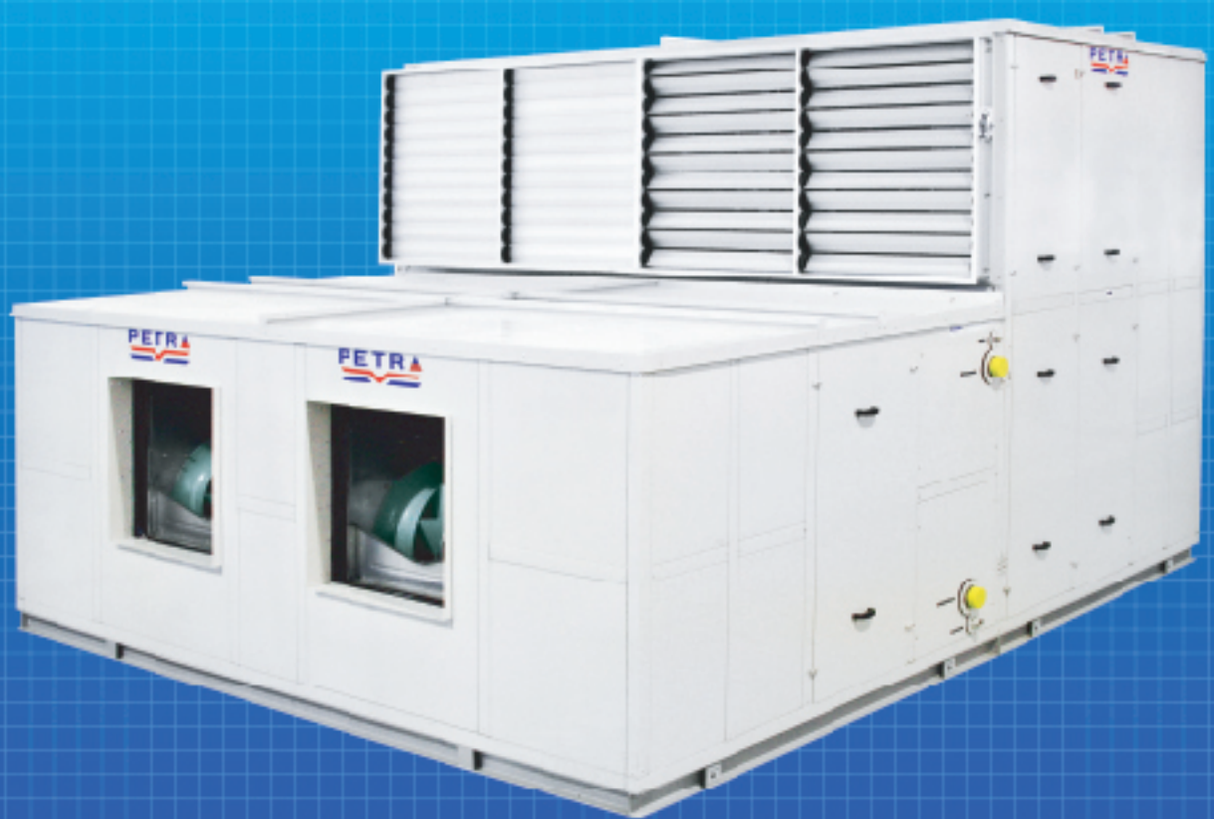
PETRA

Petra Engineering Industries Co.

# PAH USER'S MANUAL

## Air Handling Units




Air Handling Units

Installation, operation and maintenance manual

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# GENERAL

## DEAR CUSTOMER

Thank You for choosing PETRA Air Handling Unit (PAH). Please take the time to go through this manual as it contains valuable information on installation, operation and maintenance of the unit. This will help you to use your unit for a long time.

The following symbols will used in this operational manual to alert you to areas of potential hazard:


A NOTE is used to highlight additional data that may be helpful to you.


An IMPORTANT is used to focus upon information which must be noted.


A CATION is used to identify a hazard which could lead to personal or machine injury.


A WARNING is used to identify a hazard which could lead to personal death or machine destruction or break down.

This manual covers the installation, operation and maintenance of PETRA's PAH Series. This will ensure proper operation and ensures a long service life of the unit.


All procedure presented in this manual, like installation, operation and maintenance must be performed by trained and qualified person.


If you need any more information about PETRA's PAH units or other units, please do not hesitate to contact us at your nearest sales office.

## Receiving

On arrival, inspect the unit before signing the delivery note. Specify any damage on the delivery note and send letter of protest to the last carrier of the goods.

## Inspection

Check the shipment received against the shipping list, to make sure that shipment is complete. After inspecting the unit, protect properly during storage or while moving it to the actual installation site. To maintain warranty protect unit against adverse weather, theft or vandalism on jobsite.

## Damage to Units


Take stock all the accessories and loose components that comes with the unit and compare it with the submitted order list.


Be sure to inspect the unit upon receipt for damage. If damage is found, file a claim right away with the insurance company.

# SAFETY CONSIDERATION

Installation, start up and service of air conditioning equipment can be hazardous due to system pressures, electrical components and equipment location {roof, elevated structure…,etc.}. Therefore, only trained and qualified installation and service technicians should install, start up or service this equipment. We would like to remind you that failure to respect installation and maintenance instructions may void the unit warranty.


When working with the equipment, observe precautions in the literature as well as the tags, stickers and labels attached to the units.


Keep all doors and screws installed on unit while moving unit and installing ductwork. This will help ensure that the unit stays square, allowing for easier removal of doors after the ductwork is attached.


Before operating, be sure the unit is properly grounded to prevent injury or death from electrical shock.

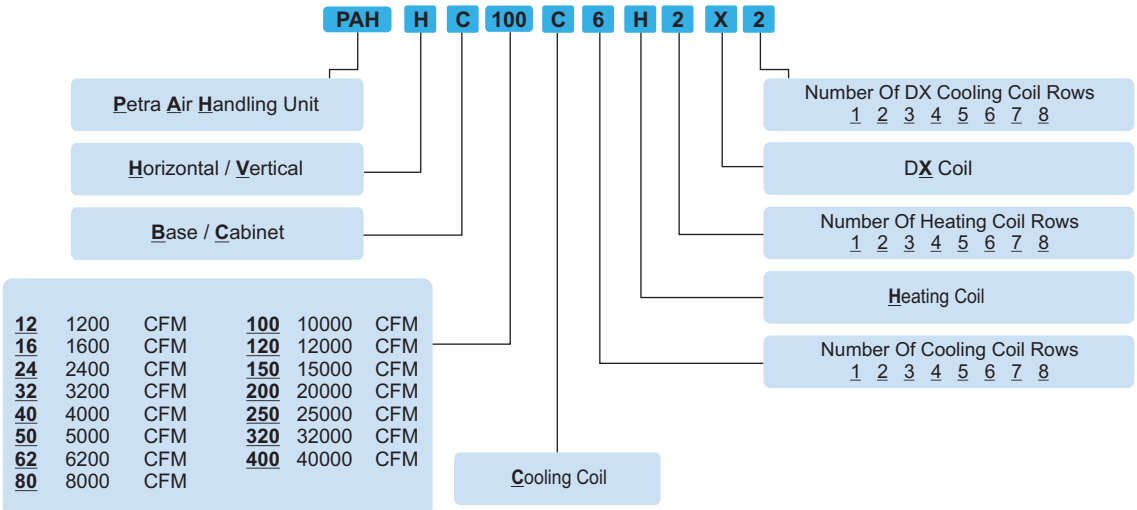

Be sure to disconnect power before servicing this equipment.


Wear safety glasses and work gloves.


Do not tip units on their side during transportation or installation or severe, internal damage may occur.

Before driving screws into the cabinet, check on the inside of the unit to be sure the screw will not hit electrical or water

## NOMENCLATURE




## WARRANTY

Petra parts only warranty


PETRA Product(s) is warranted to be free from defects in material and workmanship for twelve months after the date of installation or eighteen months after the date of delivery, whichever occurs first, if such defect arises from normal usage of the product in accordance with the instructions of the manufacturer.
In the event that any part becomes or is shown to be defective under normal usage within the warranty period, expect parts that customarily require replacement such as air filters, the manufacturer shall repair or replace such part ,at the sole discretion of the manufacturer.
The manufacturer's obligation under this warranty is limited to:

- Repairing the defective part

Or

- Furnishing a replacement part provided that the defective part is returned to the manufacturer

The warranty will be void if the product has been altered, applied to a different application that those it is designed for ,damaged ,misused ,subjected to abnormal use or service; or if the serial number has been altered, defaced or removed from the product.
The warranty will not cover any failure or improper function of any product due to misapplication or improper installation, inadequate or incorrect wiring, incorrect voltage conditions ;excessive oversize or undersize of product selection ,unauthorized service, or operation at abnormal conditions such as excessive temperatures or inadequate water flow rates.
In addition, the warranty does not include defects resulting from natural disasters, wars, riots, thefts, fires, earthquakes, floods, lightning bolts and sudden electrical surges.

For warranty purposes, the following conditions must be satisfied:

- The initial start of the unit must be carried out by trained personnel from an Authorized Petra Service Center.
- All the scheduled maintenance operations detailed in this manual must be performed at the specified time by suitably trained and qualified personnel.
- Failure to satisfy any of these conditions will automatically void the warranty.

WARNING

The warranty is void if the equipment is repaired or modified due to misuse, lack of maintenance or failure to comply with PETRA's instructions or recommendations. If the user does not conform to the above mentioned general notes, it may result in the cancellation of the warranty.

## NAMEPLATE DESCRIPTION

| | | |
|---|---|---|
| MODEL | A | |
| REF. | B | |
| SERIAL NO. | C | |
| NOMINAL POWER SUPPLY | VOLT/Hz/Ph | |
| | D | |
| SUPPLY FAN MODEL | E | |
| SUPPLY FAN MOTOR | F | kw |
| FULL FAN AMP. | G | A |
| RETURN FAN MODEL | H | |
| RETURN FAN MOTOR | I | kw |
| FULL LOAD AMP. | J | A |
| EXHAUST FAN MODEL | K | |
| EXHAUST FAN MOTOR | L | kw |
| FULL LOAD AMP. | M | A |
| ELECTRIC HEATER | N | kw |
| HUMIDIFIER HEATER | O | kw |
| COIL TEST PRESSURE | 450 Psig | |
| | B | |
| Made in Jordan | | |
| Manufacturing Year | P | |

| | |
|---|---|
| A | The code identification of the machine model. |
| B | The type of refrigerant. |
| C | The serial number of the machine. |
| D | The nominal operating power supply voltage over frequency over the number of phases required. |
| E | The model of supply fan. |
| F | Nominal power consumption of the supply fan motor. |
| G | The maximum running current of the supply fan motor. |
| H | The model of return fan. |
| I | Nominal power consumption of the return fan motor. |
| J | The maximum running current of the return fan motor. |
| K | The model of exhaust fan. |
| L | Nominal power consumption of the exhaust fan motor. |
| M | The maximum running current of the exhaust fan motor. |
| N | Nominal power consumption of the heater. |
| O | Nominal power consumption of the humidifier heater. |
| P | Manufacturing date of the machine. |

## UNIT DESCRIPTION

### Design Versatility

Unit capacities in PAH series have a wide range depending on the design requirements , also units can be constructed almost in any shape and dimensions to meet client's restricted spaces in mechanical room, roof...etc. Arranging cabinets for PETRA Air Handling Units can be achieved almost in any configuration tailored according to the clients requirements.

