENT	ACTIVITY
1	AC UNIT	Remove Packing
		Perform visual check for any transit damage.
		Undo transport screws used for fixing unit to frame
		Lift unit with crane onto Driver CAB.
		Lower down unit on the installation trough
		Tighten fastening screws
		Connect earthling connections
		Establish plug-and-socket connections for power supply

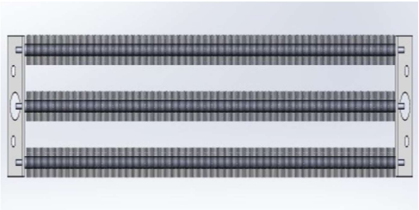
Electrical Installation Parts			
Sr. No.	**Component Code**	**Quantity**	**Shape**
1	LHB 119	23	
2	LHB 150	9	
3	T18 141	4	
4	T18 152	4	
5	T18 156	4	
6	T18 158	4	

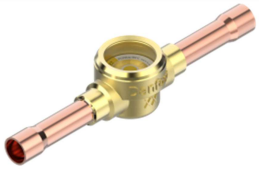
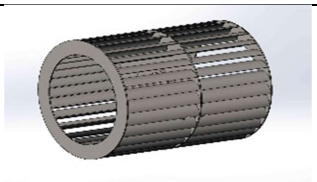
11 INSTRUCTIONS TO USERSSAFETY CONSIDERATIONS

Installing, starting up, and servicing air-conditioning equipment can be hazardous due to system pressures, electrical components and equipment location. Only trained, qualified installers and service technicians should install, start up, and service this equipment. When working on air-conditioning equipment, observe precautions in the literature, on tags, stickers, and labels attached to the equipment. Follow all safety codes. Wear safety glasses and work gloves. Use care in handling equipment.

12 SPARE PART LIST

Sr. No.	Name	Product Code	Component Photograph
1	Compressor	ACR15 008	
2	CONDENSER MOTOR	ACR15 030	
3	BLOWER MOTOR	ACR15 030	
4	CONDENSER FAN	T18 288	
5	EVAPORATOR COIL	T18 286	
6	CONDENSER COIL	T18 287	

Sr. No.	Name	Component Code	Component Photograph
7	FILTER DRIER	ACR 15 003	
8	EXPANSION VALVE	ACR15 001	
9	Heater	T18 275	
10	RETURN AIR FILTER	T18 272	
11	HIGH PRESSURE SWITCH (AUTO)	AMC 068	
12	LOW PRES. CUTOUT SWITCH	LHB 009	

Sr. No.	Name	Component Code	Component Photograph
13	THERMOSTAT SWITCH (OHP)	LHB 010	
14	Distributor	ACR15 052	
15	Refrigerant Sight Glass	ACR15 002	
16	BLOWER RUNNER	MRV 018	
17	Hand Shut Valve	LHB 051	

13 TECHNICAL QUERY AND SUPPORT

For technical enquiry or technical support, kindly contact or write a mail.

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