Petra Engineering Industries Co.

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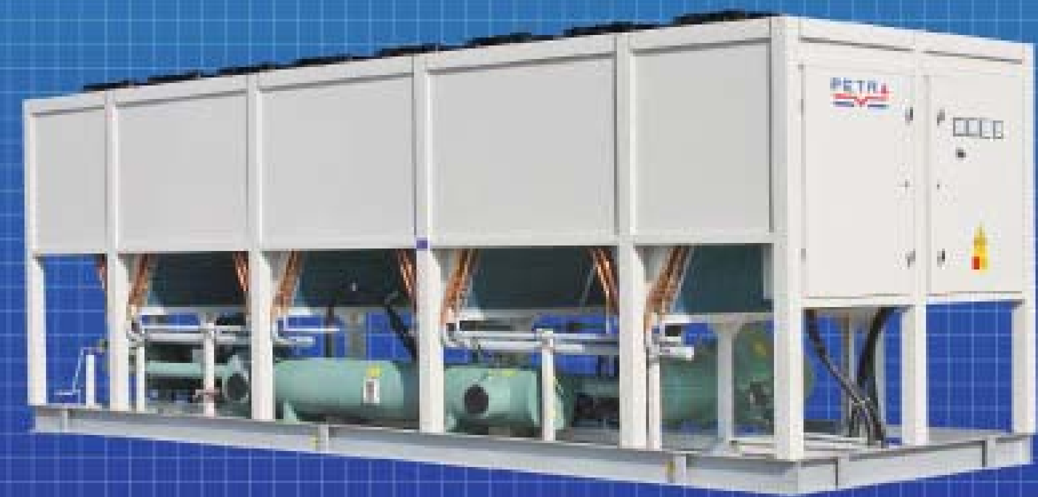
APSa USER'S MANUAL March 2011 R.0

Petra Engineering Industries Co.

APSa USER'S MANUAL

CHILLERS
R134a



Air Cooled Water Chiller with Semi-Hermetic Screw Compressor

Installation, operation and maintenance manual

General

Dear Customer

Thank you for choosing PETRA's chillers Unit with Semi Hermetic Compressor (APSa) unit. Please read this manual thoroughly since it contains valuable information on installation, operation and maintenance of the unit. This will ensure a longer life time for the unit

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

NOTE

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

CAUTION

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

WARNING

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

IMPORTANT

An IMPORTANT is used to focus on information that must be noted.

This manual covers the installation, operation and maintenance of PETRA's Chillers Unit with Semi Hermetic Compressor (APSa) unit.

This will ensure proper operation and a long-life service for the unit.

NOTE

For more information please contact your local service center or refer to PETRA Factory.

NOTE

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

IMPORTANT

All procedures presented in this manual, such as installation, operation and maintenance must be performed by trained and qualified personnel.

Receiving

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

Inspection

Check the shipment received according to 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. This step is important to maintain warranty to protect unit against adverse weather, theft or vandalism on job-site.

Damage to Units

Be sure to inspect the unit upon receipt for damage. If the unit has been damaged in transit, file a claim with the transportation company immediately and check your insurance company immediately.

Safety considerations

IMPORTANT

Installation, start up and service of air conditioning equipment can be hazardous due to system pressures, electrical components and equipment location [roofs, elevated structure...,etc.]. Therefore only trained and qualified installation and service technicians should install, start up or service this equipment.

NOTE

This manual covers the installation, operation and maintenance of PETRA's Chillers Unit with Semi Hermetic Compressor (APSa) unit.

NOTE

PETRA's Chillers Unit with Semi Hermetic Compressor (APSa) units are equipped with unsurpassed features microprocessor controller to manage the unit performance for optimum efficiency at both full load and part load values.

NOTE

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

NOTE

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.

NOTE

Follow all safety codes.

Safety considerations

WARNING
Be sure to disconnect power before servicing this equipment.

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

WARNING
DO NOT VENT refrigerant relief valves within a building. Relief valves outlet must be vented outdoors.

WARNING
Ulmost care has been taken in the design and the manufacture of the units to ensure that they meet safety requirements. However, the individual operating or working on any machinery is primarily responsible for:
personal safety, safety of other personnel, and the machinery.

WARNING
Wear safety glasses and work gloves.

CAUTION
Be careful when handling, rigging and setting bulky equipment.

CAUTION
Keep quenching cloth and extinguishers nearby when brazing.

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

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

CAUTION
The unit must not be operated outside the design limits specified in this manual.

CAUTION
The manufacturer will not be liable for any injury or damage caused by incorrect installation, operation or maintenance resulting from a failure to follow the procedures and instructions detailed in the manuals.

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.

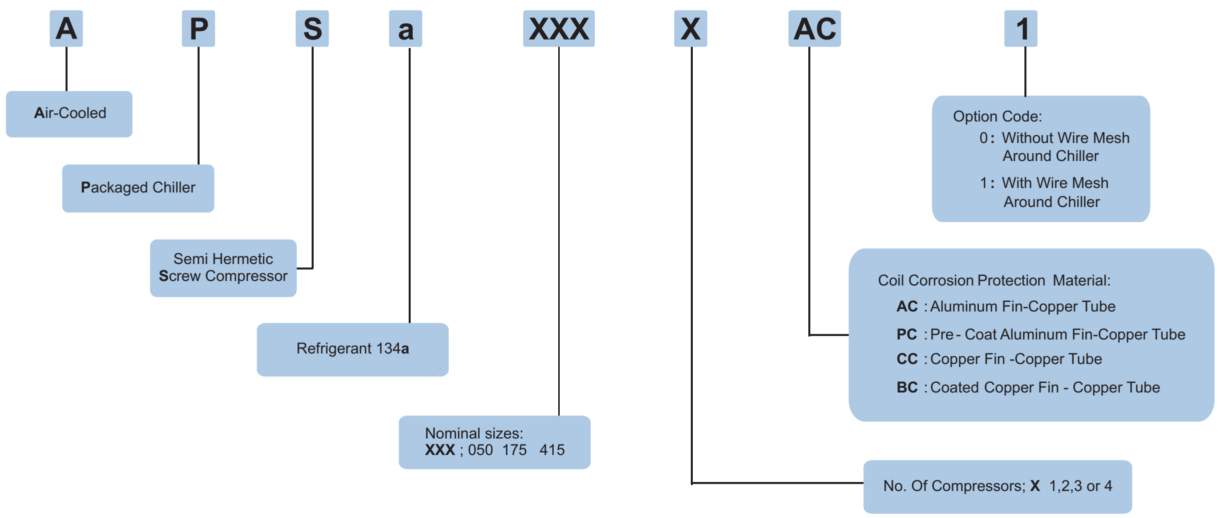
For warranty purposes, the following conditions must be satisfied:

- 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.

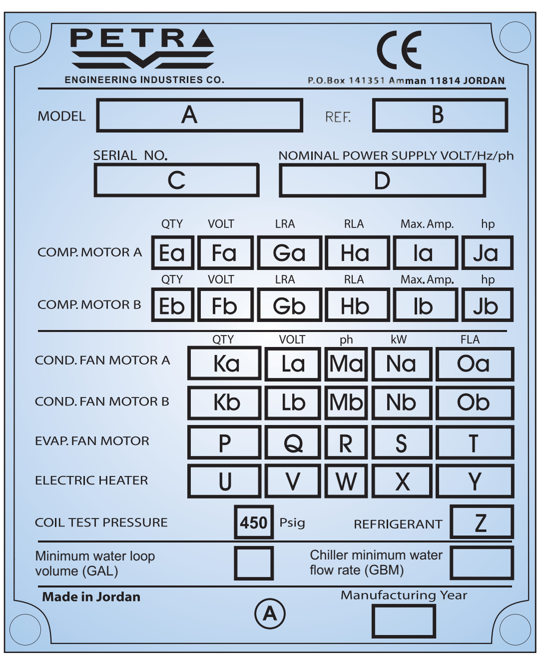
Nomenclature

APSa 100-2 AC 1



Name plate description

Nameplate Description



A : The code identification of the machine model.
B : Reference number of the project.
C : The serial number of the machine.
D : The nominal operating power supply voltage over frequency over the number of phases required.
Ea, Eb : The quantity of compressors installed.
Fa, Fb : The voltage required for the compressors with ±10% tolerance.
Ga, Gb : Locked rotor ampere (starting current) for each compressor.
Ha, Hb : Rated load ampere for each compressor.
Ia, Ib : The maximum running current.
Ja, Jb : Horse power of motor.
Ka, Kb : The quantity of condenser motors installed.
La, Lb : The voltage required for the condenser motor with ± 10% tolerance.
Ma, Mb : The number of the phases of the condenser motor.
Na, Nb : Motor Kilowatt .
Oa, Ob : Full load ampere for each condenser motor.
P : The quantity of evaporator motors installed.
Q : The voltage required for the evaporator motor with ±10%tolerance.
R : The number of the phases of the evaporator motor.
S : Motor Kilowatt.
T : Full load ampere for each evaporator motor.
U : The quantity /stages of electric heater in stalled.
V : The voltage required for the electric heater with ±10%tolerance.
W : The number of the phases of the electric heater.
X : Kilowatt capacity of the heater.
Y : Full load ampere for electric heater.
Z : The type of refrigerant

Description of components

Refrigeration components

Thermostatic expansion valve

This device controls the superheat of refrigerant vapor at the outlet of the evaporator. It acts as a throttle device between the high pressure and low pressure sides of a refrigeration system and ensures that the rate of refrigerant flow into the evaporator exactly matches the rate of evaporation of liquid refrigerant in the evaporator. Thus, the evaporator is fully utilized and no liquid refrigerant may reach the compressor.

Electronic Expansion Valve

It is a device for precise control of refrigerant mass flow. This valve consists of two main internal assemblies; the valve body and the stepper motor.
The housing of body and motor is hermetic utilizing exclusively brazing and welding technologies and elementary all gas kits, The design offers several technical advantages such as direct coupling of motor and valve assembly for easy and reliable movement of the valve assembly. There is no need for any other seals, eliminating the use of bellows and diaphragms which could be subject to life time limitations, the body is stainless steel. For the motor, the amount of rotation is dependent on the number of pulses, one pulse will move by (a =1.8°). A load trains oil will lead to continuous rotation.

The drive shaft of the rotor is connected to a spindle to transform the rotation in conjunction with a cage assembly into a line motion for moving of the valve slides. The gate valve is specially designed for linear flow characteristics in order to provide a wide range of capacity with a linear rotation between flow and positioning of the valve.

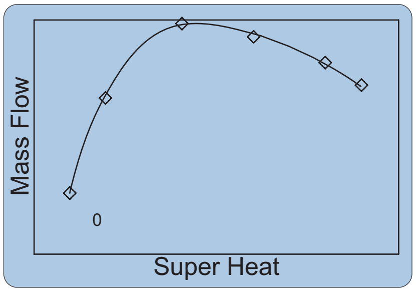
<u>Driver</u>

The driver for the EEV is a programmable device, which regulates the expansion in one refrigeration circuit with the aim of maintaining constant superheat.
This function is achieved by regulating the opening of the valve using a PID self-adjusting algorithm.
The driver features:

- 24 VAC power ± 10%
- 1 NTC analog input for measuring the temperature of the superheated vapor
- 1 current analog input (0-20 mA or 4-20mA) for measuring the evaporation
- 4 current outputs for piloting the valve's stepper motor
- 1 alarm relay
- 5 LEDs for indicating operating status
- Connection to an optional back-up battery pressure

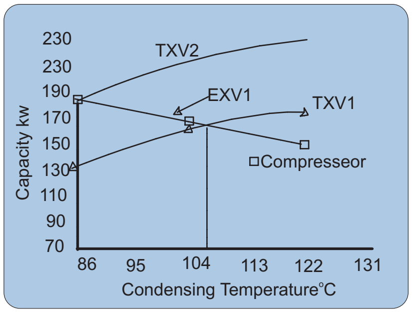
<u>Electronic Expansion Valve Control</u>

The regulation algorithm offers the following functions:
<u>Super heat control:</u> Under near static plant operating conditions. The following figure the calculated mass flow in relation to the measured heat exchange capacity of evaporator.