### Structure Quality

All frames are made of high quality extruded metal profile, and the frame rigidity is achieved through the use of a unique Pent-post construction.
This rigid structure supports the whole unit to prevent bends due to external loads.

### Serviceability

The unit construction facilitates easy accessibility for operators to maintain and service. This accessibility is reflected in the number of doors provided for the unit and easy removing panels.
This serviceability will positively affect the unit expected life.

### Options Diversity

There is a vast variety of filtration, cooling, heating, fan, and controls options that can be provided for PAH series, which enhance our unit's performance.

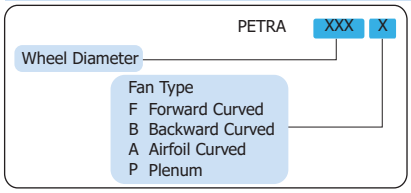
# COMPONENTS DESCRIPTION

## Fans

### PETRA's AHU Fans

PETRA fans for air handling units (PAH) are high performance centrifugal fans, The unit can be equipped with different types of fans depends on the client targeted initial and operational costs and system static pressure. The impeller size selection criterion is based on compromising between efficiency, initial cost, desired acoustic level and the available space for the unit.

### Nomenclature




### Standard Features

- All PETRA AHU fans are AMCA certified.
- All fans are selected for optimum outlet velocities and low sound levels.
- Fans are supplied with flexible connection between the fan discharge outlet and the unit casing; this will minimize the vibration and accordingly the sound level and completely isolate the fan-motor assembly from the rest of the unit structure.
- The fan shaft is made of steel machined, grounded, polished and epoxy coated to provide maximum rust protection.
- The shaft diameter is selected with maximum operational speed; will be generously below the first critical speed.
- The fan bearings are ball bearing type hermetically sealed, and self-aligning and selected to have minimum of 200,0000 hours Life time.
- The fan bearing housing is mounted on galvanized/carbonsteel structure integrated with fan scroll.
- The fan/motor assembly is mounted on rubber on shear vibration isolation mounting.

Rubber in Shear Isolator

### Options

- Non-standard fan sizes.
- Pillow block bearing fans; the bearing is mounted on cast iron supports with grease points.
- Stainless steel fan shaft.
- Fan inlet measuring element mounted on the fan bell mouth.
- Double grooved fan sheaves.
- Inlet guide vanes for backward curved fans and airfoil fans to control air flow rate.
- Other fan types (such as plenum fans).
- Twelve blades impeller for airfoil plenum fans for very quiet operation.
- Aluminum fan impeller.
- 1.0" open type, 2.0" seismic or 4.0" seismic vibration isolation mounting for fan/motor assembly. Other fan types (such as plenum fans).

1.0'' Open Type Spring Isolator (optional)

2.0'' Seismic Type Spring Isolator (optional)

- Wire mesh on the fan inlet.
- Fan/motor drive assembly belt guard.
- Extended lubrication lines.
- Externally mounted motor with extended shaft.
- The twin fans arrangement. This arrangement is the best choice for low height units. The twin fans can be with common shaft and motor or each fan has it's separate shaft and motor.

### Fans Types

The unit can be equipped with different types of fans depending on the client requirements initial and operational costs and system static pressure. Different fan-motor arrangements can be provided. All standard fans are double width double inlet (DWDI) forward curved fans.

- Double Width Double Inlet (DWDI) Forward Curved Fan (Type I: Low/Medium Static & Type II: High Static)(Standard)

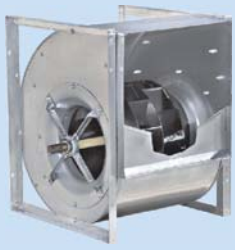
These types are the first choice for low/medium and high static pressure systems and with affordable price for client budget.

DWDI Fan-Forward Curved Type I

DWDI Fan-Forward Curved Type II

- Double Width Double Inlet (DWDI) Backward Curved Fan

This type is made of high efficiency, double width, double inlet with backward inclined blades. The construction is inspired to the maximum strength and reliability with high performance and lower sound level.



DWDI Fan - Backward Curved Type (Optional)

- Double Width Double Inlet (DWDI) Airfoil Backward Curved Fan

This type with airfoil and flat shaped blades make the operational costs lower due to higher static efficiency and make the unit quitter.

DWDI Fan - Airfoil Backward Curved Type (Optional)

- Plenum Fan Type

Plenum fans are used to pressurize the entire surrounding air plenum. This allow discharge duct work to be directly connected to the air handler from any direction.
The plenum fan design also saves space by eliminating the fan housing, transitions and diffusers within the air handling unit.

Plenum Fan Type (Optional)

# COMPONENTS DESCRIPTION

## Coils

A variety of coils including chilled water, hot water, steam coils and direct expansion coils are available to suit the client needs. PETRA's coils are designed to deliver their respective duties at optimum performance under all design conditions. All coils are tested at 450 Psi air pressure under water. They also undergo dry chemical cleaning after coil manufacturing for optimum system cleanliness. Airtight gaskets are used where coil pipes exit the unit casing. The sealing around the coil prevents air by-pass.
As a standard in the water coils, a drainage is attached to the coil, and an air vent in the highest point of the coil to relies the air from the coil.
All PAH series chilled/hot water coils and DX-coils are ARI certified to ensure quality and performance.

## Chilled / Hot Water

Chilled and Hot water coils are designed to meet a variety of heating and cooling needs. From Air Handlers to industrial requirements.

## Steam Coils

Steam coils are built with stand a variety of steam pressure.

## Direct Expansion Coils

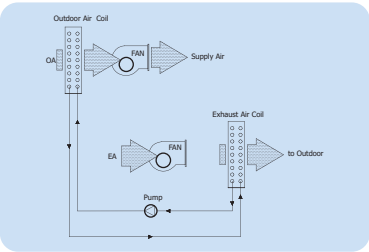
Direct expansion coils are designed to meet a wide range of temperatures, from air handler to sub-zero freezing applications. Circuiting is matched to compressor requirements, and coil face can be split to meet your specific need.

## Coil Connection

Coil connections can be provided on either right or left hand side facing air return.

## Run Around Coils

Run Around Coils consists of two finned-tube coils (air to water heat exchangers) piped together one coil is in the outdoor air stream and the other is in the exhaust air stream. This type is limited to sensible energy heat transfer.



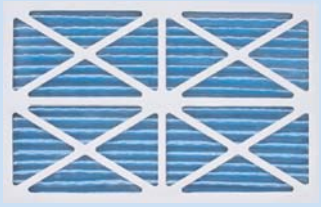

## Filters

Filter types can be selected to meet any filtration requirements, and so a wide variety of filter types are available, including flat filters, V-filters, bag filters, HEPA filters, carbon filters and other types. Selection of filters depends on the indoor air quality requirement.

## Pleated type Filters (panel and high efficiency) Standard

- Design

- Environment-friendly materials.
- High tensile strength media.
- Rigid construction
- Max. Temperature up to 194°F.



Pleated Filter

PLEATED FILTERS Dimensions

| Model PAH | Filter Dimension [Inch] | Qty |
|---|---|---|
| 12 | [24*24] | 1 |
| 16 | [24*24] | 1 |
| 24 | [16*25] | 2 |
| 32 | [24*24] | 2 |
| 40 | [24*24] | 2 |
| 50 | [24*24] | 4 |
| 62 | [24*24] | 4 |
| 80 | [20*24] | 6 |
| 100 | [20*24] | 8 |
| 120 | [20*24] | 8 |
| 150 | [20*24] | 9 |
| 180 | [24*24] | 9 |
| 200 | [20*24] | 12 |
| 250 | [20*24] | 16 |
| 320 | [20*24] | 20 |
| 400 | [20*24] | 24 |

## Flat Filter & V-Filters

2" or 4" washable metal filters are available, also synthetic type filter, when face velocity is to be reduced PETRA offers V-type filters

- Design

- Synthetic
  - Average dust weight arrestance = 85%
  - A progressively structured filter media made from thermally bonded synthetic fibers.
  - Operation Temperature up to (266°F).
- Aluminum
  - Flexibility in shape.
  - Low resistance.
  - Washable.

Aluminum Media

## Bag Filter

When higher level of filtration than flat or V-types is required, bag filters could be used, these filters are made of synthetic media, and their efficiency reaches up to 95%.

Bag Filter

- Design

- Mechanically strong with high absorption resistance.
- Excellent performance in high moisture conditions.
- Low initial pressure drop.
- High dust holding capacity.
- Long service life.
- Max. temperature of 140oF.

# COMPONENTS DESCRIPTION

## Fan Motor

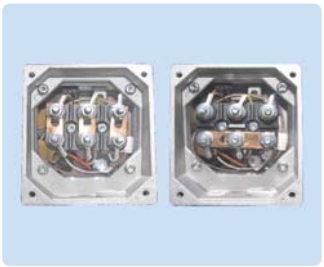
The fan motors are mounted on a galvanized steel base which is isolated from the AHU unit casing with rubber mounts as standard. All motors with (7.5 hp)( where applicable) or less are provided with variable pitch pulley for the motor and fixed pulley for the fan. Motors are Totally Enclosed Fan Cooled (TEFC), squirrel cage type with class "F" insulation and IP55 protection.

-Supply Voltage Characteristics

- The IEC 38 standard gives the European reference voltage as 400v three-phase with a tolerance of ± 10%.
- Power supplies:
- Maximum line drop between customer delivery point and customer usage point 4%
- Variation in frequency around nominal frequency:
- - continuous state.
- - ± 1 % transient state : ± 2 %.
- Three/phase mains phase balance error zero sequence component and/or negative phase sequence component compared to positive.
- Phase sequence component: <2 %.
- Harmonics:
- - relative harmonics content: <10%.
- - individual harmonic voltage : to be established.
- Surges and transient power cuts to be established.

-Wiring Diagrams

All standard motors are supplied with a wiring diagram in the terminal box.
The diagram normally used is shown below.



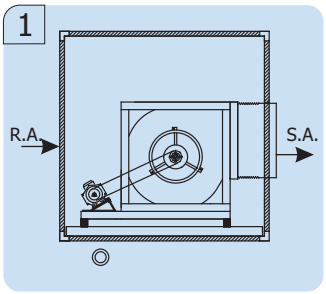
## Options

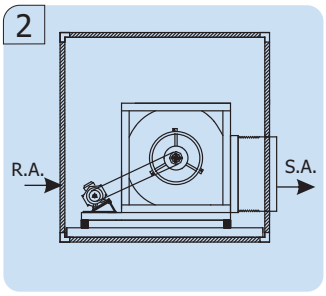
- Explosion proof motors.
- Two speed motors.
- change over.
- Circuit breaker.
- Spring vibration isolators.
- Frequency inverters.

