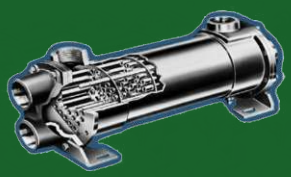
R-134a

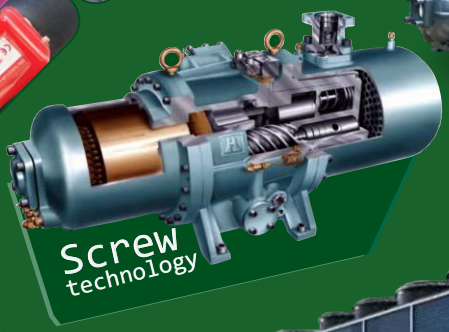
Sabro

Air conditioning

ACS Series

Screw Chillers





Screw technology

THE COMPANY 55 Years

Range 36 TR to 483 TR
(127 kW to 1698 kW)

I- Obtained ISO 9002 Certification in 1997.
II- Obtained ISO 9001 Certification in 2000.
III- Obtained BS EN ISO 9001:2008 in 2014
(HVAC Equipment(OEM) From NQA).

AHRI Standards/rating conditions

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SABRO Compact Screw Chillers
ACS Series - R-134a

SPOTLIGHT

SABRO Air cooled water chillers are complete, self-contained automatic refrigerating units that include the latest Screw technology components arranged to provide a compact and efficient unit. Each unit is completely assembled; factory wired, evacuated, charged, tested and comes complete and ready for installation. Each Air cooled screw chiller unit consists of multiple air-cooled condensers one or more accessible semi-hermetic twin screw compressors, star-delta starters - VFD, high efficiency evaporator, and complete refrigerant piping. Liquid line components included are manual liquid line shutoff valves, charging valves, filter-driers, liquid-line solenoid valves, sight glass/moisture indicators, and electronic expansion valves.

- High-performance compressor manufactured by specialized and the operation and monitoring are convenient.
- Manufacturer is adopted to ensure that the chiller is economical and durable with low vibration and low noise.
- Highly integrated motherboard is adopted and hence the function is strong and reliable.
- Advanced control algorithm is adopted to control chiller in advance and hence avoid frequent stoppage protection of chiller.
- We have set complete safety protection function in order to make chiller safely and reliably run.
- The linkage control and remote monitoring function of peripheral equipment ensure that the chiller can run safely
- The selection of excellent raw materials and fittings is the key to guaranteeing chiller quality.

Excellent reliability and powerful operation

The cutting-edge design of Air-cooled screw chiller accomplishes high performance and reliability for industrial and commercial market.

SABRO Compact Screw Chillers
ACS Series - R-134a

Contents

SABRO **ACSC** Series environment friendly (R-134a) Air Cooled Package Screw Chillers are designed & manufactured to provide utmost performance, efficiency, reliability, to meet the requirements and long life in Pakistan & Gulf's Severe climatic condition.

ACSC Series Chillers have low noise and minimum vibration ideal for vast range of commercial applications including hotels, high-rise buildings, stores, hospitals, and energy efficient cooling applications of modern manufacturing industries.

ACSC units are factory assembled, leak tested, evacuated, internally wired and fully charged with refrigerant R-134a. Every unit is fully tested before delivery and is ready for installation.

ACSC Chillers are rated on accordance with AHRI 550/590.

ACSC Chillers are designed and manufactured as per SABRO Quality, Environment, Occupational, Health and Safety Management Systems that conform with BS EN ISO 9001:2008.

SABRO provides qualified service and stock of replacement parts inside / outside Pakistan.

Legend

The following legends are used throughout this manual:

cfm ..... Cubic feet per minute	l/s ..... Liters per second
EER ... Energy Efficiency Ratio	MBH ..... Btu/hr x 1000
Hz ..... Hertz	Ph ..... Phase
kW ..... Kilowatts	PI ..... Power Input-Compressor
kg ..... Kilogram	TR ..... Tons of Refrigeration
lbs ..... Pounds	V ..... Volts

Nomenclature

A C S C - 5 1 0 0 S Y

- **A C** — Air Cooled Packaged Chillers
- **S C** — Screw Compressor, R-134a
- **5** — Power Supply 5 : 50 Hz
- **1 0 0** — Size
- **S** — S-Standard Efficiency
- **Y** — Power Supply Code
  - Y : 380V/3Ph/50Hz/60Hz
  - Y1: 415V/3Ph/50Hz/60Hz
  - P : 440V/3Ph/50Hz/60Hz
  - (Consult SABRO)

Sabro Air-cooled Screw Chillers Are..