<u>Suction pressure control:</u>

Under operating conditions of over/under load. These conditions are detected when the pressure exceeds the set limits MOP (Maximum Operating Pressure) or LOP (Lowest Operating Pressure). In these situations, super heat is still controlled. The following figure illustrates capacity variation of compressors and expansion valves at 2.8°C evaporating temperature:



Diagnostic alarms:

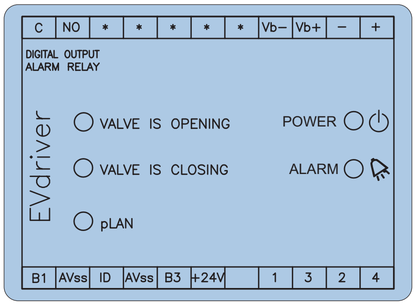
The driver is able to recognize various alarm situations, including probe error, LAN error, Valve connection error and inability of the valve to close after power failure.

Advanced Flow Control

The driver controls the opening of electrostatic expansion valve according to the desired superheat. There will be no flow through the expansion valve as long as the compressor is not running. Once the compressor start up the driver will be informed, through a digital input, and will start to control the refrigerant mass flow. This control is stand alone by precise positioning of the electronic expansion valve under different operating conditions such as compressor start up, start of further compressor, high/low head pressure, high/low load and partial load operation.
Refrigerant mass flow control has a fast response with a wide range capacity, high resolution, highly linear flow capacity and continuous modulation of mass flow with no stress in the refrigeration circuit.

List of Alarms

The four LEDs, located at the front cover of the driver, have a primary function of indicating whenever an alarm should occur. The following table illustrates the different alarms:



Alarm	Status of LEDs				Type of Reset
	Open LED	Close LED	Power LED	Alarm LED	
Open Valve At Power Failure	Blink	Blink	On	Blink	Manual
Probe Error	Off	Blink	On	On	Automatic
Stepper Motor Error	Blink	Blink	On	On	Automatic
EEPROM Error At Start	Off	Off	On	Blink	Manual
EEPROM Error At Working	**	**	On	On	Automatic

**: Shows the Valve Status

Crankcase Heater

The heater minimizes the absorption of the liquid refrigerant by the oil in the crankcase during brief or extended shutdown periods.

NOTE

The heater is located in the bottom cover of the compressor. The heater fixture must be tight to prevent it from backing out of the heater well. The heater eventually burns out if exposed to air for an extended period.

CAUTION

Never open any switch that de-energizes the crankcase heater unless unit is being serviced or is to be shut down for a prolonged period. After a prolonged shutdown on a service job, energize the crankcase.

Shut off Valve

This is a manual valve located in the liquid line used for pump down applications and for liquid line accessories repair or maintenance.

Solenoid Valve

This is normally closed with a de-energized coil solenoid valve and is fitted on the liquid line. The solenoid valve is opened when the compressor is ON and closed when the compressor is OFF.

Pressure Switches

High Pressure Switch

The switch has fixed non-adjustable settings, and is mounted in the discharged side of the compressor. The switch is provided to protect the compressor and the refrigeration system from unsafe high pressure conditions. If an unsafe high pressure condition should exist, the switch opens and shuts OFF the compressor. The unit control module prevents the unit from restarting. Don't operate the unit on high pressure more than 2825 kpa).

Low Pressure Switch

This switch, which is mounted on the compressor has fixed non-adjustable settings. It is of the automatic reset type.

NOTE

Unit should be in continuous operation for at least 10 minutes prior to checking the low pressure switch.

Pressure Switches Limit Table	Cut Out	Cut In
High Pressure kpa	2825	Manual (with differential)
Low Pressure kpa (for cooling)	140	280
Low Pressure kpa (for heat pump)	140	70

Replaceable core drier

Moisture will enter a system any time it is operated for field services. A filter drier is a very effective method for removing small amounts of moisture and contamination. It is installed in the refrigerant liquid line, so that all the refrigerant in the circulation passes through the drier, each time it circulates through the system.

Description of components

Power And Control Components

Control Circuit Breaker (CCB) (Option)

This device is incorporated in the unit as part of the control circuit to protect the control circuit from a short circuiting.

CAUTION

The crankcase heater of each three phase compressor can be energized when this control circuit breaker is switched ON. It is highly recommended to energize the crankcase heaters of the compressors 24 hours before operating the unit for the first time or if the unit was out of use for a long period of time.

Contactor

The contactors are mainly used for controlling 3-phase motors.

NOTE

The unit should contain all the required contactors to start all motors such as compressors and pumps. (Evaporator fan motors and electric heaters if available)

Power Circuit Breaker (PCB) (Optional)

The function of the power circuit breaker is to provide protection from short circuit for the whole unit or for each motor.

Voltage Monitor/Phase Failure Relay (PFR)

Feature

1. Phase reversal.
2. Over or under voltage.
3. Multiple type of fault auto recovery and lock function.

PFR Adjustment procedure

There is a 8 way DIP switch to program the 3 phase monitor to the table below.
Upon power up, the controller will blink the red LED quickly indicating at warm up stage. This process may take a few seconds [0 - 20 sec depends on the voltage supply and monitor settings]. Red LED will be off once the power supply is stable. Green LED and relay will turn on 5 sec later.
Should the controller is unable to read the healthy 3 phase supply after 20 seconds, it will lock the error and flash the red LED according to the alarm code. It will check the power supply again 280 sec later.

Upon confirmation of healthy 3 phase supply, system will monitor the power supply constantly according to the DIP switch settings. Should there be failure occurred, system will flash the red LED slowly until the error delay time out and relay will be turn off. If power supply is recovered before the error delay time out, red LED will be off and system operate as normal. System will lock the error if this failure happens ⩾ 5 times within 2 hours. This fault can be reset by manually turn off the power supply only.

NOTE

All PETRA units can work using the nominal power supply ±10%

IMPORTANT

1. PFR Factory setting must be adjusted with factory approval
2. Adjustment of PFR below or over ±10% will void the unit warranty

SW 1 SW 2	SW 3 SW 4	SW 5	SW 6	SW 7 SW 8
Fault time delay	Voltage tolerance	Reserved	Voltage measuring	3 phase input
00 - 5 sec	00 - 5 %		0 - Monitor	00 - 380 V
01 - 10 sec	01 - 10 %		1 - Bypassed	01 - 400 V
10 - 15 sec	10 - 15 %			10 - 415 V
11 - 20 sec	11 - 20 %			11 - 440 V
To select time delay to confirm fault	Check according to SW 7 SW 8 settings		When set to '1', no under/over voltage checking will be done	Select accoriding to power supply

Standard features

Construction

- Galvanized C-channel chiller base with lifting lugs painted with Acrylic Polyurethane paint.
- V-shaped, air-cooled condenser allows less installation space requirements
- Modular design with multiple compressor execution provides flexibility for varying load conditions and avoids total shut down of the chiller during servicing of any of the refrigeration circuits.
- Easily accessible system components
- Weather proof with ample space for easy access power and control panels
- Heavy duty mounting chassis for the whole unit coated with weatherproof, polyester powder electrostatic paint, oven-baked to ensure maximum gloss and hardness.
- Anti-vibration mounts under compressor (rubber pad type).

Refrigeration

- Independent refrigeration circuit per compressor.
- Liquid, discharge and suction pipes are all of hard copper pipes. They are formed using the highly accurate CNC pipe bending machines in order to minimize pipe-brazed joints which in turn increases system reliability.
- Components of each refrigeration circuit:
  - Expansion valve.
  - Liquid line solenoid valve.
  - Liquid line shut off valve.
  - Liquid line moisture indicator sight glass.
  - Replaceable core type filter
  - Fully charged unit with R134-a refrigerant.
  - High safety pressure switches (capsule type; factory pre-set).
- Epoxy paint for all exposed copper piping system of the refrigeration circuit
- Liquid injection kit
- Stepless capacity control for each compressor (25-100)%

Electrical

- Inherent motor protection for each compressor Part winding start
- Inherent motor protection for each condenser fan motor
- Smart lead-lag operation for compressors
- Free terminal for remote ON/OFF connection
- Free terminal for general alarm output
- High ambient kit
- Control voltage is 220-240V for all components.
- Power supply monitor (phase failure relay)
- Single point power connection for each electrical panel (refer to electrical data tables).
- Starting contactors for compressors and condenser fan motors
- Automatic pump down control.
- ON/OFF switch for each compressor.
- Control circuit breaker for short circuit protection.
- Circuit breaker for each compressor.
- Short cycling protection for compressors (time delay).
- Control transformer sized to supply the needs of the control circuit, sourcing power from the main unit power connection.
- Microprocessor control for full management of the chiller operation and safety circuits
- Control terminal strip for easy connection with electrical board and easy field installation.
- Head pressure control by the simple. ON/OFF condenser fan motor according to ambient temperature down to 7°C.

Optional features

Construction

- Chiller sound enhancement Options
  There are 3 options to enhance the chiller sound pressure level:
  a- Compressor compartment with standard fan
  b- Ultra low fan speed720 rpm/900 rpm (50/60Hz) and compressor with compartment
  c- Special design fan blades with external rotor motor and compressor with compartment.
  d- Insulation jacket around compressor.
- Coils protection material
  There are 3 options for coils material:
  a- Polyurethane precoated aluminum fins with copper tubes
  b- Copper fins with copper tubes
  c- Polyurethane post coat copper fins with copper tubes
- Galvanized steel wire mesh guard around the chiller's perimeter
- Cooler cladding can be aluminum, stainless steel or polyester painted (22 gauge) galvanized steel
- Cooler insulation:
- Cooler can be insulated with 1.5 inch or more thickness closed cell foam insulation.
- Chiller Vibration Isolation:

The following options are available for chiller vibration isolation:

a- Neoprene rubber pads
b- 1 inch Spring isolator

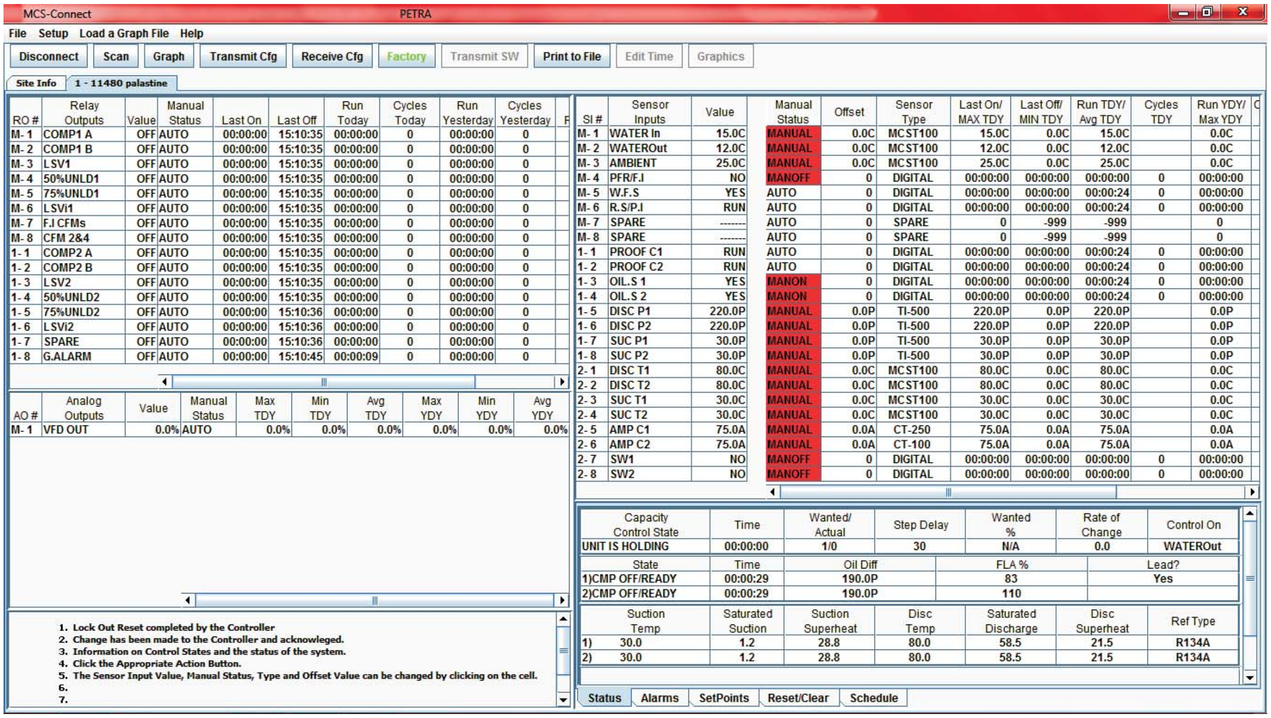
Refrigeration

- Cooler tape heater: Factory installed heater to protect cooler from freeze-up at low ambient down to (-20°F).
- Ice storage option: Special chillers are available for this option, please consult the factory for more details.
- Glycol option: Used for applications requiring water outlet temperature below 40°F.
- Suction valves for compressors larger than 90 HP.
- Suction accumulator.
- Liquid receiver.
- High pressure relief valve.
- Pressure gauges (High + Low).
- Water flow switch: Required as a safety interlock to prevent operation of the unit without evaporator flow (available for field installation only).
- Electronic expansion valve.

Electrical

- Low ambient head pressure control
  If the chiller is intended for use in low ambient conditions (below 7°C), low ambient control must be added. This can be achieved by varying the speed of the condenser fan motor by using a variable frequency drive. The speed of the condenser fan motor can be regulated with reference to the high-pressure sensor to maintain constant condensing pressure in the condenser.
- Unit mounted fused or non-fused disconnect service switch with external handle to isolate unit from power for servicing.
- Ground current protection for whole unit power supply. The current is monitored by toroidal coils around the power leads.
- Building automation system connection.
- External overload for each compressor.
- External overload for condenser fans.
- Ampere meter and/or voltmeter installed on the electric panel door.
- Circuit breaker for condenser fan motors.
- Main power circuit breaker for the whole unit with door isolator.
- Capablity of connecting two chillers to operate as one unit by using one controller.
- Chiller plant manager for multiple chillers to control chillers operation and operate their respective pumps and valves.
- Soft starter for Compressors.

Microprocessor controller



A screen shot showing various status information

MS-Windows © by Microsoft Corporation.

Displayed Data

- Leaving/Entering water temperature
- Ambient temperature
- Compressor discharge pressure/temperature
- Compressor suction pressure/temperature
- Compressor drawn current
- Suction/Discharge super heat
- Compressor load percentage
- Saturated suction/discharge
- Compressor oil diff
- Compressor timers
- Digital input status
- Output relays status
- Protections status
- Historical alarm
- Schedule
- Adjustable setpoint

System Control

The unit may be started or stopped manually, or through the use of an external signal from a Building Automation System. In addition, the controller may be programmed with daily and yearly start-stop schedule management.

Capacity Control Strategy

This control strategy is based on developing a control zone and then to step the compressor(s) through their stages to maintain the control sensor reading within this zone. To accomplish this, the system will constantly monitor the control value, its rate of change and position in relation to the control zone.

Soft Load Function

The compressors will start un-loaded to ensure soft start function, and then it will start loading gradually and according to load request, to prevent sudden load changing and save energy.

Compressor Efficiency

Because the most efficient compressor performance is at 100% load, PETRA has developed its own load/un-load strategy to provide an efficient performance. The number of compressors operating and the load percentage of each compressor will be monitored to achieve what is called the Optimum Capacity Limit to switch off compressors. Action will be taken after a certain programmable time delay.

Capacity Control Strategy

Compressor selection (activation) will depend on operating hours (automatic lead-lag management) to maintain the same operating hours for each compressor. Also, manual selection is possible.

In addition, the compressor's advanced time delay management avoids frequent ON/OFF switching for the compressor which ensures long life operation.

Head Pressure Control

PETRA provides analog output signals for fan speed controller (Option)

System Protections

PETRA provides special advanced software designed to be proactive; that is, to take corrective action to keep a safety condition from occurring. If a safety does occur, the software attempts to restart the unit when the system returns to normal. This approach eliminates most, if not all of the nuisance alarms that occur.

Alarms and Safeties

- Cutout and Un-loading:
- High discharge pressure
- High discharge temperature
- Low suction pressure
- Low suction temperature
- Freeze state
- High ampere state

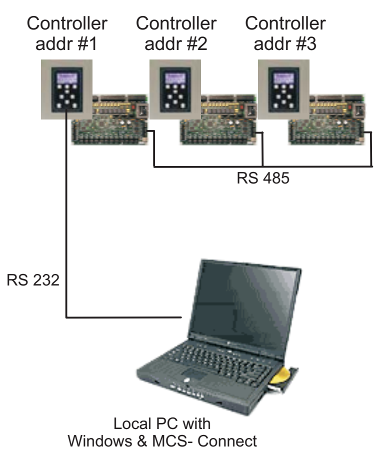
Other Alarms and Safeties

- Low discharge pressure
- Unsafe suction pressure
- Unsafe discharge pressure
- Flow switch (No flow protection)
- Phase loss protection
- Low differential oil pressure
- Unsafe oil pressure
- Low oil level
- Motor temperature
- Low motor amps
- Probe error alarm

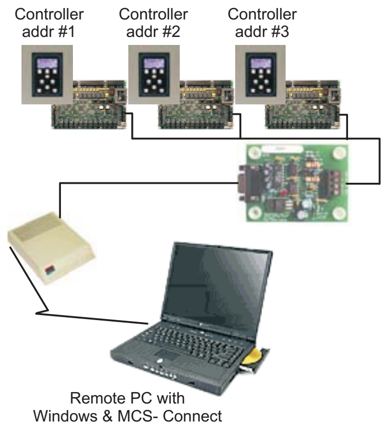
Communications & Building Management System

PETRA provides the user with **two options** in communicating with a Building Management system, as follows:

MCS 485 Network with local Rs232 communications:



MCS 485 Network with local Remote modem communications:



A. Communications

Within the communications structure there are two options as follows:

1. RS-232

This is usually used to connect to:

- A PC communicating at 19,200 baud via the MS Windows© based software package,'PC- Connect'.
- A modem communicating remotely over the telephone network at 14,400 baud.

2. RS-485

A three-position terminal block used to communicate with a Building Management System. As part of this capability BacNet, MODBUS, Johnson
Controls N2 built in controllers and LON Talk Communications capabilities are available Through Lon card option

B. Hard Wire

Within the hard wire structure there are six features as follows:

1. RUN / STOP - (BMS to controller)
2. EMER. STOP - (BMS to controller)
3. CHILLED WATER RESET - (BMS to controller)
4. DEMAND LIMITING - (BMS to controller)
5. COMPRESSOR RUN - (controller to BMS)
6. ALARM - (controller to BMS)

Installation

Unloading

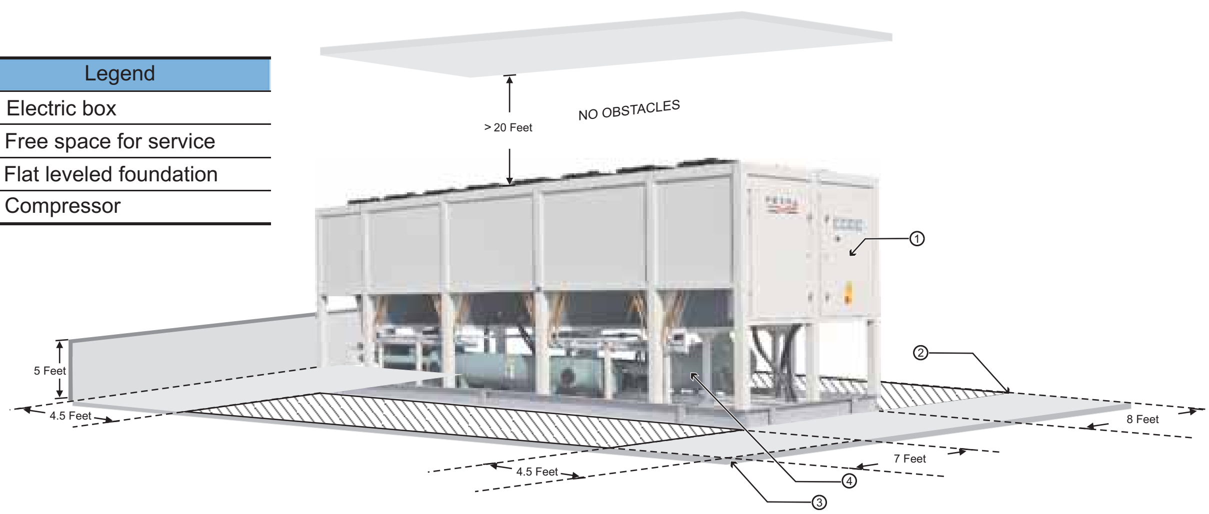
These units are designed for overhead rigging. So for proper unloading and handling, a suitable crane is needed. Use wear flex slings as shown in figure below. All units are supplied with lifting lugs on base sides. Spreader bars should be used to keep cables or slings clear from the unit sides to avoid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

Place the unit gently and without shock hazard

When installing the units consider the following points:

- Foundation should be made of flat-levelled concrete.
- Minimum free space beside the condenser coil.
- Minimum free space on both sides of the unit for service and maintenance.
- Free space of not less than 3000mm above the condenser fans should be available to prevent air short-circuiting.
- Once the unit is in place, check again that the unit is leveled, so that oil equalizes properly.