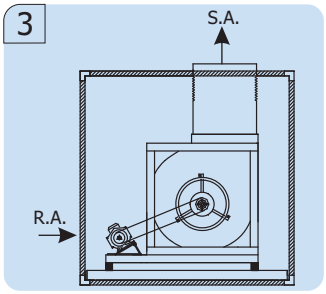
Standby motors with manual or automatic

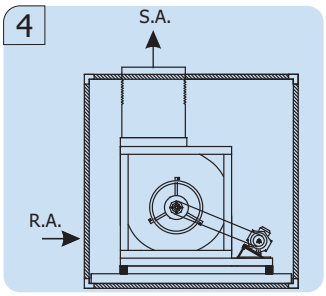
Frequency Inverter.

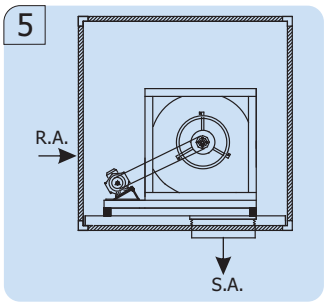
## Fan and Motor Arrangement

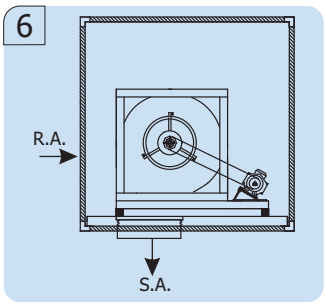


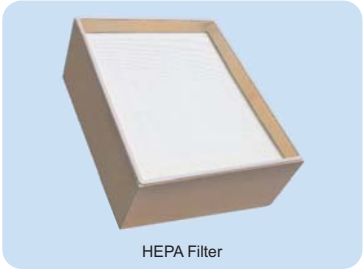



# COMPONENTS DESCRIPTION

BAG FILTERS Dimensions

| Model PAH | Filter Dimension [Inch] | Qty |
|---|---|---|
| 12 | [20*24] | 1 |
| 16 | [20*24] | 1 |
| 24 | [12*24] | 1 |
| | [20*24] | 1 |
| 32 | [20*24] | 2 |
| 40 | [24*24] | 2 |
| 50 | [20*24] | 4 |
| 62 | [20*24] | 4 |
| 80 | [24*24] | 4 |
| 100 | [20*24] | 6 |
| 120 | [24*24] | 6 |
| 150 | [20*24] | 9 |
| 180 | [24*24] | 9 |
| 200 | [20*24] | 12 |
| 250 | [20*24] | 12 |
| | [12*24] | 3 |
| 320 | [20*24] | 12 |
| | [24*24] | 6 |
| 400 | [20*24] | 12 |
| | [24*24] | 9 |



HEPA Filter

## - Design

- Filtration efficiency up to 99.999%.
- Less costly installation space is necessary.
- Energy Saving..
- Long service
- Max. Temperature up to 194oF.

This filter is used in clean room applications to achieve very high efficiency of filtration

HEPA FILTERS Dimensions

| Model PAH | Filter Dimension [Inch] | Qty |
|---|---|---|
| 12 | [20*24] | 1 |
| 16 | [20*24] | 1 |
| 24 | [30*24] | 1 |
| 32 | [20*24] | 2 |
| 40 | [24*24] | 2 |
| 50 | [30*24] | 2 |
| 62 | [20*24] | 4 |
| 80 | [24*24] | 4 |
| 100 | [20*24] | 6 |
| 120 | [24*24] | 6 |
| 150 | [30*24] | 6 |
| 200 | [30*24] | 6 |
| | [20*24] | 3 |
| 250 | [30*24] | 3 |
| | [24*24] | 9 |
| 320 | [30*24] | 5 |
| | [24*24] | 10 |
| 400 | [30*24] | 6 |
| | [24*24] | 12 |

## Other Types of Filters

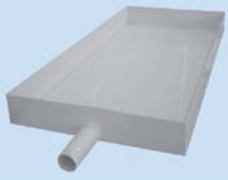
1. Auto roll Filters
2. Electrostatic Filters
3. Carbon Filters

## Drain Pans

Drain pan is supplied as standard under the cooling coil, drain pan is made of 0.06 Inch thick painted galvanized steel with a connection from side, the drain pan is insulated with 1/8" closed cell foam insulation class "O" to prevent condensation. The drain pan is double sloped drain pan

## Options

- Stainless steel drain pan
- Double wall insulated drain pan
- Drain pan connection from both sides



Standard Drain Pan

## Economizer

In economizer operation the outside air and return air dampers operate to maintain the supply control set point. If economizer operation cannot provide enough cooling to satisfy the supply air control set point, mechanical cooling will be energized. Once mechanical cooling is operating, the outside air damper

### Mixing and Exhaust Boxes

The mixing box module combines the incoming outdoor air with the circulated return air from the conditioned space, mixing box is supplied with fresh and return air dampers, while the exhaust box function is to exhaust some of the circulated air and return the rest to the supply air stream, both mixing or exhaust box dampers are low leakage opposed. Aluminum blades type are used, and these blades are assembled in aluminum frame. These dampers can be operated manually or by an actuator (Optional). A combination for mixing boxes with panel filters can be provided in one module.

## Options

- Motorized dampers.
- Economizer section with exhaust box.

### Dampers

All dampers are made with rigid aluminum frame with multi airfoil aluminum blades so as to reduce pressure drop and sound generated when air passes through the blades. An opposed blades arrangement is used with virtually no air leakage. Damper blade's rotation is achieved by the PVC gear's rotation.

## Seals Classified

- Jam seals: flexible metal compression type along control damper sides.
- Blade seals: seal along control damper blade edges.

# COMPONENTS DESCRIPTION

## Options

- Upon request the dampers are supplied with a manually adjustable lever that can be located on either side of the damper.
- Damper could be linked for motorized operation.

## Face and By-Pass Damper

This type of damper is designed to pass an air stream around a coil in order to control the air stream conditions. Up to 100% air by-pass can be achieved if required.

## Sand Trap Louver

The Sand Trap Louver is constructed of heavy gauge galvanized steel with U-shape plates mounted and encased in a galvanized steel frame. These plates prevent the large particles from entering the air handling unit with the fresh air, and thus helps in prolonging filter life and the cleanliness of the air stream.

Sand Trap Louver

### Electric Heater Batteries

Electric heaters are available in a wide range of capacities (Kw and stages), they are mounted on the coil module to reduce unit footprint, and can be supplied in a stand alone section if required. Heaters are made of copper plated steel fins brazed to an steel tubular sheath which includes an 80/20 Nickel/Chrome resistance wire connected to terminals pins. The tubular sheath is filled with high quality compressed Magnesium oxide to ensure even heat distribution along the element. The terminal pins are insulated with ceramic bushes to isolate the element electrically and thermally from the casing. Auto and manual cutout is supplied as standard with the electric heaters.

The following components will be supplied with the unit:

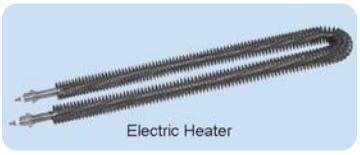
- Contactor for each stage
- Automatic safety cutout
- Manual safety cutout

Electric Heater Control Steps

| Electric Heater | Single stage | 2 Stages | | 3 Stages | | |
|---|---|---|---|---|---|---|
| | 1st | 1st | 2nd. | 1st | 2nd. | 3rd. |
| kW | kW | kW | kW | kW | kW | kW |
| 6 | 6 | 3 | 3 | ... | ... | ... |
| 7.5 | 7.5 | 3 | 4.5 | ... | ... | ... |
| 9 | 9 | 4.5 | 4.5 | ... | ... | ... |
| 12 | 12 | 6 | 6 | 4 | 4 | 4 |
| 15 | 15 | 7.5 | 7.5 | 5 | 5 | 5 |
| 20 | 20 | 10 | 10 | 7 | 7 | 6 |
| 24 | 24 | 12 | 12 | 8 | 8 | 8 |
| 30 | 30 | 15 | 15 | 10 | 10 | 10 |
| 36 | 36 | 18 | 18 | 12 | 12 | 12 |
| 40 | 40 | 20 | 20 | 13 | 13 | 14 |
| 45 | 45 | 22.5 | 22.5 | 15 | 15 | 15 |
| 50 | 50 | 25 | 25 | 17 | 17 | 16 |
| 55 | 55 | 27.5 | 27.5 | 18 | 18 | 19 |
| 60 | 60 | 30 | 30 | 20 | 20 | 20 |
| 65 | 65 | 32.5 | 32.5 | 22 | 22 | 21 |
| 70 | 70 | 35 | 32.5 | 23 | 23 | 24 |
| 75 | 75 | 37.5 | 37.5 | 25 | 25 | 25 |

## Options

- Manual safety cutout
- Power circuit breaker/fuse for each stage
- Air flow switch
- SCR modulating control



Electric Heater

## Sound Attenuator

Sound attenuator can be provided where a significant reduction of fan noise is required. Sound absorption is achieved by installing mineral wool splitters, fixed in galvanized steel frames and mounted parallel to the airflow. Various splitter lengths are available to provide a range of attenuator performances.
The sides exposed to the air stream are covered with a glass fiber scrim to avoid erosion to the mineral wool by the air stream. The standard thickness of the splitters is 7.9 inch
Sound attenuators can be provided in the supply and return air-side. These attenuators can be supplied with different sizes depending on the required sound level.

## Propeller Exhaust Fan for Economizer Operation

The economizer section can be equipped with a propeller exhaust fan. This optional feature can be selected if the external static pressure for the return duct is less than 0.5" W.G.

## Variable Frequency Drive (VFD)

This optional feature is to provide factory pre-wiring to the motor(s) terminals to a solid-state variable frequency drive, to control the motor speed through modulating electrical signal. This VFD is encased in a painted metal box to protect it from tampering unauthorized personnel.

## Unit Controller & Control Panel

The standard (PAH) Unit is provided without a controller, however the unit can be equipped with microprocessor controller with contactors and fuses for the internal components assembled in a weatherproof panel. This microprocessor will control the unit operation to maintain the user specified conditions.

### Humidifier

Various types of humidifiers are available depending on the application, and it can be supplied with or without controllers, sensors and all necessary hardware.
These types include the following:

## Steam Cylinder Type

By using immersed electrodes, steam cylinder stainless steel steam distribution pipe complete with electronic controls for water level regulation and automatic flushing.

Steam Cylinder Type

## Electric Pan Humidifier

Air is humidified by evaporating water in a painted galvanized sheet metal tank using electric element heaters. The humidifier tank is provided with a float valve, drainage output, quick-fill opening and a water level switch.

1. Insect Screen:
   This option can be provided to prevent the entry of
   insects, birds and small animals into the system.
   This screen is made of galvanized wire mesh.
2. Rail grill.
3. Rain hood.