Designed to help you create a better environment now and for the future, providing increased energy efficiency, improved performance with lower sound-levels and when it comes to the refrigerant, **Sabro really does leave you free to select an environment friendly air cooled chiller without compromising either capacity or efficiency.**

- All in one package.
- Single point electrical connections.
- Units can be handled conveniently and flexibly thus saving installation cost & installation space.

SABRO reserves the right to change, in parts or in whole the specifications of its Air Conditioning Equipment at any time in order to add the latest technology. Therefore, the enclosed information may change without any prior notice.

Trust the Airxperts

SCREW CHILLER Major Advantages

World class high efficiency (High efficiency model)

Top level efficiency is in accordance with AHRI Standard 550/590.
Optimized compressor design including a rotor and a slide valve is suitable for comfort cooling applications.
The rotor is designed to work efficiently for different pressure ranges covering air conditioning and refrigeration application.
The slide valve controls the cooling capacity by controlling the position of the slide where refrigerant suction starts using internal Pr. difference between discharge & suction.
Sabro ACS Model has stepless & steps capacity control (100, 75, 50, 25%) capability which is optimized for part-load condition.
Precise rotor tip clearance provides excellent energy efficiency in the screw rotary compressor because this reduces leakage from high pressure to low pressure side during compression, achieving top class COP.

Sabro V-shape condenser coil was designed using numerical and experimental analysis, having optimum air flow path to optimize heat rejection performance.
Also, the enhanced condenser fin geometry allows the optimum heat transfer performance at small air side pressure drop, and this reduces the fan-motor power consumption. The fin is pre-coated to prevent corrosion at normal conditions and epoxy coated fin condenser which is sustainable in harsh conditions, is also available as option.

Low noise and low vibration

The unit was designed with a compact structure and robust assembly. The condenser fan is completed with high-efficiency wing style axial fan and direct driven motor for low sound level. The unit configures compressor sound insulation box (Option), which makes Sabro ACS chillers silent and stable.

Tolerance is maintained within a few microns just like one-tenth hair thickness. Robust components with highly skilled assembling process help the compressor last for a long time.
Sabro condenser production technology is already well-known to worldwide air conditioning manufacturing industries because of its leading technologies.

Installation, start-up

- Small operating footprint fit most retrofit applications. (Compact model)
- Factory testing for high reliability.
- Factory-installed and tested controls help to reduce start up time and minimized extra cost.
- Display temperatures and pressure for each component spot.

Compressor specification

- Semi-hermetic twin-rotor screw compressor.
- Direct-drive, low speed/RPM.
- Only three moving parts, resulting in high reliability.
- The slide valve has a unique profile, optimized for part-load conditions.
- Field serviceable and easy maintenance.
- Precise rotor tip clearance
- A refrigerant dispersing device is set internally to compressor for motor cooling.

Factory testing/Unit performance testing

Sabro air-cooled screw chillers are given complete functional test at factory. Sabro computer-based testing programs completely check the components including sensors, wiring, electronics and microprocessor control functions.

Sabro promotes factory performance tests for ACS chillers &WCS(water-cooled) chillers to show, we stand behind the products which are designed and build up.

The benefits of a performance test include verification of performance, prevention of operational problems, and assurance of a smooth start-up. Each compressor is run and tested to verify capacity and efficiency.

Structural strength analysis

Structure is designed to ensure stiffness for various disturbances by steps of structure modeling, meshing, excitation and evaluation.

Structural strength evaluation simulation

Aerodynamic analysis

Condenser part is appropriately designed by aerodynamic analysis like inlet and outlet uniform airflow design and dead zone reduction design.

Heat circulation evaluation simulation

Eco-friendly refrigerant R134a

System designed with Eco-friendly refrigerant R134a which does not harm the ozone layer & protects environment.
The HCFC (R22, R123) series cannot produce any more from 2020 according to the Montreal Protocol for protection of ozone layer.