Legend	
1	Electric box
2	Free space for service
3	Flat leveled foundation
4	Compressor



Connection

Chilled Water Piping

Once the unit has been located in its final position, the chiller water piping may be connected. A typical water piping diagram for a water cooler is illustrated in figures on the next page. This diagram shows main components which should be used as follows:

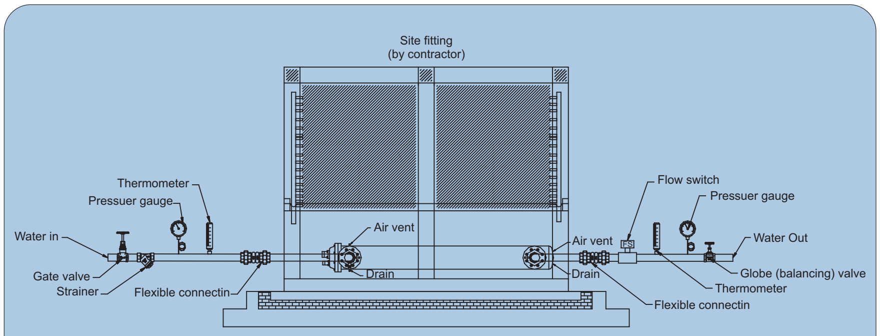
- Refer to "Cooler Connections" section for right size of piping.
- Stop valves should be installed in all lines to facilitate servicing.
- Flexible connections should be installed on the cooler inlet and outlet to ensure against transmission of water pipe vibration.
- Drain connections should be provided at drain connection of the cooler for complete drainage of the cooler.
- Air vent or small valves should be installed at the cooler.
- A strainer must be installed in the cooler inlet line just ahead of the cooler. This is important to protect the cooler from entrance of large particles which could cause damage to the evaporator. (Recommended 40 mesh strainer)
- Thermometers and pressure gauges should be installed in the inlet and outlet water lines.
- A chilled water flow switch must be installed in the leaving water piping of the cooler. There should be a straight horizontal run of at least 5 diameters on each side of the switch. Choose the right size of the flow switch blade which complies with the pipe in which it is installed. The switch to be wired to the specified terminals which are shown in the unit's wiring diagram.
- All piping works to and from the cooler must be designed taking into consideration the following:
  - Piping should be kept free of all foreign matters.
  - Avoid elbows, tees, and valves which decrease the pump capacity. All piping should be kept as straight as possible.
  - All piping must be supported independent of the chiller.
  - The chilled water piping system should be laid out so that the circulating pump discharges directly into the cooler. The suction for this pump should be taken from the piping system return line.
  - Flushing the chilled water piping from any foreign material before the system is placed into operation should be done without cooler connection to the system.

NOTE

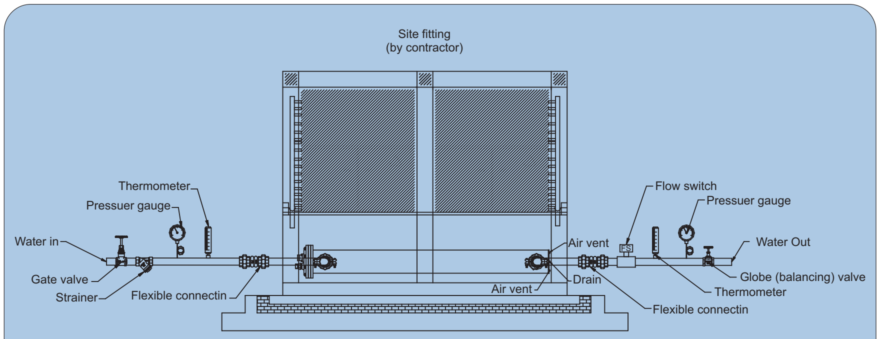
- For more details, please refer to:
  Petra catalogue (general data, performance table, chiller's layout, pressure drop curves, ..etc.).
- For chilled water piping and cooler connections, please refer to the figures on the next page.
- Pipe connection could be NPT up to 76 mm flange or flexible pipe victulic pipe joint on other.

CAUTION

Don't flush any foreign material into or through the cooler.
This should be done without cooler connection to the system.



Flange pipe connection



Flange pipe connection

Altitude correction factors

Capacity correction factors must be applied to standard ratings at altitudes above sea level using the multipliers on the right:

High Ambient Temperature

High outdoor ambient chiller start-up and operation is possible for chillers at ambient temperatures up to 125°F at nominal voltage (for standard units). For higher ambient temperature, please refer to PETRA factory.

Capacity Correction (Antifreeze)

Inhibited ethylene glycol (or any other suitable glycol or brine) should be used in installations where sub-freezing temperatures are expected (If this application is needed, please contact PETRA factory).

Unit Leveling

Unit must be leveled when installed to ensure proper oil return to the compressors.

Fluid Temperature

1. Maximum leaving chilled fluid temperature for unit is 50ºF. For continuous operation, it is recommended that inlet fluid temperature does not exceed 60ºF (If continuous operation is required for inlet water temperature above 60ºF, please refer to PETRA factory).
2. Minimum leaving chilled fluid temperature for a standard unit is 40ºF (for lower leaving temperature contact PETRA factory).

Condenser Airflow

Any restrictions on the unit's fan airflow will affect the unit's capacity, condenser head pressure, and compressor power input. Such restrictions (i.e. not providing vertical clearance or lateral clearance, insufficient unit-to-unit clearance) will cause warm air re-circulation or coil starvation. Minimum required operational and maintenance clearances around the unit are shown in the figure below.

Cooler Flow Range

Chiller ratings and performance data pertain to a cooling temperature rise of 10°F. Chillers may be suitable for operation in a range from 5.4 to 14.5°F temperature rise without adjustment, provided flow limits are within minimum limits on outlined in table below. High flow rate is limited by pressure drop that can be tolerated.

Minimum Cooler Flow: Based on the maximum permissible Δ T across the cooler 14.5°F.

Maximum Cooler Flow: Based on Minimum Permissible ΔT across the cooler 5.4°F.

Fluid loop volume: To obtain proper temperature control,the loop fluid volume must be at least 2.4 GPM/Ton based on a 10ºF difference in water/fluid temperature for chiller nominal capacity in air conditioning applications, taking into consideration the minimum system volume.

Cooler protection: A protection against low ambient freeze-up is required for ambient temperatures below 32ºF .

Protection should be in the form of:

1- Inhibited ethylene glycol or any other suitable glycol (Option).

2- Cooler is equipped with an electric heater tape that helps prevent freeze-up (Option).

Altitude [ft]	Correction Factor
Sea level	1
1000	0.995
2000	0.99
3000	0.985
4000	0.98
5000	0.973
6000	0.967
7000	0.96
8000	0.95

MODEL	Minimum cooler flow rate (GPM)		Minimum loop volume (Gallon)	
	50 Hz	60 Hz	50 Hz	60 Hz
APSa 50-1	78.2	89.2	562.8	642.0
APSa 55-1	85.2	96.7	613.2	696.0
APSa 60-1	84.8	98.5	610.8	709.2
APSa 65-1	93.7	108.0	674.4	777.6
APSa 70-1	101.5	116.2	730.8	836.4
APSa 70-2	103.5	118.0	745.2	849.6
APSa 75-1	114.7	132.2	825.6	951.6
APSa 80-1	126.0	144.5	907.2	1040.4
APSa 95-2	137.7	157.5	991.2	1134.0
APSa 95-1	138.2	158.2	994.8	1138.8
APSa 100-1	153.8	175.0	1107.6	1260.0
APSa 100-2	154.2	175.2	1110.0	1261.2
APSa 110-2	164.7	188.5	1185.6	1357.2
APSa 120-2	172.8	197.5	1244.4	1422.0
APSa 125-2	181.0	205.8	1303.2	1482.0
APSa 135-2	199.5	227.8	1436.4	1640.4
APSa 140-2	212.3	241.5	1528.8	1738.8
APSa 145-2	222.0	254.7	1598.4	1833.6
APSa 160-2	235.0	268.0	1692.0	1929.6
APSa 165-2	244.8	278.5	1762.8	2005.2
APSa 175-2	259.2	293.0	1866.0	2109.6
APSa 190-2	267.7	303.5	1927.2	2185.2
APSa 195-2	282.2	318.8	2031.6	2295.6

MODEL	Minimum cooler flow rate (GPM)		Minimum loop volume (Gallon)	
	50 Hz	60 Hz	50 Hz	60 Hz
APSa 200-2	292.2	332.0	2103.6	2390.4
APSa 210-2	305.8	347.0	2202.0	2498.4
APSa 220-2	318.7	363.5	2294.4	2617.2
APSa 235-2	341.8	387.5	2461.2	2790.0
APSa 245-2	362.5	408.0	2610.0	2937.6
APSa 250-2	374.5	422.5	2696.4	3042.0
APSa 260-2	389.2	440.8	2802.0	3174.0
APSa 275-2	402.7	456.8	2899.2	3289.2
APSa 290-2	408.2	461.7	2938.8	3324.0
APSa 300-2	423.3	481.2	3048.0	3464.4
APSa 310-3	464.7	528.2	3345.6	3802.8
APSa 325-2	504.7	574.0	3633.6	4132.8
APSa 345-4	518.2	585.8	3730.8	4218.0
APSa 360-4	535.5	607.0	3855.6	4370.4
APSa 380-4	564.3	637.8	4063.2	4592.4
APSa 385-3	567.8	643.2	4088.4	4630.8
APSa 390-4	578.2	651.8	4162.8	4693.2
APSa 400-4	584.3	663.8	4207.2	4779.6
APSa 410-4	599.5	678.7	4316.4	4886.4
APSa 415-4	611.7	693.8	4404.0	4995.6
APSa 465-4	637.3	727.0	4588.8	5234.4
APSa 470-4	671.5	756.5	4834.8	5446.8
APSa 480-4	683.5	775.0	4921.2	5580.0
APSa 500-4	753.8	853.6	5407.8	6123.6

Unit Check Before Starting

- Insure that all piping has been completed.
- Check for refrigerant piping leak.
- Open suction, discharge and liquid line valve for each system.
- The compressor oil level should be maintained so that an oil level is visible in the sight glass The oil level can only be tested when the compressor is running in a stabilized conditions. In this case, the oil should be between ¼ and ¾ in the sight glass. At shut down oil level can fall to the bottom limit of the oil sight glass.
- Insure that the water pumps are ON.
- Check and adjust water pump flow and pressure drop across the cooler. Verify flow switch operation.
- Check the control panel and compressor electrical box to assure it's free of foreign material.
- Be certain all water temperature sensors are inserted completely in their respective wells and are coated with heat conductive compound.
- The main cable for the power supply of the unit is as the manufacturer recommendation (refer to the electrical data table for unit ampacity to select the main power supply cable).
- Proper disconnect switch is installed beside the unit for emergency or for maintenance purposes. (Refer to electrical data tables for proper size).
- The chiller is supplied through main power circuit breaker or non fused disconnect switch (refer to the electrical data table for the proper selection of the circuit breaker size).
- All field connection wiring is connected properly to the control terminal such as:
  - Water flow switch signal
  - Pump inter lock signal
  - General alarm signal
  - Remote switch signal
- Refer to electrical field wiring for more information. Also it is important to refer to the wiring diagram for the exact field wiring connection. (Field connection is represented by dash dot lines on the wiring diagram)
- Make sure that there are no obstacles available that may stop the condenser fan(s).
- Inspect visually for any loose wires.
- Check CFM rotation direction after commitioning.

Before Starting the Unit

- Check the electrical connection for tightness.
- Switch on the main power supply.

Use the following formula to determine the present voltage imbalance:

Example: Present Voltage Imbalance

$$100 \times \frac{\text{Max. Voltage Deviation}}{\text{Average Voltage}}$$

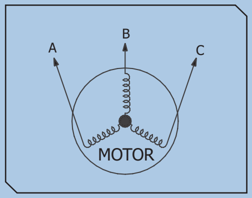
Supply voltage = 380 volt/3ph/50Hz
AB = 383 volt
BC = 376 volt
AC = 378 volt

$$\text{Average Voltage} = \frac{383 + 376 + 378}{3}$$

=379 volt

Determine maximum deviation from average voltage:

AB = 383 - 379 = 4v
BC = 379 - 376 = 3v
AC = 379 - 378 = 1v



Maximum deviation is [4v]. Determine present voltage imbalance:

$$\text{Voltage imbalance} = 100 \times \frac{4}{379} = 1.0\%$$

The amount of phase imbalance is satisfactory, as it is below the maximum allowable phase imbalance value [2%]

CAUTION

Check that the voltage monitor [Phase Failure Relay Lamp] is giving a green LED. If hot, the device will give a red LED to indicate failure with the main power supply.