# COMPONENTS DESCRIPTION

## Heat Recovery Sections

This optional module includes an energy-recovery device that depends on ambient conditions, and uses the exhaust air stream to control the entering outdoor air conditions. Various types of heat recovery systems may be used in the range of PAH series including:

## Energy Wheel

Consist of a rotating wheel constructed from special material suited for energy transfer, the supply air flows through one half of the rotary wheel and the exhaust air flows in counter flow through the other half. Supply air and exhaust air thus flow alternately through small passages in the rotor in opposite direction; energy wheel heat exchangers are used in double deck units for large units. There are several types of energy wheels that can be supplied (sensible, or enthalpy, and polymer, or aluminum structure)

Energy Wheel

## Cross Flow Heat Exchanger (Fixed Plate Exchanger)

This type of heat recover relies on the thermal conduction for energy recovery, it consists of alternate Layers of plates separated and sealed, and this type is limited to sensible energy recovery. Cross flow heat exchangers are used in double deck units

## Heat Pipe

This type of energy recovery utilizes two coils filled with refrigerant. The energy transferred from supply/exhaust air by changing the phases (liquid/vapor) of the refrigerant inside the tubes without pumping force. In addition, this type of heat recovery can be utilized when there is a need for dehumidification cooling and reheat to achieve humidity close control to the space. This can be done by placing one of the two coils before the cooling coil and the other placed after the cooling coil.
This arrangement works as pre-cooling and re-heating for the supply air, which enhances the cooling coil performance for dehumidification purposes.

## Diffuser Plate

This plate is provided when high face velocities exist especially when final-filters are provided in the air-handling unit, or in multizone and dual duct units to provide even air distribution between the hot and cold zones. Diffuser plate is made of heavy gauge galvanized steel perforated plate.

## Droplet Eliminator

To avoid water carry-over at high velocities, PETRA recommends using a droplet eliminator in the unit. Eliminator blades are manufactured from reinforced polypropylene, encased within a galvanized steel frame, and designed to completely eliminate water carry over from cooling coils with minimal air pressure drop.
In most cases droplet eliminators are fitted within the cooling coil module, but droplet eliminator could be fitted anywhere inside the air handling unit if required.
As an optional PETRA provide aluminum eliminators.

Droplet Eliminator

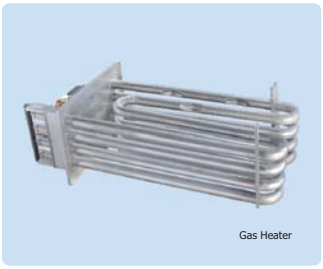
## Bulk Head Light

Vapor proof bulkhead light can be provided as an optional feature for serviceable internal parts. The terminals for these lights might be with switches or without. This optional feature will be useful to carry out any service or maintenance procedures at any time (Day or Night)

Bulk Head Light

## Gas Heater

Tubular type gas heater completely assembled and wired system integral within the air conditioning unit for both outdoor and indoor applications taking into consideration availability of fresh air in the unit space.The heat exchanger has been designed to provide maximum and uniform heat transfer with low pressure drop for the gas and curved non-welded serpentine design experiences less thermally induced stress making it highly durable for longer service life and manufactured from heavy duty 20-guage aluminized steel as standard and available with 409 stainless steel material as an option.



Gas Heater

The ignition system is automatic and is done through a process called flame rectification where flame conducts a very small amount of electricity then the pilot flame; thus igniting the main burner flames. So an intermittent ignition system is used in our gas heater. Venting system of PETRA gas heater is certified in accordance with category (I) and (III) venting requirements, this venting flexibility makes the site installation easier and more cost effective. This venting system is provided with centrifugal fan drafter assembly which includes a pressure switch in order to protect the unit from back or closed drafter. Our gas heater is also provided with a complete gas shut off and a purge period of 5 minutes.
Our standard gas heater is supplied with one stage gas valve; 2- stage gas valve or electronic modulation gas valve can be provided as an option. This modulating valve is mounted between standard gas control valve and burner manifold and is fully open with no power applied to it. And the minimum ratio we can reach is 50% of full input rate and then it is fully modulated from 50% to 100% for units containing one gas heater. Our turn down ratio can be lowered to 25% when using two-gas heater in one unit and less when using three-gas heater in one unit.

# INSTALLATION

## Storage

If the PAH units are to be stored, before installation, it is
important to take the following precautions:

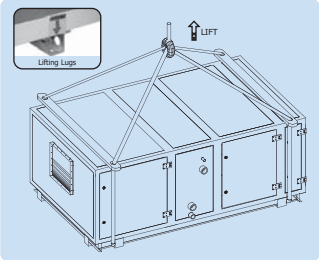
- Keep the unit in a safe area, away from the construction site in order to maintain the integrity of the unit.
- Keep the protective packing of the unit until it is finally installed. If the packing is torn or lost, protective covering should be provided to avoid subjecting the unit to site and weather conditions, and manipulation.
- It is recommended that the unit is periodically inspected during storage

CAUTION

Moisture, debris, and minerals can cause permanent damage to the components

## Unloading

These units are designed for overhead rigging. So for proper unloading and handling, a suitable crane is needed. Use wear flex slings. All units are supplied with lifting holes on base sides. Spreader bars should be used to keep cables or slings clear from the unit sides to avoid damages for unit frame.



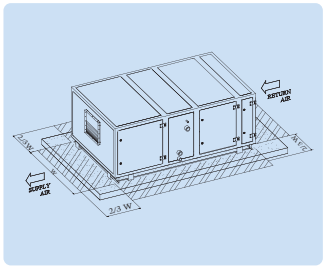

CAUTION

Do not use metal slings to lift the machine because it might damage the unit. Use wear flex slings and do not use forklift trucks on the units

## Operating Space

When installing the unit consider the followings:

- Foundation should be made of flat-leveled concrete or steel stand.
- Free space on both sides of the unit for service and maintenance (if there is no barrier on adjacent wall).
- Once the unit is in place. Check again that the unit is leveled.
- Minimum free spaces on both sides of the units for service and maintenance.




## Site Requirements

To achieve optimum performance and free maintenance it is essential to prepare an installation site meets with the location and space requirements for the model being installed.

CAUTION

The unit site should be selected for minimum sun exposure, and far away from any source that may attack any parts of the unit.

IMPORTANT

PETRA is not responsible for equipment problems resulting from an improperly designed or construction foundation.

IMPORTANT

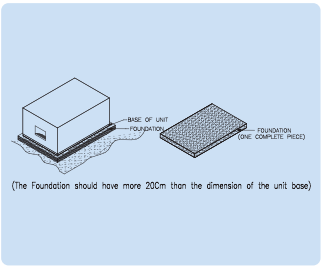
PAH must be installed with adequate vibration isolation beneath the unit to prevent any vibrations, which is might be transmitted to the building.

CAUTION

Do not locate the PAH unit beside or closed to other building or large building, because it might reflect the sound back, this may attack the sound sensitive receiver.

IMPORTANT

On rooftop locations, PAH should locate on a place with adequate structural strength to tolerate its weight and to be more safe for the whole building.




## Section Installation

When the unit is provided in sections, make sure to follow the arrangement provided in the drawing of the unit. The sections of the unit are labeled in order to ensure the correct assembly of the unit.

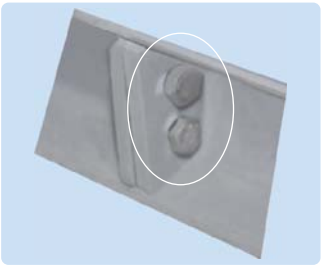
## Section Assembly

- Add gasket all around section from the two side, also add silicon all around outer frame.
- Use provided steel pieces (flat shape) to fix the sections frames with each other
- Fix the steel piece from one side only by using provided bolts (8*20), but without tight the bolts.
- Assemble this entire sheet as below for the two sides for each frame before continuing the work.

Then use screwdriver to tight each adjacent sections, (to conform the holes of the steel piece to holes of section frames, and then add the bolts in the other side of the steel piece and fix them correctly.

## Base Assembly

Use the provided nut and bolts (10*40)mm to assemble the section's bases with each other. (Use spanner 17mm for this).



## Fan-Motor Arrangement Installation

### Drive Installation

Install shaft key. Install bushing on clean shaft, flange end first. If bushing will not freely slide on the shaft, insert a screwdriver or similar object into the flange saw-cut to act as a wedge to open the bushing's bore. If using the setscrew, tighten it just enough to prevent the bushing from sliding on the shaft.

CAUTION

Excessive wedging will split the bushing, and do not over tighten setscrew.

Slide sheave into position on bushing aligning the drilled holes in the sheave with the tapped holes in the bushing flange. Loosely thread the cap screws with lock-washers into the assembly.

### Drive Removing

- Relieve drive by shortening the center distance between driver and driven sheaves.
- Left off belts
- Loosen and remove cap screws. If the bushings have key-way setscrews, loosen them.
- Insert cap screws in tapped removal holes and progressively tighten each one until mating part is loose on bushing.
- Remove mating part from bushing, and if necessary, bushing from shaft.

### Check Alignment

Make sure that drive shafts are parallel. The most common causes of misalignment are non-parallel shafts and improperly located sheaves

Wrong Alignment

### - Install Belts

Shorten the center distance between the driver and the driven sheaves so the belts can be put on without the use of force. While the belts are still loose on the drive, rotate the drive until all the slack is on one side. Then increase the center distance until the belts are snug. The drive is now ready for tensioning.

CAUTION

Never roll or pry the belts into the sheave grooves. This can damage the belt cords and lead to belt turnover, it is both difficult and unsafe to install belts this way.

NOTE

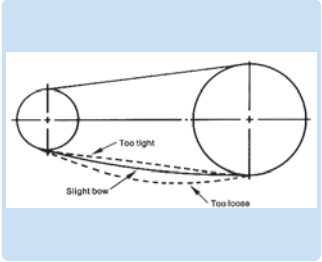
Keep take-up rails, motor base or other means of center distance adjustment free of dirt, rust and grit. Lubricate adjusting screws and slide rails from time to time

When belts are forced into the sheave with a screwdriver or other wedge, the outer fabric is often ruptured and cords broken. It is well worth the time to move the driver unit forward so V-belts can be slipped easily into the sheave groove without damage

### Tensioning of V-Belt Drives

The general method for V-belt tension should satisfy most drive requirements.

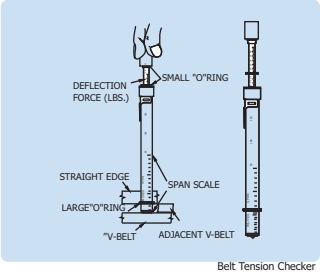
- Reduce the center distance so that the belts may be placed over the sheaves and in the grooves without forcing them over the slides of the grooves. Arrange the belts so that the top and bottom spans have about the same sag. Apply tension to the belts by increasing the center distance until the belts are snug.