AHRI Standard Compliance

The performance of the screw chiller complies with Air Conditioning, Heating, and Refrigeration Institute (AHRI) latest standards program (AHRI Standard 550/590). Providing independent, third-party verification, the AHRI regularly tests chiller to ensure compliance.

AHRI Standard 550/590

Chillers conform to the following Standards and Codes:

- AHRI 550/590 - water chilling packages using the vapor compression cycle.
- ANSI/ASHRAE 34 - number designation and safety classification of refrigerants.
- ASME Section VIII - boiler and pressure vessel.
- GB/T 18430.1 - water chilling (heat pump) packages using the vapor compression cycle - part 1: water chilling (heat pump) packages for industrial & commercial and similar applications.

Equipment overview

Semi-hermetic twin compressor

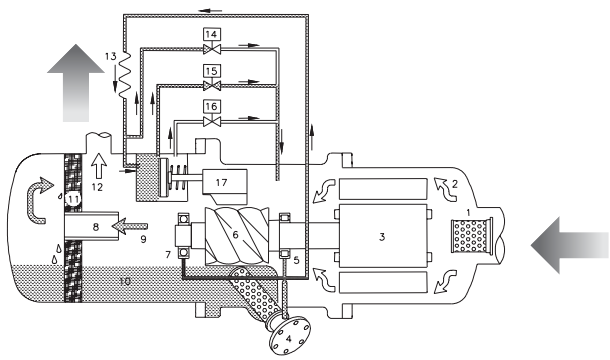
The semi-hermetic screw compressor is meant especially for applications in air-conditioning and refrigeration. With high operating load design, each compressor is of high efficiency and reliability in all operating conditions. Each compressor has the latest and advanced 5-to-6 Patented Screw Rotor Profile designed to ensure high capacity and efficiency in all operating conditions.

The compressor is equipped with separated radial and axial bearings, liquid injection and economizer connection, PTC motor temperature thermistors and discharge temperature thermistors, a motor protector, and oil level switch and oil pressure differential switch and other accessories.. The complete accessories and their new designs guarantee the compressor has the best reliability, longest bearing life during heavy duty running and strict operating conditions.

The slide valve for capacity control is located in the compressor chamber. The slide valve is actuated by injection of pressurized oil into the cylinder from the oil sump as well as bypass of oil through solenoid valves in each oil lines with pressure differential.
The screw compressors are equipped with either 3-step/4-step capacity control system or continuous (stepless) capacity control system. Both of the capacity control systems consist of a modulation slide valve, piston rod, cylinder, piston and piston rings. The slide valve and the piston are connected by a piston rod. The principle of operation is using the oil pressure to drive the piston in the cylinder. The lubrication oil flows from the oil sump through the oil filter cartridge and capillary then fills into the cylinder due to the positive oil pressure bigger than the right side of spring force plus the high pressure gas. The positive pressure differential causes the piston to move toward the right side in the cylinder.

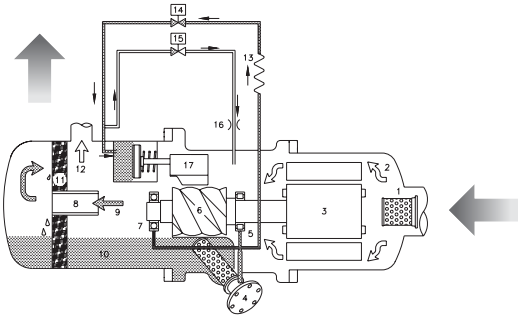
When the slide valve moves toward the right side, the effective compression volume in the compression chamber increases. This means the displacement of refrigerant gas also increases, as a result the refrigeration capacity also increases. However, when any of the step solenoid valve (for 4-step capacity control system) is opened, the high pressure oil in the cylinder bypasses to the suction port, which causes the piston and the slide valve to move toward the left side, and then some of the refrigerant gas bypasses from the compression chamber back to the suction end.

As a result, the refrigeration capacity decreases because of the reduction of displacement of refrigerant gas flowing in the system. The piston spring is used to push the piston back to its original position, i.e. minimum load position in order to reduce the starting current for the next starting.