NOTE

Contact your local electric utility company immediately if supply voltage phase imbalance is more than ± 2%.

Operation

Unsafe Suction Pressure

This safety is similar to the low suction pressure safety except this set point can be set up with a lower value and a very short safety time. If the suction pressure drops below the value of the set point or the digital input turns ON and it remains there for the time specified in the safety time of that set point, the compressor will be locked out and a low suction alarm generated. This safety will always cause a lock out on the first trip requiring a manual reset to restart the compressor. For the firsts minutes after the compressor has started the safety time is extend by twice the normal time delay, this enables the set point safety time to be set much tighter for normal operation.

Low Discharge Pressure

If the discharge pressure drops below the value of the set point and it remains there for the time specified in the safety time of that set point, the compressor will be locked out and a low discharge alarm generated.

High Discharge Pressure

If the discharge pressure raised above the value of the set point or the digital input turns ON and it remains there for the time specified in the safety time of that set point, the compressor will be locked out and a high discharge alarm generated.

High Discharge Temperature

If the discharge temperature analog input rises above the value of the set point or the digital input turns ON and it remains there for the time specified in the safety time, the compressor will be locked out and a high temperature alarm generated.

Hi Motor Temperature or Motor Fault

If the high motor temperature input rises above the value of the set point or the digital input turns ON and it remains there for the time specified in the safety time, the compressor will be looked out and a high motor temperature or motor fault alarm generated.

Hi Oil Temperature

!f the oil temperature rises above the value of the set point or the digital input turns ON and it remains there for the time specified in the safety time of that set point, the compressor will be locked out and a high oil temperature alarm generated.

Hi Motor Amp

If the ampere analog input rises above the value of the set point or the digital in put turns ON and it remains there for the time specified in the safety time of that set point, the compressor will be locked out and a high motor amp alarm generated. This safety is bypassed for the first 3 seconds after a compressor has started.

Low Motor Amp

!f the ampere analog input drops below the value of the set point and it remains there for the time specified in the safety time of that set point. the compressor will be locked out and a low motor amp alarm generated. This alarm can be used to indicate low refrigerant. This safety is bypassed for the firsts seconds after a compressor has started.

No Compress Proof

If a compressor is called to be on and the compressor proof input is OFF (this is a digital input), a NO COMP PROOF alarm will be generated.

Operation Limitations

Temperature

If the unit is to be used in an area with high solar radiation, it should be mounted so that the control box is not exposed to direct solar radiation. (Refer to the Temperature Table below)

Temperature Table	°C
Maximum Ambient Temp	52.0
Maximum Cooler [EWT]*	15.5
Minimum Cooler [LWT]**	3.3

* EWT: Entering Water Temperature
** LWT: Leaving Water Temperature
[But for brine chiller application the minimum cooler LWT will be lower]

Maintenance

Preventive Maintenance

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

Weekly

After the unit has been operating for approximately 30 minutes and the system has stabilized, check the operating conditions & complete the procedures below:

- Check the evaporator refrigerant pressure & the condenser refrigerant pressure.
- Check the liquid line sight glasses. The refrigerant flow past the sight glasses should be clear. Bubbles in the refrigerant indicate either low refrigerant charge or excessive pressure drop in the liquid line.
- If operating pressure and sight glass conditions seem to indicate.
- refrigerant shortage, measure the system superheat and system sub-cooling.
- If operating conditions indicate a refrigerant overcharge, remove refrigerant at the liquid line service valve. Allow refrigerant to escape slowly, to minimize oil loss. Do not discharge refrigerant into the atmosphere.
- Measure the power supply voltage, compressor and fan running amperes.
- Inspect the entire system for unusual conditions and inspect the condenser coils for dirt and debris.

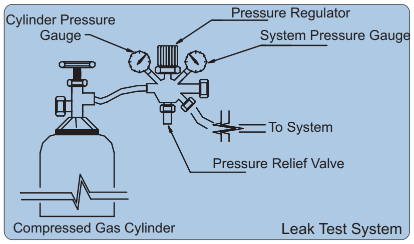
Annual Maintenance

- Perform all weekly maintenance procedures.
- Have a qualified service technician to check the setting & function of each control.
- Inspect the condition of compressor & control contactors and replace as required.
- Inspect all piping components for leakage and damage.
- Clean and repaint any areas that show signs of corrosion.
- Inspect electrical wiring condition and tighten any loose connections.
- Clean the condenser coils.
- Clean the condenser fans, check the fan assemblies for proper clearance in the fan openings and for motor shaft misalignment, abnormal and play, vibration & noise.
- Check the oil level.

Leak Test System

All units should be under sufficient pressure to conduct a leak test after installation. If there is no system pressure, admit nitrogen into the system until some pressure is observed and then proceed to test for leaks. After leaks are repaired the system must be dehydrated.
Use dry nitrogen and refrigerant to raise the system pressure up to 1035kPa. The procedure

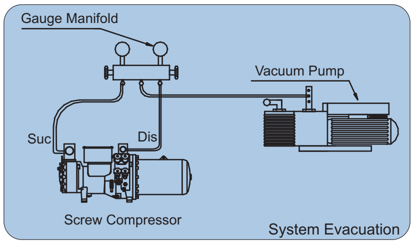
requires a separate relief valve with gauge set and a gas cylinder.
With the compressed gas cylinder in the upright position, admit the dry nitrogen slowly until the desired pressure is obtained. Carefully check the complete system for leaks by means of soap bubbles. Where bubbles appear, a leak exists.
Check at all points that are expected to leak, such as flare connections, flanges, quick coupling, brazing, joints..etc. Leave the system for a certain time and watch the gauge for any drop in reading. When the test is complete, system pressure should be reduced to 0KPa the compressor is evacuated and charged with the proper kind of refrigerant.



Leak Test System

System Evacuation

System evacuation is considered the most important process to prepare the unit for charging and to remove both air and moisture from the system.



System Evacuation

1. Connect gauge manifold to the system.
2. Purge all pressure from the system by opening the system valve[s] and the gauge manifold hand valves.
3. Connect the center hose on the gauge manifold to the vacuum pump.
4. Start the vacuum pump.
5. Close OFF the gauge manifold hand valve.
6. Stop the vacuum pump but not before closing the gauge manifold hand valves.
7. Disconnect the center hose of the gauge from the vacuum pump and connect it to a cylinder containing the proper type of refrigerant.
8. Open cylinder valves and loosen the center hose at gauge manifold. Purge the hose for a few seconds then tighten the connection.
9. Close the refrigerant cylinder valves and admit refrigerant into the system until a pressure of about 35kPa is indicated on the gauges.
10. Disconnect the hose from the cylinder.
11. Open the gauge manifold hand valves and purge the pressure from the system.
12. Repeat steps 3 through 13.
13. Repeat steps 3 through 9 only.
14. Open the gauge manifold hand valves and admit refrigerant into the system cylinder. Pressure is indicated on the gauges.
15. Close the high side gauge manifold hand valves.
16. Start the unit and add the proper charge of refrigerant.

Refrigerant Charge

The unit is charged with the refrigerant for which it is designed. Efficient operation of an air-conditioning unit depends on the correct charge of refrigerant by weight. In case of an under charged unit, the evaporator is starved of refrigerant, which leads to low compressor suction pressure, loss in output and perhaps overheating of the compressor motor, in case of suction gas cooled compressors (high superheat). Overcharging the unit can lead to condenser overflow and thus too high condenser pressure, to evaporator flooding and possibly to compressor damage due to liquid coming into the compressor.
Sudden pressure in the condenser indicates exceeding the pumping capacity of the unit and filling of the condenser with liquid, increased cooling of suction line as well as an increase in noise of the working valve in the compressor. Liquid knocking also indicates unit overcharge or incorrect adjustment and/or incorrect function of the control system. Gaseous refrigerant is only
Charged if small quantities are intended. Refrigerant bottles with double or single valves stand
Upright and refrigerant is charged by means of the pressure gauge connection in the compressor suction shutoff valve. When doing so, check condenser pressures when charging liquid refrigerant and determine charging weight. If cylinder pressure drops too low for further charging before the job is finished, place cylinder in a bucket of warm (25° - 45°C) water, or use a heat lamp to increase pressure. Do not apply heat with a torch. Never heat cylinder above 50°C.

CAUTION
Never heat bottles with the flame of the lamp such as a Bunsen or welding burner.

The process used most often to determine the correct refrigerant quantity is by observing the refrigerant flow in the sight glass in the liquid line. Since an uninterrupted supply of liquid is necessary for the proper functioning of expansion valves, it may be assumed that the unit has been correctly filled when a clear flow of liquid refrigerant is visible. Bubbles or foam usually indicate insufficient refrigerant. However, care should be taken that no bubbles are seen in the sight glass, even though, the unit has been fully filled. Additionally the temperature in the condenser could also lead to sudden evaporation, e.g. by switching the fan ON at the condenser. Thus, the sight glass is a valuable device in determining the correct filling quantity.
After all field connections (electrical and mechanical) have been completed and the system has been evacuated, the system can be fully charged with refrigerant in two ways as shown below.

Importance of proper charging

The main job of a service engineer is to upkeep modern, mechanical cooling system running. It is essential to know the proper way to handle refrigerant to all types of systems. All systems do not use the same refrigerant. All systems do not use the same amount of charge even when capacities may be entirely comparable.

Check the name-plate on factory - assembled systems

All manufacturers include a name-plate that clearly lists the refrigerants for which the system was designed. How much charge to use will vary widely from system to system. This makes it doubly important always to check the catalogues & service bulletins.

Vapor Charging

Do not charge blends in vapor phase. This means that the refrigerant should be removed from the cylinder as a liquid (either from the dip tube in a two valve cylinder or by inverting the cylinder). The liquid is allowed to evaporate (flash) in the charging lines. Small systems with a single component refrigerant such as 134a are usually charged through the gauge port of the compressor suction service valve.
Normal procedure is:.

1. Back-seat suction service valve as for normal operation.
2. Loosely connect line from service manifold to suction service valve gauge port.

3. Connect center line from manifold to the refrigerant cylinder.
4. Back-seat discharge service valve
5. Loosely connect remaining line from service manifold to discharge service valve gauge port.
6. Slightly open cylinder valve to purge vapor up to the compressor discharge service valve.
7. Tighten discharge service valve connection at gauge port.
8. Purge vapor from cylinder up to compressor suction service valve.
9. Tighten suction service valve connection gauge port. Open both compressor service valve.
10. Place cylinder of refrigerant on weighing scale.
11. Pressurize system to full cylinder pressure and make final leak check.
12. Start compressor. Run unit head pressure and suction pressure stabilize. Open the cylinder valve completely and control the flow of refrigerant from the manifold.
    From time to time, note suction pressure with the cylinder valve closed. From time to time note discharge pressure to see that it does not rise above the level normally expected under operating conditions. For air-cooled system, the discharge pressure should be approximately the pressure corresponding to ambient temperature plus 10°C (refrigeration) to 17°C (air conditioning).
13. When correct weight of refrigerant has been introduced, close cylinder valve and disconnect charging line.
14. When satisfied that the system is operating as it should, back-seat both suction and discharge service valve. Bleed pressure from both gauge lines through the manifold charging port.
15. Replace cylinder valve cap and fit flare plugs in open ends of charging and gauge lines. Replace plugs in gauge ports of compressor service valve.