- Operate the drive a few minutes to seat the belts in the sheave grooves. Observe the operation of the drive under its highest load condition. A slight bowing of the slack side of the drive indicates proper tension. If the slack side remains taut during the peak load, the drive is too tight. Excessive bowing or slippage indicates insufficient tension. If the belts squeal as the motor comes on or at some subsequent peak load, they are not tight enough to deliver the torque demanded by the drive machine. The drive should be stopped and the belts tightened.
- Check the tension on a new drive frequently during the first day by observing the slack side span. After a few days' operation the belts will seat themselves in the sheave groove and it may become necessary to adjust so that the drive again shows a slight bow in the slack side

### Tension Measurement Procedure

1. Measure the belt span (see sketch).




Belt Tension Checker

2. Position bottom of the large o-ring on the span scale at the measured belt span.
3. Set the small o-ring on the deflection force scale to zero.
4. Place the tension checker squarely on one belt at the center of the belt span. Apply a force on the plunger and perpendicular to the belt span until the bottom of the large o-ring is even with the top of the adjacent (next) belt or with the bottom of a straight edge laid across the outside diameters of the v-belt sheaves.

# INSTALLATION

5. Remove the tension checker and read the force applied from the bottom of the small o-ring on the deflection force scale.
6. Compare the force you have applied with the values given in the table next page. The force should be between the minimum and maximum shown. The maximum value is shown for “New Belt” and new belts should be tensioned at this value to allow for expected tension loss. “New Belt” tensions should be used at initial installation and after jog start or 1-3 Minutes of operation. Used belts should be maintained at the minimum value as indicated in the chart. “Used Belt” tensions should be used for the 8 hour and subsequent checks. If the belt span was measured in inches, then use the pounds of force values for comparison. If the belt span was measured in centimeters, then use the kilograms of force values for comparison.

NOTE

The ratio of deflection to belt span is 1:64 in either units of measurements.

7. Whenever possible, jog start for a few revolutions or preferably run drive for approximately 1-3 minutes and then re-tension in accordance with steps 1-6. Running the drive for a few revolutions or minutes will help seat the belt(s) in the groove(s). This relatively early re-tensioning may reduce or minimize the amount of re-tensioning required in the first 24 hours of drive service.

NOTE

1) For gripbands (multiple or banded belts), the belt deflection force in the above tables must be multiplied by the number of ribs in the gripband. Lay a narrow steel bar such as keystock across the gripband belt and apply the belt deflection force to the bar such that all the individual ribs are deflected evenly.
2) The belt deflection force capacity of the Browning belt tension checker is 33 lbs. or 15 kg. Other means of applying force must be used if force requirement is greater than this.

| Belt Cross Section | Smallest Sheave Diameter Range | RBM Range | Belt Deflection Force | | | |
|---|---|---|---|---|---|---|
| | | | Super Gripbelts and Unnotched Gripband | | Gripnotch Belts and Notched | |
| | | | Used belt | New Belt | Used belt | New Belt |
| | 3.0-3.6 | 1000-2500 | 3.7 | 5.5 | 4.1 | 6.1 |
| | | 2501-4000 | 2.8 | 4.2 | 3.4 | 5.0 |
| A,AX | 3.8-4.8 | 1000-2500 | 4.5 | 6.8 | 5.0 | 7.4 |
| | | 2501-4000 | 3.8 | 5.7 | 4.3 | 6.4 |
| | 5.0-7.0 | 1000-2500 | 5.4 | 8.0 | 5.7 | 8.4 |
| | | 2501-4000 | 4.7 | 7.0 | 5.1 | 7.6 |
| | 3.4-4.2 | 860-2500 | — | — | 4.9 | 7.2 |
| | | 2501-4000 | — | — | 4.2 | 6.2 |
| B,BX | 4.4-5.6 | 860-2500 | 5.3 | 7.9 | 7.1 | 10.5 |
| | | 2501-4000 | 4.5 | 6.7 | 6.1 | 9.1 |
| | 5.8-8.6 | 860-2500 | 6.3 | 9.4 | 8.5 | 12.6 |
| | | 2501-4000 | 6.0 | 8.6 | 7.3 | 10.9 |

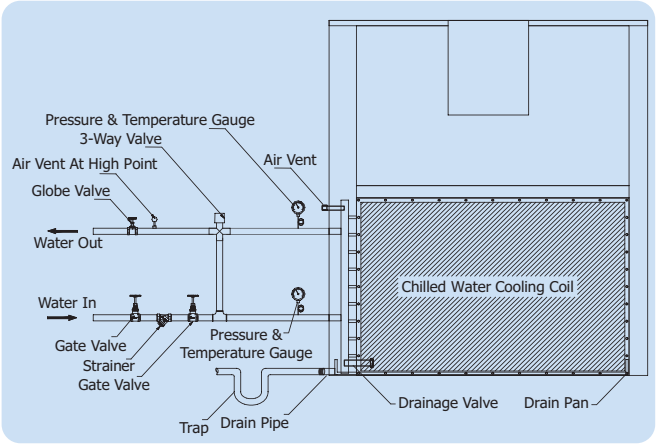
# CONNECTION

## Mechanical Connection

### Chilled water piping

Once the PAH unit has been located in its final position, the chilled water piping can be connected. A typical water piping diagram for the PAH unit is illustrated below.

- Drain connections should be provided at low points to permit complete drainage.
- Air vent should be installed at the proper location near the unit.
- A strainer should be installed in the inlet line to protect/prevent entrance of large particles which could cause damage to the evaporator coil.
- Thermometer and pressure gauges should be installed in inlet/outlet of water lines.
- All piping works should be kept free from all foreign matters.
- All piping should be supported independent of the PAH unit.
- Flushing the chilled water piping from any foreign material before the unit is finally connected to the system.



# CONNECTION

## Standard Coil Connection Size

| COIL SPECIFICATION of PAH | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| MODEL | PAH 12 | PAH 16 | PAH 24 | PAH 32 | PAH 40 | PAH 50 | PAH 62 | PAH 80 |
| Size (in) | 0.75<br>1<br>1.25 | 0.75<br>1<br>1.25 | 1<br>1.25<br>1.5 | 1<br>1.25<br>1.5<br>2 | 1.25<br>1.5<br>2 | 1.25<br>1.5<br>2 | 1.25<br>1.5<br>2 | 1.5<br>2<br>2.5 |

| COIL SPECIFICATION of PAH | | | | | | | |
|---|---|---|---|---|---|---|---|
| MODEL | PAH 100 | PAH 120 | PAH 150 | PAH 200<br>2 COILS | PAH 250<br>2 COILS | PAH 320<br>2 COILS | PAH 400<br>2 COILS |
| Size (in) | 1.5<br>2<br>2.5 | 2<br>2.5<br>3 | 2<br>2.5<br>3 | 2<br>2.5<br>2.5 | 2<br>2.5<br>3 | 2<br>2.5<br>3 | 2.5<br>3<br>4 |

### - Drain

All units are provided with drain for evaporator coil. This drain must be trapped and connected to the nearest floor drain. A drainage valve is located inside the unit to be used when coil is to be drained, the water goes inside the drain pan.

NOTE

Trap depth should not be less than 50mm from the drain connection size.

## Electrical Connection

### Field Electrical Connection

The STANDARD air handling units are supplied without control box or junction box. If the control or power components are required they should be specified previously. Refer to the standard wiring diagram attached.

## Startup The Unit

- Fully open chilled water valves of supply and return pipes, water balance g.p.m..
- Make sure of complete air vented from the return pipe (water out) from unit.
- After unit is permanently positioned, fan isolation shipping lock-down bolt, should be removed.
- Check motor mounting to make sure all nuts are tight. Confirm that the motor voltage, phase, and HP size are compatible with wiring diagram.
- Fan wheel(s) should rotate freely. Check motor and fan sheave for proper alignment and make sure set screws are tight. Check bearing collar set screws on fan shaft and fan hub set screws for tightness. Loose collars or set screws will damage the shaft quickly. Ball bearing have been lubricated at the factory and do not need further
- Attention at startup the unit. DO NOT operate fan with Imbalance. During fan startup observe the rotation and if fan is operating backward reverse for an enough space of the supply electrical power if three phase.
- Rotate dampers shafts to test action; rough handling may caused damper blades to bind.
- Filters are often furnished and mounted in the racks or in boxes inside the unit. Check to make sure the filter cartridge count is correct.

# OPERATION

- Check all screws, nuts, bolts, electrical and piping connections for tightness.
- Hinged or slide rail motor mounts are furnished with two adjusting bolts, bolts must be adjusted equally or so drives maintain proper alignment. Correct belt tension should be acquired by use of belt tension checker tool. Over tightened belts reduce belt and bearing life substantially, yet belts must be tight enough to prevent slippage.

NOTE

PAH units have adjustable fan drives. The fan speed must always be within the range given on the unit nameplate and in the product data. If there is any doubt about the permissible fan speed, contact PETRA factory before making any adjustment.

## After 48 Hours of Operation

- Disconnect and lock electrical power source. Check tightness of all bearing, wheel and sheave setscrews.
- Recheck all belt tension and adjust if necessary. Belts tensioned sufficiently to slip two seconds at start up will perform satisfactorily, extending life and reducing vibration. If retensioning is necessary, be certain sheave alignment is retained.

## Electrical Checks Before Operation

- The main cable for the power supply of the unit is as per PETRA recommendation and local codes. (Refer to the electrical table for the selection of the main power supply cable).
- Proper disconnect switch is installed beside the unit for emergency /maintenance purpose.
- Refer to the wiring diagram for the exact field wiring connection. (Field connection is represented by a dash dot lines on the wiring diagram).
- Inspect visually for any loose wires.

## Start Up Check list (before operating the unit)

### Start Up Checklist For Air Handling Unit

| | |
|---|---|
| **Project Name:** | **Date:** |
| Customer Name: | Project No.: |
| **Model:** | **Address:** |
| Signature: | |

| LOCATION OF MACHINE | YES | NO | COMMENTS |
|---|---|---|---|
| Check for any left over cardboard pieces or packing material on evaporator coil? | | | |
| Check if there is minimum 2 meters distance between the machine and any restricting surface? | | | |
| Check for any objects restricting incoming / outgoing air flow at evaporator? | | | |
| Check the leveling of machine. | | | |

| CONDITION OF MACHINE | YES | NO | COMMENTS |
|---|---|---|---|
| Check if pulley belts loose? | | | |
| Check the unit if it's completely and properly installed with ductwork connected. Verify that all construction debris is removed, and that the filters are clean. | | | |
| Check if there are any gas or oil leaks in system? | | | |
| Check tightness of setscrews in bearings and fan wheels | | | |
| Check fans and verify that they rotate freely. Verify that the belts are tight and the sheaves are aligned. | | | |
| Check that all holes in the floor are tightly sealed to prevent water leakage. | | | |
| Verify that the condensate drain is trapped, and that the drain pan is level. | | | |
| Check if all mechanical protection devices operate properly? | | | |
| Check if pulleys equally spaced? Are they properly fixed in place? | | | |

| ELECTRICAL CONNECTIONS | YES | NO | COMMENTS |
|---|---|---|---|
| Check wiring system if there is any loose | | | |
| Check the cable size and compare it with the design | | | |
| Check overload setting for all motors (fans) | | | |

| DUCTING SYSTEM | YES | NO | COMMENTS |
|---|---|---|---|
| Check if volume dampers are open? | | | |
| Check if there is any leakage in the duct? | | | |
| Check if all ducting properly insulated? | | | |
| Check the external static pressure in the system and compare it to the design one. | | | |

# MAINTENANCE


Do not enter the unit until all rotating components, fans, motors are at rest. Pull fuses, switch off, lock and tag all power switches so that the unit can not be restarted while work is being carried out

## Regular Maintenance

Each PAH unit is designed and constructed for minimum maintenance and dependable operation. However, certain maintenance procedures are required to ensure maximum operating efficiency. Some suggested procedures with the recommended intervals are listed below

### Monthly Maintenance

- Check and clean Air intakes and exhaust outlets.
- Check Supply air filters. Clean or replace it.