4-step scapacity control

No	Component	No	Component
1	Suction filter	10	Lubricant
2	Gas in (low pressure)	11	Oil separator catridge
3	Motor	12	Gas out (high pressure without oil)
4	Oil filter catridge	13	Capillary
5	Suction bearings	14	Solenold valve, SV2
6	Male rotor	15	Solenold valve, SV1
7	Discharge bearings	16	Orifice
8	Oil separator baffle	17	Slide valve
9	Gas out (high pressure with oil)		



Step-less capacity control

No	Component	No	Component
1	Suction filter	10	Lubricant
2	Gas in (low pressure)	11	Oil separator demister
3	Motor	12	Gas out (high pressure without oil)
4	Oil filter catridge	13	Capillary
5	Suction bearings	14	Solenold valve (min. %), SV 25% / 33%
6	Male rotor	15	Solenold valve (50% of full load), SV 50%
7	Discharge bearings	16	Solenold valve (75% / 66% of full load), SV 75% / 66%
8	Oil separator baffle	17	Slide valve
9	Gas out (high pressure with oil)	*	For RC2-100, 140 & 180 the SV50% omitted

Heat exchanger
Evaporator-Flooded type

"Flooded" shell and tube type evaporator having refrigerant in the shell and chilled water inside the tubes. The shell is of welded carbon steel construction with steel tube sheets and copper heat exchange tubes. Removable steel water boxes at both ends of the cooler allow tube cleaning without disturbing the refrigerant circuit. Tubes are mechanically expanded into tube sheets with double grooves to ensure leak tight and trouble free operation.

Multiple compressor/ circuit chillers have coolers with separate refrigeration circuits for each compressor. Each refrigeration circuit is provided with its own pressure relief valve. All chillers are fitted with drain valves on the removable heads and shell. All coolers are factory insulated with 25mm of closed cell expanded synthetic rubber with all joints vapor sealed.

Falling film type

"Falling film" shell and tube type evaporator having refrigerant in the shell and chilled water inside the tubes.
Advantage of this type evaporator is higher heat transfer performance and reduced refrigerant charge.
Distributer located on the top side of inside shell makes uniform flow of refrigerant, this refrigerant flows downward by gravity as a continuous film.
The shell is of welded carbon steel construction with steel tube sheets and copper heat exchange tubes. Removable steel water boxes at both ends of the cooler allow tube cleaning without disturbing the refrigerant circuit.

Tubes are mechanically expanded into tube sheets with double grooves to ensure leak tight and trouble free operation. Multiple compressor/ circuit chillers have coolers with separate refrigeration circuits for each compressor.

Each refrigeration circuit is provided with its own pressure relief valve. All chillers are fitted with drain valves on the removable heads and shell. All coolers are factory insulated with 25mm of closed cell expanded synthetic rubber with all joints vapor sealed.

Air cooled condenser

Condenser coils are constructed from copper tubes with **spiral grooves on their inside surface** to maximize heat transfer efficiency. The two types of condenser fin can be provided as a standard based on customer's request. The one is that aluminum condenser fins have a corrosion resistant and quality hydrophilic coating to minimize dust and moisture accumulation and ensure a long working life. The fins have rippled and louvered surfaces to improve heat dissipation efficiency.

SABRO has the provision of Acra-clad protective coated corrosion-resistant fins™-reduces heat exchanger corrosion. This specially developed coating offers maximum protection, even in the most humid of conditions.

Each condenser section comprises coils in a reversed - V arrangement. Condenser fans are axial type using designed s-shaped blade. Therefore it makes high air flow and low vibration and sound with the combination of this technology, chiller can be operated in ambient temperature up to 54℃ (129℉). Fan motors are waterproof rated to IP54 with class 'F' insulation suitable for operation in temperatures from -20℃ to 65℃ (-4℉ to 150℉).

Electronic expansion valve

Electrically operated expansion valves is used for precise liquid injection in evaporators.
EE-Valves are designed for HFC/HCFC conditions, providing 34 bar (493 psig) working pressure.
Balanced design providing bi-flow operation as well as solenoid tight shut-off function in both flow directions at MOPD(Maxium Operating Pressure Differential) 33 bar (478.6psig).
This valve controls refrigerant flow for different operating conditions by change orifice size to-increase- or-decrease flow area through the valve.
This valve is controlled by microprocessor signal.