NOTE

1) If possible, refrigerant should always be charged by weight, using a good scale.
2) If cylinder pressure drops too low for further charging before the job is finished, place cylinder in a bucket of warm (25-45°C) water, or use a heat lamp to increase pressure. Do not apply heat with a torch. Never heat cylinder above 52°C.

Liquid Charging

Charging the refrigerant in the liquid phase has always been customary for larger systems. It is essential for charging blend refrigerants. If a complete charge is to be added to an evacuated system the liquid is frequently charged through the compressor discharge service valve. The compressor is not operated while charging. The procedure for attaching the manifold and purging the lines is similar to that described for vapor charging. On most systems, a charging port is located on the liquid line downstream from the receiver. In this case, refrigerant can be added while the system is not operating. General suggestions will not always apply to specific operations but the following outline may be helpful.

Connect the refrigerant cylinder to the charging port

Connect the refrigerant cylinder to the charging port. Use as short a line as possible to minimize water contamination or use a drier if indicated by conditions. The cylinder should be upside down if it does not have a liquid/ vapor valve. Install a pressure gauge so that the compressor discharge pressure can be observed.

Crack cylinder valve and purge charging line

With the connection to the charging port loose, crack cylinder valve and purge charging line with refrigerant using the VAPOUR hand wheel of a cylinder fitted with a liquid/ vapor valve. Tighten connection, open cylinder valve and check for leaks.

Close the valve at the receiver outlet

Close the valve at the receiver outlet or if there is no receiver close the valve in the liquid line upstream from the charging port. This is necessary to prevent the condensing pressure from forcing liquid into the cylinder.

Slowly open the charging port valve and charge liquid

With the compressor running , slowly open the charging port valve and charge liquid using the LIQUID hand wheel at a rate fast enough to keep the compressor from cutting out on low-pressure control if possible. The refrigerant flow can also be controlled by the cylinder valve to avoid ending up with a hose full of liquid refrigerant, The same result can be obtained by closing the cylinder valve first when charging is finished.

Watch the discharge pressure

Watch the discharge pressure. A rapid rise in pressure indicates, that the condenser is filling with liquid. If this is the case, the system pump-down capacity still seems low on charge, an auxiliary receiver may be needed.
When the proper weight of refrigerant has been added, close the cylinder valve and let the low-pressure control stop the compressor.
Close the charging port valve and vent refrigerant vapour from the hose by loosening connection.
Open the liquid line valve or receiver outlet valve and check the operation of the system.
Replace cap on cylinder valve and charging valve. Plug both ends of the charging hose or manifold so it will be clean for the next use.

CAUTION

1- Never charge the liquid in the low pressure side of the system.
2- Don't overcharge. Overcharging results in higher pressure, possible compressor damage and higher power consumption.
3- During charging or removal of refrigerant, be sure water/fluid is continually circuiting through the cooler to prevent freezing. Damage caused by freezing is considered abuse and may void PETRA warranty.

System Pump Down

This procedure is used to isolate the refrigerant in the condenser coil. This process can be utilized for maintenance, repairs and long periods of shutdown.
Pump down procedure:

- Install pressure gauge in the unit, if not installed.
- Install a jumper across the terminals of the low pressure cutout.
- Operate the unit.
- Start closing the shut off valve while the unit is operating.
- When low pressure gauge reaches about 4.5 Kpa shut down the unit.
- Immediately close the compressor suction valve.
- Remove the jumper from the low pressure cutout.
- Repeat the above for 2 or 3 times.
- Repeat the above for 2 or 3 times.

Maintenance

Changing Filter Drier Core

The main function of the filter dryer is to eliminate any humidity or deposits inside the system. When the filter is blocked, a certain pressure drop across the filter occurs and a temperature difference between the liquid in/out and the filter can be sensed. In this case the filter has to be changed.
The process is as follows:

- System pump down procedure has to be carried out.
- Remove the screws and the filter cover.
- Take out the old core.
- Clean the filter shell.
- System pump down procedure has to be carried out.
- Remove the screws and the filter cover.
- Take out the old core.
- Clean the filter shell.
- Use a new core(s) and cover the filter tightly.
- Evacuate the low pressure side (do not forget to open solenoid valve).
- Open all valves.
- The unit is ready to start.

Compressor Oil

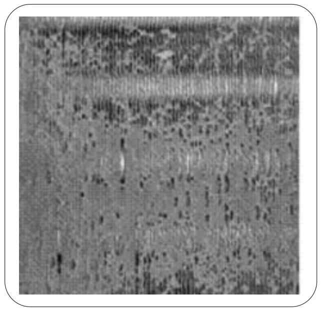
All units are factory charged with oil. The approved oils to be added upon need are:
For APSa series units: BSE 170 OR Equivalent.

CAUTION

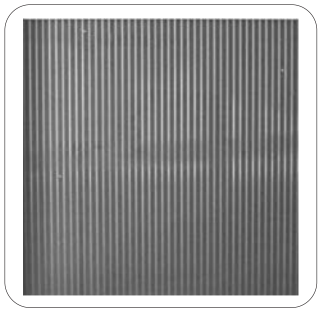
Do not re-use drain oil and do not use any oil that has been exposed to the atmosphere.

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

For coil combing:

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

Final Check

Before leaving the unit, check the following:

- Oil level can be seen in the sight glass of the compressor.
- All controls and protective devices function properly.

Cleaning the Evaporator

The chilled water system is a closed-loop and therefore should not accumulate scale or sludge. If the chiller becomes fouled, first attempt to dislodge the material by back flushing the system.

Water Flow Limits

Evaporated flow rates below the tabulated values will results in laminar flow causing freeze-up problems, scaling and poor control. Evaporator water flow rates exceeding those listed may result in excessive tube erosion.

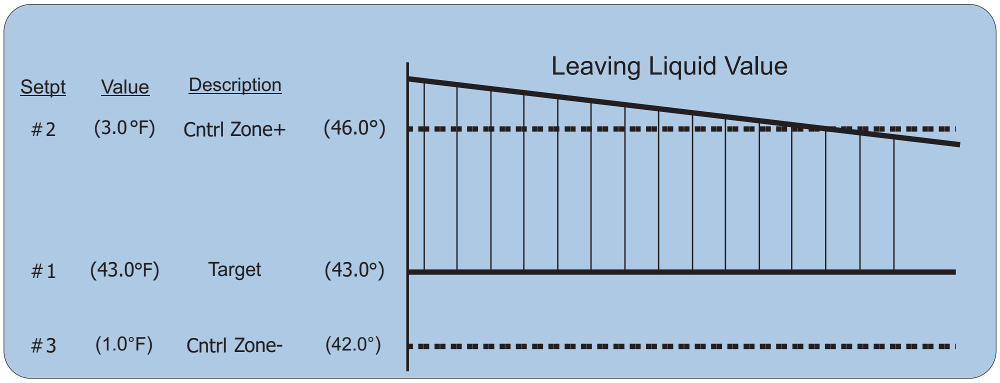
NOTE

The use of improperly treated or untreated water in this equipment may result in scaling, erosion, corrosion, algae or slime.

Sequence of operation

The APS chiller depends on its on-board microprocessor for control. For initial start-up, the following conditions must be met:

- Chilled water pump-running.
- Chilled water flow switch-made.
- Customer control contact-closed.
- Compressor switches-ON.
- Control circuit breaker-ON.
- Main system voltage-ON.
- All safety conditions-satisfied.
- Compressor time delay-elapsed.
- Leaving chilled water temperature-above setpoint.



The system will attempt to keep the control value within the control zone that has been developed by calculating the required system capacity. The system's capacity will be based on the number of circuits (compressors) that are required to operate. The system will adjust the required capacity between the minimum and the maximum values. All the compressors that are operating will be synchronized to meet the system's capacity. When the maximum capacity value has been reached, an additional compressor, if available, will be required to operate. The number of compressors required to operate will be increased by one and the system's capacity will be set to the minimum value and the sequence will begin again.
The number of compressors operating and the load percentage of each compressor will be monitored to achieve what is called the Optimum Capacity Limit to switch off compressors. Action will be taken after a certain programmable time delay.
When the minimum capacity value has been reached, a compressor will be turned off. The number of compressors required to operate will be decreased by one and the system's capacity will be set to the maximum value and the sequence will began again.
The compressor slide control is based on the current drawn from that compressor. For example, if the current drawn is greater than the capacity indicated, then the compressor is unloaded. Conversely, if it is less, then it is loaded.
The compressors that are operating can be loaded, where their load solenoids are pulsed; unloaded where their unload solenoids are pulsed or in a hold state, where no action is required.
(compressor) reflects this action.
When the water temperature falls below the setpoint, the compressor will shut down.

Safety considerations

Freeze Protection

If the leaving liquid temperature drops below the set point value the system, and all circuits, will enter a lockout state and a freeze notification alarm will be generated.

<u>Note</u>:you have the option of one freeze protector the package or individual freeze protections by circuit. This is selected in the PC-Config program.

No Flow Protection

If the flow switch is for the chiller system, then the entire system will be shut down with the LOCK OUT state if set point "PUMP FAFLURE" is an active lockout type of set point. If the set point is inactive, the system will determine if there is a second pump, if so it will be started. Else, the system will be shut down and automatically restarted when the flow switch is on. indicating that there is flow, If the flow switch is for the individual circuit, then that circuit will be locked out.

Phase Loss Protection

Phase loss, as indicated by the phase loss monitor, will result in the system and all circuits being locked off and a phase loss notification alarm will be generated. No set point is required.

Emergency Stop

Emergency stop, as indicated by the emergency stop switch, will result in the system and all circuits being locked oft and an emergency stop notification alarm will be generated. No set point is required.

Low Differential Oil Pressure

This safety is designed to meet the compressor manufacturer requirements on oil pressure. For the first 5 seconds following a compressor start this safety is NOT checked. For the next 30 seconds, if the oil differential pressure drops below of the value of the set point or the digital input turns ON and it remains there for the time specified in the safety time of that set point, the compressor will be locked out and a low oil alarm generated. After this time period, if the oil differential pressure drops below the value of the set point and it remains there for the time specified in the safety time, the compressor will be locket out and a low oil alarm generated. This enables the set point value and the safety time to be much tighter. This safety is interrogated when the compressor is ON and not in a pump down state.

Low Suction Pressure

If the suction pressure drops below the value of the set point or the digital input turns ON and it remains there for the time specified in the safety time, the compressor will be locked out and a low suction alarm generated. For the first 3 minutes after the compressor has started the safety time is extend by 2 minutes, this enables the set point safety time to be set much tighter for normal operation. This safety can also be used as a freeze protection based upon the suction kPa.