The evaporative air conditioning equipment, when it doesn't use for along time more than 1 month it must be cleaned before operating process.

### Every Three to Six Month Maintenance

- Lubricate fan bearings (if pillow block type).
- Check bearing locking set screws and other set screws for proper tightness. All bearing races must be secure.
- Check sheave pulley alignment and level of shafts.
- Check fan belt tension. Adjust if belts slip. Replace worn or frayed belts with a new matched set.
- Inspect coils for dirt build-up. Clean fins if air flow is clogged.

### Annually Maintenance

- Inspect electrical wiring for condition. Tighten all connections.
- Inspect the unit casing and accessories for chipping or corrosion. If damage is found, clean and repaint with a good grade of rust resistant zinc chromate paint.
- Inspect the drain pan for sludge or other foreign material. Clear the drain openings and drain line to ensure adequate flow.
- Check damper linkages, set screws and blade adjustment for proper tightness and operation. Do not lubricate nylon damper rod bushing.
- Re-calibrate the filter manometer (if available).

## Preventive Maintenance


Disconnect electrical power and allow rotating parts to stop before servicing the unit. Failure to do so may result in personal injury or death from electrical shock or entanglement in moving parts.

- Inspect air filters. Clean or replace if clogged.
- Check the over all condition of the unit (insulation, paints, tightness of screws, belt tension,….. Etc)


The procedure listed in this section should be completed every three to six months. The frequency of their completion will depend on the load and ambient conditions.

### Special Maintenance

- After each severe wind storm, check the unit's exterior panels for secureness.
- After each major electrical storm, check the unit for blown fuses or tripped overloads.
- Check the unit's insulation periodically to make sure that it is secure.

Perform all maintenance procedures and inspections at the recommended intervals. This will prolong the life of the equipment and minimize the possibility of costly failures.

## Components Maintenance

### Damper Blades and Linkage

Dampers should be inspected regularly for dirt or debris build up to insure abnormal wear or damage does not occur. Outside air damper should be checked closely for minimal leakage when closed.

### Filter Assembly

Tracks should be checked for rail seal retention where required and all rails should be cleaned annually to control dirt build up, filter drag and dust by-pass during change out of media. Dirty filters reduce the air volume handled by the unit, and thereby its capacity. Unit should not to be run without proper filters or fan motor overload, dirty coil and restricted air flow will result. In dusty environments a more frequent maintenance may be necessary:

- Withdraw the filter from the unit.
- Dislodge heavy particles with a vacuum cleaner, or by tapping filter on solid surface. Take care not to damage the filler.
- Wash in warm water. If needed, use mild solution of commercial solvent. Set filter on end to let water drain. Allow filter to dry thoroughly.
- Reinstall filter in the unit.

### Casing and Access Doors

Door gasket should be checked for leakage and must be in proper alignment and if damaged, should be replaced. Inside access panels must be latched properly to avoid air recirculation.

### Electrical Connection

Check connections of wiring and retighten so danger of a poor connection causing overheating and component failure through inadequate current handling can be avoided. The wiring should be made and remain in accordance with local codes that apply to this equipment.

### Humidifier

Strainer screen in supply line should be cleaned a few days after put in operation and thereafter at least once a season, if much dirt is found in the screen it should clean more than one. The trap should be inspected at the same time strainer is cleaned.

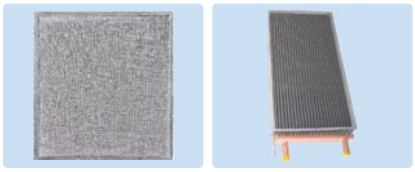
### Condensate Drain

At the start of each cooling season check that drain pan and drain line are clear of obstruction so that condensate flows away.

- Clean drain pan from dust, debris or lint.
- Disconnect drain line.
- Flush with clear water.
- If line clogged use a pipe cleaner to remove obstruction.
- Check the drain line at filter cleaning time during cooling season.

### Coil Cleaning

Periodic verification of coil cleanliness is required. Dirty coils increase air side pressure drops and reduce heat transfer potential, thus unbalancing the system. Every six months examine finned surface for accumulation of dirt or lint. If necessary wash down the affected areas with a mild detergent solution and a soft brush. Care should be taken not to disturb the fin surfaces.



Before Cleaning | After Cleaning

NOTE

Clean the condenser coils at least Once each year, or more frequently if the unit is located in a "dirty" environment. This will maintain proper unit operating efficiencies. To clean the coils, use a soft brush and a vacuum cleaner.

A compressed air line may be used to blow out any solids between the fins. Clean refrigerant coils with cold water and detergent or one of the commercially available chemical coil cleaners.

CAUTION

Do not probe the coils with a metal scrapper as damage may cause tube leaks.

For coil combing:

- Choose proper fin width comb.
- Be careful not to damage tubes and fins.

## Fan-Motor Arrangement Maintenance

### Setscrews

Setscrews lock bearings, sheaves, locking collars, and fan wheels to their shafts. It is very important that all setscrews be checked periodically to assure that they have not loosened. If this is not done, severe equipment damage could occur.

### Motor Bearings Lubrication

Fan motors should have grease added after every 2000 hours of operation. Using the following
procedure, relubricate the bearings while the motor is warm, but not running.

- Remove and clean upper and lower grease plugs.
- Insert a grease fitting into the upper hole and add a small amount of clean grease with a low pressure gun.
- Run the motor for five minutes before replacing the plugs.

NOTE

Bearing Should Be Lubricated At Intervals According To The Following Tabel (In Week)

| BEARING LUBRICATION | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | RPM | | | | | | | |
| Hourse Run Per Day | 1 To 250 RPM | 251 To 500 RPM | 501 To 750 RPM | 751 To 1000 RPM | 1001 To 1500 RPM | 1501 To 2000 RPM | 2001 To 2500 RPM | 2501 TO Max RPM |
| 8 | 12 | 12 | 10 | 7 | 5 | 4 | 3 | 3 |
| 16 | 12 | 7 | 5 | 4 | 2 | 2 | 1 | 1 |
| 24 | 10 | 5 | 3 | 2 | 1 | 1 | 1 | 1 |

NOTE

Specific greasing instructions may be found on the motor nameplate. If special lubrication instructions are on the motor, they will canceled all other instructions.

### Fan Bearings Lubrication

Fan bearing with grease fittings or with grease line extensions should be lubricated with a lithium base grease which conforms to NLGI number 2 for consistency and which is free of chemical impurities. Improper lubrication can result in early bearing failure.
To lubricate the fan bearings, complete the following:

1- Bearings are to be lubricated while unit is not running, disconnect main power switch.
2- Connect a manual grease gun to the grease line or fitting.
3- While turning the fan wheel manually add grease, preferably when bearing is warm, until a light bead of grease appears at the bearing grease seal.

### Fan Bearings Tightening Instruction (Double Lock Set Screw)

The pillow block bearing with double set screw locking arrangement requires specific tightening instructions.
Complete the following:-

1- Rotate the shaft until the double lock bearing set screws are in the vertically up position.
2- With V-Belt tension, snug (hand tighten) all four set screws of the double lock bearing in the numerical sequence.
3- Torque each set screw of the double lock bearing in the numerical sequence to 66 inch pounds.

Complete the following recommended steps for bearing replacement.

1- Using a light weight hammer and drift pin, insert in the drift pin hole, and strike in the direction of shaft rotation to positively engage the collar. The wide inner ring is now locked to the shaft.
2- Tighten the set screw to recommended torque.

### Force Deflection Method Tensioning V-Belt Drives

General Rules of Tensioning:

1- Ideal tension is the lowest tension at which the belt will not slip under peak load conditions.
2- Check tension frequently during the first 24-48 hours of operation.
3- Over tensioning shortens belt and bearing life.
4- Keep belts free from foreign material which may cause slip.
5- Make V-drive inspection on a periodic basis. Never apply belt dressing as this will damage the belt and cause early failure.
6- Drain pan condition and drain flow.

CAUTION

Do not over –tension belts. Excessive tension will reduce fan and motor bearing life, Accelerate belt wear, and possibly cause shaft failure

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2- Tighten the set screw to recommended torque.

## Maintenance check list

### Maintenance Check List For Air Handling Unit

| Fan | Regularly | When Necessary |
|---|---|---|
| Check bearings for noise. | ✓ | |
| Grease bearings. | | ✓ |
| Clean fan, remove any damage and corrosion, retighten fastening | | ✓ |
| Check fan for cleaning, fouling, damage, corrosion and fastening. | ✓ | |
| Check impeller for imbalance and vibration. | ✓ | |
| Check flexible joint for leaks. | ✓ | |
| Check gap width of open impellers. | ✓ | |
| Check functioning of inlet vane control. | ✓ | |
| Check fastening of protective devices for function. | ✓ | |
| Check functioning of vibration dampers. | ✓ | |
| Check functioning of dehydrating equipment. | ✓ | |

| Electric motor | Regularly | When Necessary |
|---|---|---|
| Check electric motor for fouling, damage, corrosion, fastening, smooth running, heating and rotational direction | ✓ | |
| Check firm seat of terminals in terminal block; Tighten if necessary | ✓ | |
| Measure tension, current input and phase symmetry | ✓ | |
| Check bearings for noise | ✓ | |
| Grease bearings. Follow manufacturer´s instruction | | ✓ |
| Clean electric motor, remove any damage and corrosion | | ✓ |

| Belt drive | Regularly | When Necessary |
|---|---|---|
| Check belt drive for fouling, damage, wear, tension, alignment of motor and fan pulley, function and fastening | ✓ | |
| Adjust alignment of motor and fan pulley | | ✓ |
| Check protective device for damage, fastening and functioning | ✓ | |
| Adjust belt tension | | ✓ |
| Clean belt drive | | ✓ |
| Replace belt set | | ✓ |

## Force Deflection Method Tensioning V-Belt Drives

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3- Over tensioning shortens belt and bearing life.
4- Keep belts free from foreign material which may cause slip.
5- Make V-drive inspection on a periodic basis. Never apply belt dressing as this will damage the belt and cause early failure.
6- Drain pan condition and drain flow.


Do not over –tension belts. Excessive tension will reduce fan and motor bearing life, Accelerate belt wear, and possibly cause shaft failure

## FANS

| PROBLEM | CAUSES | RECOMMENDED ACTION |
|---|---|---|
| Noise | **Impeller hitting inlet ring** | • Bearing loose in bearing support, tight the bearing.<br>• Crooked or damaged impeller, refer PETRA factory to change the impeller.<br>• Impeller loose on shaft, tight impeller-shaft connection<br>• Inlet ring damaged, change the ring or refer PETRA factory to change it.<br>• Shaft loose in bearing, tight the shaft- bearing connection. |
| | **Drive** | • Tight (motor and/or fan) sheave on its shaft.<br>• Adjust the belt stretching after 48 hours of operation.<br>• Belts may be too tight loose them.<br>• Misaligned sheaves; aligned them as illustrate in maintenance section.<br>• Belts worn, replace the belts Remove the isolation base shipping restraints.<br>• Clean the belts from any oil or dirt materials. |
| | **Bearing** | • Replace bearings if there are defect or if the bearings are worn<br>• Lubricate bearings.<br>• Tight the bearing supports.<br>• Tight the shaft.<br>• Align the seals.<br>• Clean the bearing from any foreign materials. |
| | **Shaft seal squeal** | • Lubricate it.<br>• Aligned it again. |
| | **Impeller** | • Tight it on shaft<br>• DO NOT run fan if impeller is defect; refer or contact PETRA factory.<br>• Check the balance of the impeller<br>• Replace the impeller if it is worn as a result of corrosive material moving through flow passage. |
| | **Housing** | • Clean housing from foreign material<br>• Clean it also from cutoff or other loose part to prevent ratting during operation. |

## FANS

| PROBLEM | CAUSES | RECOMMENDED ACTION |
|---|---|---|
| Noise | Pulsation or Surge | • Restricted system causes fan to operate at poor point of rating, and ducts vibrate at same frequency as fan pulsations. Check the duct design and duct system |
| | Rattles and/or Rumbles | • Assure the isolation from vibration for duct work, cabinet parts and the unit-building connection are installed completely. |
| CFM low-insufficient air flow | Fan | • Clean the fan blades.<br>• Assure that belts are not loose.<br>• Adjust the fan speed in adequate speed (do not leave it at too slow sped) |
| CFM low- insufficient Air flow (continued) | Filters | • Clean the filters and assure there is no clogging. |
| | Coils | • Clean the coils and assure there is no clogging. |
| | Obstructed fan inlets | • rearrange elbows and prevent any air restricted from cabinet wall or other obstructions. Fan speed may be increased to counteract the effect of restricted fan inlet. |
| | No straight duct at fan outlet | • PETRA fans are normally tested using duct system with a length of straight duct at fan outlet, so if there are no straight duct at the outlet of the fan, the performance will decrease. If it is impossible to install a straight section of duct at the fan outlet increase the fan speed to counteract the pressure loss. |
| CFM high- too much Air flow | System | • Assure that access door is closed.<br>• If the filter (s) is(are) not in place for cleaning purposes or other purposes, assure to reinstall it(them) |
| | Fan | • Reselect the fan speed if the speed is put on too fast. |
| Static pressure low,CFM high | System | • The system may has small resistance to air flow, to solve this problem reduce or adjustthe fan speed to obtain desired air flow (**NOTE**: this will reduce the requirement horse power) |
| | Fan | • Reduce or adjust the fan speed to obtain desired air flow. |

# TROUBLE SHOOTING

## FANS

| PROBLEM | CAUSES | RECOMMENDED ACTION |
|---|---|---|
| **Static pressure low,CFM low** | **System** | • Fan inlet and/or outlet conditions not same as when the unit tested. Check the inlet/outlet condition |
| **Static pressure high CFM low** | **System** | • Clean filters and/or coils from dirty. |
| **High horse power** | **Fan** | • Reduce or adjust fan speed to obtain the desired speed.<br>• Too low system resistance for forward curved fan adjusts the fan speed to reach the desired speed. |
| | **System** | • If filters are removed for cleaning or other purposes, assure to reinstall the filters.<br>• Make sure that access door is closed. |
| **Fan does not operate** | **Electrical or m** | • The fuses are blown. Replace<br>• Replace the belts if they are defect or broken.<br>• Tight the pulleys.<br>• Assure that Electricity is turned on.<br>• Impeller touching scroll, solve this problem by tight the impeller on the shaft and tight the shaft-bearing connection.<br>• Assure that fans run on the correct voltage. |

## ELECTRIC HEATING COILS

| PROBLEM | CAUSES | RECOMMENDED ACTION |
|---|---|---|
| **Electric heater not operating** | **Electrical or mechanical** | • Assure that disconnect switch or main circuit breaker may be in the ON position.<br>CAUTION: If heater has built- in disconnect switch, door must be closed and switch turned ON before heater operate.<br>• The fan must be on before the heater operate, this done if the fan and heater are interlocked with a fan relay.<br>• Allow heater temperature to return to normal so that automatic thermal cutout may reset or manual reset thermal cutout may be reset. correct cause of overheating before proceeding.<br>• Local hot spot developed or if automatic reset thermal cutout failed to open first, when overheating occurred. Correct causeof overheating and replace heat limiter.<br>• Check main fuses, if open,correct cause of failure before replacing fuses. |
| **Electric heater cycles (will not stay on)** | **Electrical or mechanical** | • Check air inlet and discharge openings for obstructions.<br>• See that filters are not clogged, fire dampers are open and air system is balanced.<br>• Check to see that the heater terminal box is tight against duct and heater safety devices are receiving sufficient air flow.<br>• Look at heater coils in operation if there are any red area this mean there are not enough air receiving. Make sure that air flow through every part of the heater is sufficient. |
| **Improper temperature regulation** | **Electrical or mechanical** | • Make sure associated control equipment, such as thermostats, are in the correct location and that all controls are adjusted according to manufacturer's specifications for existing field conditions.<br>• Check air system balance to see that correct amount of air flow is supplied for proper zone control. |

## HEATING/COOLING COILS and CONDENSATE DRAIN PAN

| PROBLEM | CAUSES | RECOMMENDED ACTION |
|---|---|---|
| **Coil does not operate** | **Steam valve failure(Steam Coil)** | • Check both manual and electrically valve, if air operated check optimum air pressure. For electrically valve, check for no power or loose connection. For manual one, check to see if valve is open. Repair or replace valve in necessary.<br>• Defective thermostat or wrong setting; correct cause of defective and if necessary repair of replace them. |
| | **Steam trap failure (Steam Coil)** | • Check steam trap, repair or replace |
| | **Diverter valve (Hot Water Coil)** | • Check power to valve as above in (steam valve failure)<br>• Diverter valve piped wrong, check the valve. |
| **Coil does not deliver adequate heat** | **No steam or hot water. Or insufficient steam pressure** | • Check boiler for proper steam pressure or hot water temperature setting. And check boiler controls |
| | **Thermostat** | • Relocate the thermostat.<br>• Replace it if there are defectives.<br>• Reset the set point. |
| | **Dirty finned tubes** | • Clean finned tubes gently using vacuum or air hose. |
| **Moisture on walls downstream of cooling coil** | **Excess capacity through coolingcoil.** | • Check air flow through coil. |
| | **Standing water in drain pan** | • See "Standing Water in Drain Pan" problem below |
| **Standing water In drain pan** | **Unit is not level** | • Check level of unit |
| | **Drain connection is clogged** | • Assure to clean drain pan from dirt or debris. |
| | **Condensate drain line to drain is not correctly pitched.** | • Check pitch in line towards floor drain. |
| | **Trap is sized incorrectly** | • Assure to trap the drain pan to prevent flooding of the drain pan and potential water damage to the air-handling unit and other building facilities. |

## ELECTRIC MOTORS

| PROBLEM | CAUSES | RECOMMENDED ACTION |
|---|---|---|
| Motor fails to start | Blown fuse or open circuit Breaker | • Replace fuse or reset circuit breaker |
| | Overload trips | • Check and reset overload |
| | Improper line connections | • Check connections with diagram supplie dwith motor |
| | Open circuit in winding or starting switch. Evidence by Humming sound from motor When switch is closed | • Check inside motor to determine if switch is closed.<br>• Check for loose connections. |
| | Improper current supplied | • Check to determine that power supply compatible with motor nameplate specifications. |
| | Mechanical failure | • Determine that motor and drive turn freely.<br>• Check bearings and lubrication |
| | Defective rotor | • Check broken bars or end rings. Replace rotor if necessary. |
| | With a 3 phase power source One phase may be open | • Check line for open phase |
| | Defective capacitor | • Replace capacitor |
| Motor stalls | Low line voltage | • Check across AC line and correct if possible |
| Motor runs and then dies down | Partial loss of line voltage | • Determine and check the adequacy of the power supply and then check for loose connection and reconnect. |
| | Stator shorts when motor warms up. | • Replace stator |
| Motor does not come up to speed | Voltage too low at motor terminals | • Check the AC line and correct the problem if possible. |
| | Line wiring to motor too small | • Use and install larger line wiring. |
| | Broken rotor bars | • Replace motor. |
| Motor takes too long to accelerate | Loose connections | • Check connections and tighten where necessary |
| Wrong rotation (just for3 phase) | Wrong sequence of phases | • Check wiring diagram and reverse any two motor leads at line connection |
| Motor overheats temperature rise above ambient greater than nameplate specifications | Motor fan may be clogged with dirt preventing proper ventilation | • Clean the fan after replace the cover, replace the cover after that. |

## ELECTRIC MOTORS

| PROBLEM | CAUSES | RECOMMENDED ACTION |
|---|---|---|
| Motor overheats temperature rise above ambient greater than nameplate specifications | Motor (3 phase) may have one phase open. | • Assure that all connections are connecting correctly and tight. |
| | Line voltage too high | • Check the AC line and correct it if possible. Step-down transformer may be required |
| | Line voltage too low | • Check the AC line. Consult power company. Step-up transformer may be required |
| | Rotor rubs stator bore | • Check motor bearings from defective or worn and replace them. |
| Motor vibrates when Connected to driven equipment | Motor mounting bolts loose | • Tighten mounting bolts |
| | Tight or Clogged type coupling used toconnect motor to driven the fan. | • Replace coupling with coupling less tight or less rigid. |
| | Driven fan unbalanced | • Balance the fan. |
| | Worn motor bearings | • Check motor bearings from defective or worn and replace them if necessary. |
| | Motor(3phase) running on single phase | • Check if there are an open circuit and correct it by reconnect it |
| | Bent motor shaft | • Replace shaft or rotor |