Unit Operation Check list

Running Check List

Model:	Address:
Project No:	

OPERATION CONDITIONS	READING
Unit Operation Mode	
Running Time After Stabilization	
Pressure Drop At Cooler	(Pa)
Evaporator Flow Rate	(CFM)
Condenser Flow Rate	(CFM)
Ambient Temperature	(°C)
Compressor Running Operation	
Frequency	(Hz)
Entering Wet Bulb Temp.	(°C)
Leaving Wet Bulb Temp.	(°C)
Humidity %	

REFRIGERATION TEST	READING
Refrigerant Charge Type	
Refrigerant Charge Weight	(Kg)
Condenser Inlet Temperature	(°C) (Air/Water)
Condenser Outlet Temperature	(°C) (Air/Water)
Evaporator Inlet Temperature	(°C) (Air/Water)
Evaporator Outlet Temperature	(°C) (Air/Water)
Discharge Pressure	(Kpa)
Liquid Line Pressure (At Shut Off Valve)	(Kpa)
Suction Pressure	(Kpa)
Discharge Temperature	(°C)
Liquid Line Temperature (Before Exp. Valve)	(°C)
Suction Temperature	(°C)
Sub Cooling	(°C)
Evaporator Superheat	(°C)

ELECTRICAL TEST	READING
System Voltage At Test ± 10%	R-S: R-T: S-T:
Compressor Running	(A)
Condenser. Fan Motor Running	(A)
Evaporator Blower Motor Running (Supply)	(A)
Evaporator Blower Motor Running (Return)	(A)
Earth Continuity	Ok: Not Ok:
Insulation Test	Ok: Not Ok:

Start Up Check list

Start Up Checklist (before operating the unit)

Project Name:	Date:
Customer Name:	Project No.:
Model:	Address:
Signature:	

Location of Machine	YES	NO	COMMENTS
Check if there is minimum 2 meters distance between the machine and any restricting surface			
Check if all components of machine easily accessible and serviceable			
Check the Leveling of machine			
Check for any leftover cardboard pieces or packing material on evaporator coil			

Condition of Machine	YES	NO	COMMENTS
Check if any refrigerant line broken			
Check if there are any gas or oil leaks in system			
Check if protection devices in electric panel operate properly			
Check if all mechanical protection devices operate properly			
Check if evaporator fans are rotate freely			
Check if pulleys are properly fixed in place			
Check if pulley belts loose			

Electrical Connections	YES	NO	COMMENTS
Check the cable size and compare it with the design			
Check wiring system if there is any loose			

Water System	YES	NO	COMMENTS
Check the connection between the control circuit and the pump contactor			
Check the pump compatible with requirement of unit. And what is amount of water that pumps is pumping			
Check the pressure gauge and globe valve at pump exit			
Check the air release valves on water lines			
Check the connections between cooler and water circuit			
Check the temperature sensors on cooler entering and leaving water lines			

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			

Troubleshooting

Use the tables in this section to assist and help you in identifying the cause or causes of any malfunctions in the unit's operation. The column headed RECOMMENDED ACTION will suggest repair procedures.

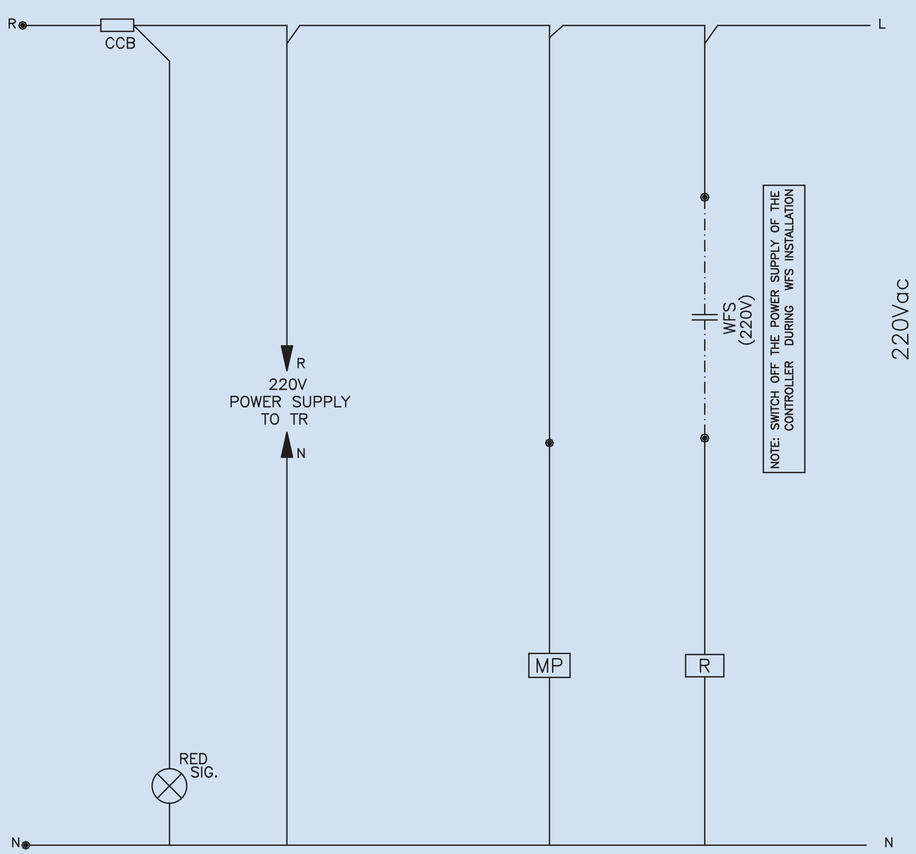
CAUTION

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

Source of Trouble	Possible Causes	Corrective Steps
1. Compressors fails to start	a. Main switch open b. Thermal lockout relay opened c. Defective contactor d. System shut down by safety devices e. Thermostat set too high f. Liquid line solenoid will not open g. Motor electrical trouble h. Loose wiring	a. Close switch b. See point 11. c. Repair or replace d. Determine type and cause of shutdown and correct it before resetting safety switch e. Check evaporator temperature. Lower thermostat setting, if possible without freeze-up f. Repair or replace g. Check motor for opens, short circuits or burn-out h. Check all wire junctions. Tighten all terminal screws
2. Compressor noisy or vibrating	a. Improper isolation b. Improper piping support c. Improper clearances d. Flooding of refrigerant into crankcase e. Motor rotor is loose (SRC)	a. Check isolator operation b. Relocate, add, or remove hangers. c. Running gear worn. Overhaul compressor and replace defective parts d. Check rating and setting of expansion valve e. Check key fit and tightness of rotor locking bolt
3. High discharge pressure	a. Discharge shut-off valve partially closed b. High ambient temperature c. System overcharged with refrigerant d. Excessive loading e. Non condensibles in system	a. Open valve b. Provide cooler air to condenser c. Remove excess d. Reduce load e. Purge the non-condensibles
4. Low discharge pressure	a. Suction shut-off valve partially closed b. Insufficient refrigerant in system c. Low suction pressure d. Compressor operating unloaded e. Worn Discharge service	a. Open valve b. Check for leaks. Repair and add charge c. See point 6. d. See corrective steps for failure of compressor to load up. See point 8. e. Ovehaul compressor
5. High suction pressure	a. Excessive load b. Expansion valve over feeding c. Compressor operating unloaded	a. Reduce load or add equipment b. Regulate superheat. Check valve Rating against the application c. See point 8.

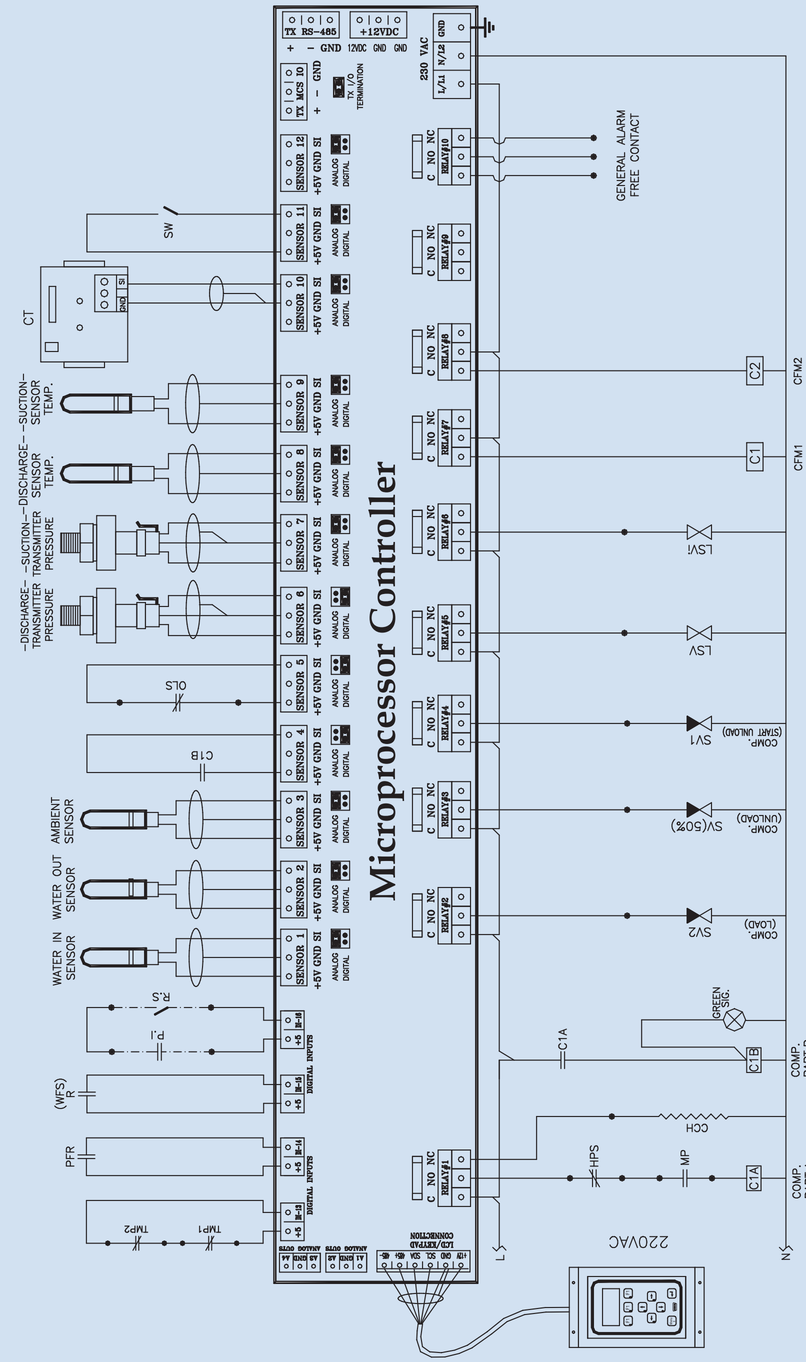
6. Low suction pressure	a. Chilled water pump not operating b. Lack of refrigerant c. Evaporator dirty or iced up. d. Clogged liquid line filter drier e. Expansion valve malfunctioning f. Condensing temperature too low g. Chiller pump off	a. Check and start pump b. Check for leaks. Repair and add charge c. Clean or defrost d. Replace cartridge(s) e. Check and reset for proper superheat. Repair or replace if necessary f. See corrective steps for failure of compressor to unload. See point 7 g. Check. Add interlock
7. Compressor will not unload	a. Defective capacity control b. Unloader mechanism stuck. Unloader lifting pins worn	a. Replace b. Replace cylinder liner unloader assembly
8. Compressor will not load up	a. Defective capacity control	a. Replace
9. Compressor loses oil	a. Shortage of refrigerant b. Low suction pressure c. Expansion valve stuck open d. Restriction in refrigeration system	a. Repair leak and recharge system with refrigerant and oil b. See entry “low suction pressure” c. Repair or replcae expansion valve d. Locate restriction and remove
10. Internal thermal protection lockout opened	a. High condensing temperature b. Low voltage during high load condition c. Loose power wiring d. Defective relay e. Defective or grounded wiring in motor or power circuits f. Power line fault causing single phase running or unbalanced voltage g. Failure of second starter to pul up-on partwinding system	a. See corrective steps for high discharge pressure b. Check supply voltage and for excessive line drop c. Check all connections and tighten d. Replace e. Repair or rewire f. Check supply voltage. Notify power company. Do not restart until fault is corrected g. Repair or replace contactor or time delay mechanism
11. Compressor “short cycles”	a. Thermostat differential set too close b. Leaky solenoid valve c. Overcharge of refrigerant d. Lack of refrigerant	a. Check evaporator temp. Reset differential ensuring that there is no freeze up b. Replace solenoid valve c. Remove excess d. Check for leaks. Repair and add charge
12. Motor overload relays open	a. Defectve relay assembly b. Low voltage during high load condition c. Locked compressor d. Defective or grounded wiring in motor e. Loose power wiring	a. Repair or replace b. Check supply voltage and for excessive line drop c. Overhaul compressor d. Repair or rewire e. Check all connections and tighten

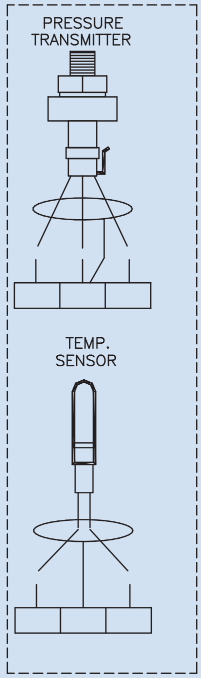
Control Diagram



WARNING : RISK OF ELECTRIC SHOCK CAN CAUSE INJURY OR DEATH:
DISCONNECT ALL REMOTE ELECTRIC POWER SUPPLIES
BEFORE SERVICING.