# ELECTRICAL DATA TABLES

## ELECTRIC MOTORS

### Power Supply : 380-420V/3PH/50Hz

| PAH MODEL | POWER [HP] | POWER [KW] | FLA [A] | LRA [A] | MCA [A] | MOP [A] |
|---|---|---|---|---|---|---|
| PAH 12 | 0.75 | 0.55 | 1.67 | 7.34 | 2.1 | 15 |
| PAH 16 | 0.75 | 0.55 | 1.67 | 7.34 | 2.1 | 15 |
| PAH | 1 | 0 75 | 2 06 | 9.3 | 2 58 | 15 |
| | 1.5 | 1.1 | 2.5 | 12.0 | 3.13 | 15 |
| PAH 32 | 2 | 1.5 | 3.4 | 18.0 | 4.25 | 15 |
| PAH 40 | 3 | 2 2 | 5 0 | 30 0 | 6 25 | 15 |
| PAH 50 | 3 | 2.2 | 5.0 | 30.0 | 6.25 | 15 |
| PAH 62 | 3 | 2 2 | 5 0 | 30 0 | 6 25 | 15 |
| | 4 | 3 | 6 6 | 39 6 | 8 25 | 15 |
| PAH 80 | 5 5 | 4 | 8 6 | 61 1 | 10 75 | 15 |
| PAH 100 | 7.5 | 5.5 | 11.6 | 75.4 | 14.5 | 25 |
| PAH 120 | 10 | 7.5 | 15.8 | 111.0 | 19.75 | 35 |
| | 12 | 9 | 18 5 | 127 7 | 23 13 | 40 |
| PAH 150 | 15 | 11 | 21 9 | 169 0 | 27 38 | 45 |
| PAH 200 | 15 | 11 | 21.9 | 169.0 | 27.38 | 45 |
| PAH 250 | 20 | 15 | 29.6 | 246.0 | 37.0 | 60 |
| PAH 320 | 25 | 18 5 | 35 9 | 273 0 | 44 9 | 80 |
| PAH 400 | 30 | 22 | 43.0 | 339.7 | 53.8 | 90 |

### Power Supply : 380 or 460V/3PH/60Hz

| PAH MODEL | POWER [HP] | POWER [KW] | FLA [A] | LRA [A] | MCA [A] | MOP [A] |
|---|---|---|---|---|---|---|
| PAH 12 | 0.75 | 0.55 | 1.5 | 6.6 | 1.88 | 15 |
| PAH 16 | 0.75 | 0.55 | 1.5 | 6.6 | 1.88 | 15 |
| PAH 24 | 1 | 0.75 | 1.9 | 8.55 | 2.38 | 15 |
| | 1.5 | 1.1 | 2.6 | 12.48 | 3.25 | 15 |
| PAH 32 | 2 | 1·5 | 3·4 | 18·0 | 4·25 | 15 |
| PAH 40 | 3 | 2·2 | 4·9 | 29·4 | 6·13 | 15 |
| PAH 50 | 3 | 2·2 | 4·9 | 29·4 | 6·13 | 15 |
| PAH 62 | 3 | 2·2 | 4·9 | 29·4 | 6·13 | 15 |
| | 4 | 3 | 6·6 | 39·6 | 8·25 | 15 |
| PAH 80 | 5·5 | 4 | 8·5 | 60·4 | 10·63 | 15 |
| PAH 100 | 7·5 | 5·5 | 11·7 | 76·1 | 14·63 | 25 |
| PAH 120 | 10 | 7·5 | 15·0 | 105·0 | 18·75 | 30 |
| | 12 | 9 | 18·0 | 124·2 | 22·5 | 40 |
| PAH 150 | 15 | 11 | 21·6 | 166·0 | 27·0 | 45 |
| PAH 200 | 15 | 11 | 21 6 | 166 0 | 27 0 | 45 |
| PAH 250 | 20 | 15 | 28·4 | 235·7 | 35·5 | 60 |
| PAH 320 | 25 | 18 5 | 36 2 | 275 1 | 45 25 | 80 |
| PAH 400 | 30 | 22 | 43·0 | 329·0 | 53·75 | 90 |

### Power Supply : 230V/3PH/60Hz

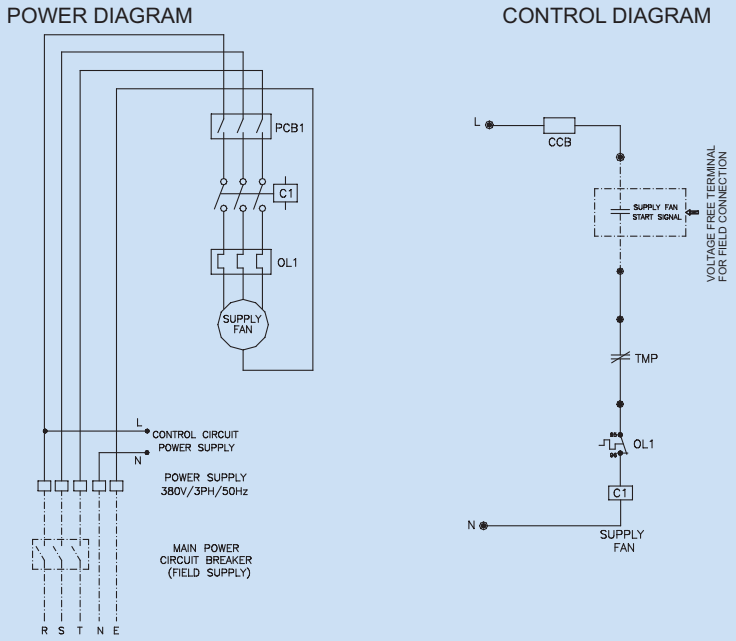
| PAH MODEL | POWER [HP] | POWER [KW] | FLA [A] | LRA [A] | MCA [A] | MOP [A] |
|---|---|---|---|---|---|---|
| PAH 12 | 0·75 | 0·55 | 2·6 | 11·44 | 3·25 | 15 |
| PAH 16 | 0·75 | 0·55 | 2·6 | 11·44 | 3·25 | 15 |
| PAH 24 | 1 | 0·75 | 3·1 | 13·95 | 3·88 | 15 |
| | 1·5 | 1·1 | 4·3 | 20·64 | 5·38 | 15 |
| PAH 32 | 2 | 1·5 | 5·7 | 30·21 | 7·13 | 15 |
| PAH 40 | 3 | 2·2 | 8·1 | 48·6 | 10·13 | 15 |
| PAH 50 | 3 | 2·2 | 8·1 | 48·6 | 10·13 | 15 |
| PAH 62 | 3 | 2·2 | 8·1 | 48·6 | 10·13 | 15 |
| | 4 | 3 | 11·0 | 66·0 | 13·75 | 20 |
| PAH 80 | 5·5 | 4 | 14·4 | 102·24 | 18·0 | 30 |
| PAH 100 | 7·5 | 5·5 | 18·6 | 120·9 | 23·25 | 40 |
| PAH 120 | 10 | 7·5 | 24·3 | 170·1 | 30·38 | 50 |
| | 12 | 9 | 29·8 | 205·62 | 37·25 | 60 |
| PAH 150 | 15 | 11 | 35·5 | 273·35 | 44·38 | 70 |
| PAH 200 | 15 | 11 | 35·5 | 273·35 | 44·38 | 70 |
| PAH 250 | 20 | 15 | 46·6 | 386·78 | 58·25 | 100 |
| PAH 320 | 25 | 18·5 | 62·7 | 476·52 | 78·38 | 125 |
| PAH 400 | 30 | 22 | 75·0 | 568·0 | 93·75 | 150 |

LEGEND
MCA: Minimum Circuit Ampacity
MOP: Maximum Overcurrent Protection
FLA: Full Load Ampere
LRA: Locked Rotor Ampere

NOTE
1- Minimum Circuit Ampacity (MCA) is based on 125% of the maximum operating Amps. for the largest motor plus 100% of the maximum operating Amps.
2- Maximum Overload Protection (MOP) is based on 225% of the maximum operating Amps. for the largest motor plus 100% of the maximum operating Amps.

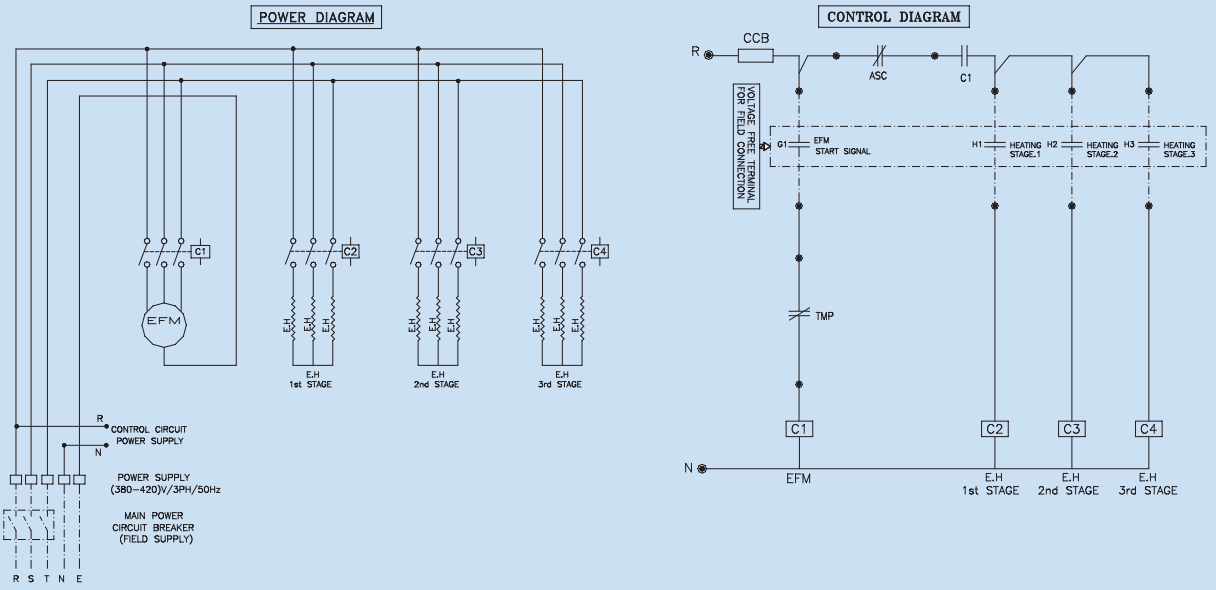
## WIRING DIAGRAM

### Wiring Diagram for PAH Units
(With motor starter and power circuit breaker)




| LEGEND | |
|---|---|
| C | CONTACTOR |
| CCB | CONTROL CIRCUIT BREAKER |
| PCB | POWER CIRCUIT BREAKER |
| OL | OVERLOAD RELAY |
| TMP | THERMAL MOTOR PROTECTOR |
| Wn | WIRING NUMBER |
| n | TERMINAL NUMBER |
| —·—·— | CONNECTION BY OTHERS |

## Wiring Diagram for PAH Units with Electrical Heater




| LEGEND | |
|---|---|
| C | CONTACTOR |
| CCB | CONTROL CIRCUIT BREAKER |
| PCB | POWER CIRCUIT BREAKER |
| OL | OVERLOAD RELAY |
| TMP | THERMAL MOTOR PROTECTOR |
| Wn | WIRING NUMBER |
| n | TERMINAL NUMBER |
| —·—·— | CONNECTION BY OTHERS |

PETRA

Petra Engineering Industries Co.

www.petra-eng.com

Manufacturer reserves the right to discontinue, or change at any time, specifications or designs without notice and without incurring obligations.

PAH USER'S MANUAL Nov. 2011 R.0