Control Diagram





Lists & Tables

LEGEND			
COMP.	Compressor	HPS	High Pressure Switch.
CFM	Condenser Fan Motor	TR	Transformer
CCB	Control Circuit Breaker.	R.S	Remote Switch
TMP	Thermal Motor Protector.	OLS	Oil Level Switch
C	Contactor.	SV	Sliding Valve
PFR	Phase Failure Relay.	WFS	Water \flow Switch
CCH	Crankcase Heater.	LSVi	Liquid Solenoid Valve Injection
LSV	Liquid Solenoid Valve.	⦿n	Terminal Number.
MP	Motor Protector	⊗	Signal Lamp
PI	Pump Interlock	Wn	Wiring Number.
CT	Current Transformer	———	Field Connection.
SW	Switch		

PFR INDICATOR LIGHT DIAGNOSTICS	
RUN	GREEN
RESTART DELAY	GREEN
REVERSE PHASE	RED
UNBALANCE / SINGLE PHASE	RED
HIGH / LOW VOLTAGE	RED

MCS DISPLAY

ALARM:

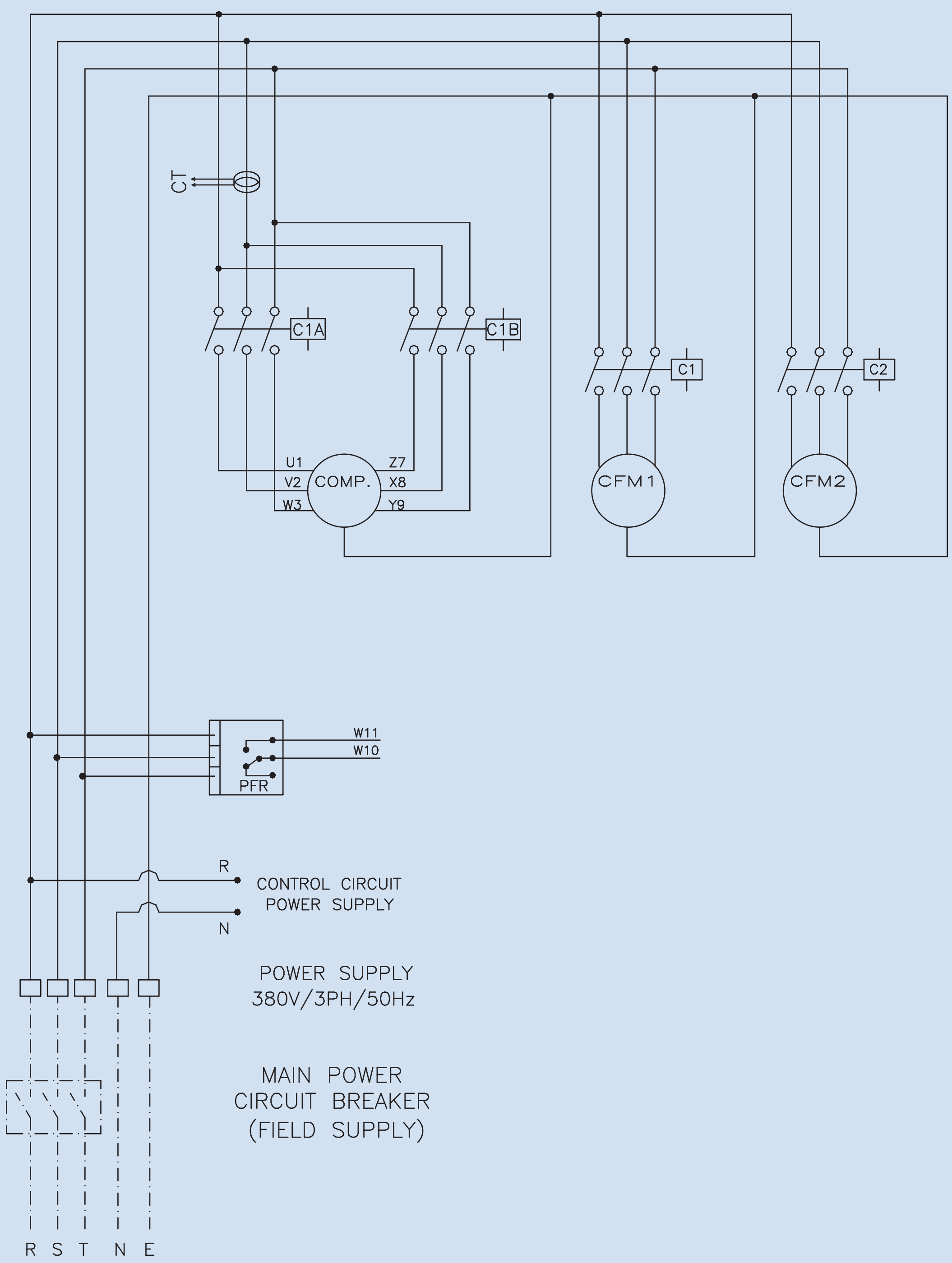
1* IN CASE OF “ COMP. PROOF” ALARM MESSAGE FOR ANY CIRCUIT
CHECK: HPS, MP, (EXD ALARM) RELATED TO THAT CIRCUIT

2* IN CASE OF “FREEZE” ALARM IT MEANS ONE OF THE FOLLOWING:
- FREEZE CONDITION
- WATER OUT SENSOR ISN’T CONNECTED OR DOESN’T OPERATE

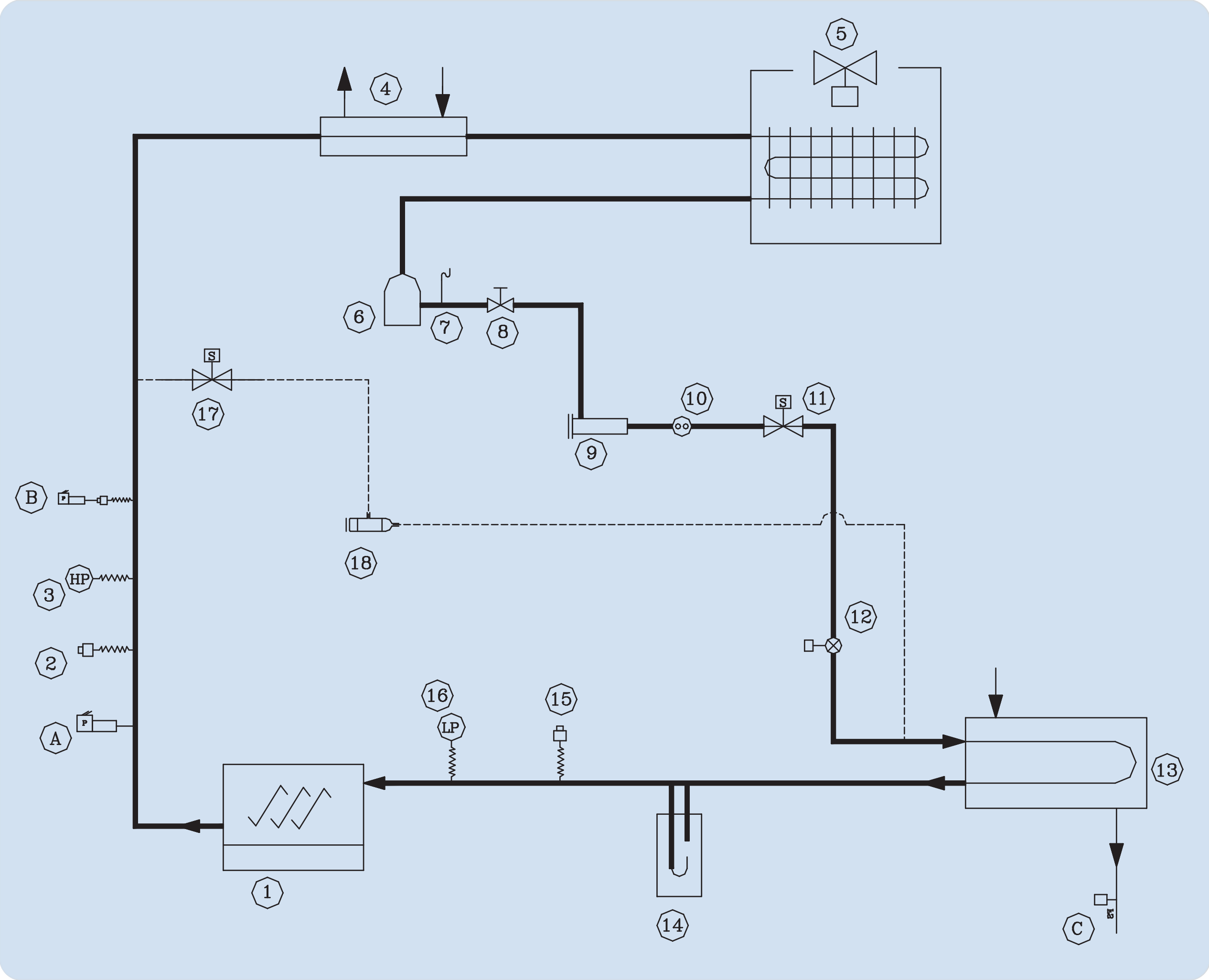
LEGEND

DISC.P: DISCHARGE PRESSURE
SUC.P: SUCTION PRESSURE
DISC.T: DISCHARGE TEMPERATURE
SUC.T: SUCTION TEMPERATURE

Power Diagram



For Cooling Units Only



#	ITEM	STATUS
1	Screw Compressor	STD
2	Charging Nipple	STD
3	High Pressure Gauge	OPTION
4	Desuperheater	OPTION
5	Condenser Coil	STD
6	Liquid Receiver	OPTION
7	Fusible Plug	OPTION
8	Shut Off Valve	STD
9	Filter Drier	STD
10	Sight Glass	STD
11	Solenoid Valve	STD
12	Expansion Valve	STD
13	Cooler	STD
14	Suction Accumulator	OPTION
15	Charging Nipple	STD
16	Low Pressure Gauge	OPTION
17	Solenoid Valve	OPTION
18	Hot Gas By Pass	OPTION

#	CONTROLLER	STATUS
A	High Pressure Switch	STD
B	High Ambient Kit	STD
C	Flow Switch (Loose Item)	OPTION