SEE FURTHER DETAILS IN "GENERAL FEATURES SECTION"

General Features

High COP

ACSC Series chillers provide tremendous savings in operating costs by using high efficiency, semi hermetic screw compressor. High COP is made possible due to perfect screw profile and precise machining. The stepless capacity control provides precise capacity as required by the system load, and thus giving higher part load efficiencies. The compressor can be loaded from 25%, 50% 75% to 100% of capacity depending upon the requirement through state of the art microprocessor control which precisely monitors the water temperature and accurately modulates the compressor accordingly.

Maintenance Free Operation

ACSC Series chillers have compact design and are supplied as a complete package, ready to be wired and piped for operation. Screw compressors in Sabro **ACSC** Series provide virtually maintenance free operation as there are fewer moving parts. Special bearings facilitate longer run periods of compressor without any need for maintenance.

Wide Operating Range

ACSC chillers are designed, as standard, to operate at a wide range of ambient temperatures from 68°F (20°C) to 125°F (51.6°C). Consult **SABRO.**

Main Component Features

Compressors

ACSC Series Chillers use high performance and high efficiency screw compressors which are with 5:6 ratio screw rotor profile designed specifically for modern refrigerant characteristics, double-walled rotor housing, robust in construction and have a very few moving parts to minimize noise and ensure rigidity. Screw Compressors are directly flanged on a three stage oil separator with low oil carry over and pressure drop demister to ensure minimal refrigerant dilution in the oil and maintain high oil viscosity. Oil sight glass, oil drain valve, oil heater, discharge check valve, discharge stop valve are available as standard.

ACSC screw compressors have excellent bearing life and superior compressor reliability. Screw compressors utilize the combination of 11 axial and radial bearings and α axial balance piston design.

Continuous (Stepless) capacity control system and automatic start unloading are provided as standard.

All compressors are provided with motor winding temperature protection, discharge temperature protection, phase reversal protection, phase failure protection and oil level protection.

Condensers

Condenser coils are manufactured from seamless Hi-x copper tubes mechanically bonded to aluminium fins to ensure optimum heat transfer. All coils are tested against leakage by air pressure of 450 psig (3102 kPa) under water. All standard coils are 3 rows ,14/15 FPI (1.59 mm fin spacing) ,3/8"(9.5mm) O.D. tubes.

Condenser fin materials should be matched with site conditions to inhibit coil corrosion and ensure extended equipment life.

For different application requirements, other optional condenser fin materials are available:

- Copper fins • Precoated Aluminum fins
- Copper fins electro-tinned after manufacturing
- ACRYLIC Protective coating for sea-line/coastal areas. This option provides substantial corrosion protection beyond standard coil construction.

Condenser Fans

The condenser fans are propeller type, aluminium alloy blades, directly driven by electric motors. Motors are Totally Enclosed with class 'F' insulation and IP55 protection.

The motors are factory wired to chiller unit control panel where the motor starters are located to control the operation of these motors. The fans are individually statically and dynamically balanced(for laminar flow enabling low noise operations) at the factory. Complete fan assembly is provided with suitable acrylic coated fan guards.

Evaporator-*e*nergy *e*fficiency-resolute out-put

ACSC evaporators are direct expansion, shell and tube, with removable head, and having multiple refrigerant circuits. Evaporator shell is made of enclosed MS shell. Tubes of copper fixed to steel end plates. Baffles are provided in the water flow to increase heat transfer efficiency. Evaporators are provided with drain & vent plugs. Cooler shell is insulated with 1.0"(25mm) thick flexible closed cell insulation, K factor 0.28 Btu. in/ft².h.oF (0.04W/m.oK).Maximum working pressure of waterside is 145 psig (1000 kPa) and refrigerant side is 230 psig (1586 kPa).

Electronic Expansion Valve

ACSC series chillers use electronic sporlan expansion valve for precise control refrigerant mass flow. Our electronic expansion valve improves EER (Energy Efficiency Ratio) at full & part-load conditions. Also it improves temperature control & increases the range of operating conditions.

Casing/Structure Frame

The unit casing in **ACSC** series chillers is made of zinc coated galvanized steel sheets conforming to JIS-G 3302 and ASTM A 653 which is phosphatized and baked after an electrostatic powder coat of approximately 60 microns. This finish and coating can pass a 1000 hour in 5% salt spray testing at 95°F (35°C) and 95% RH as per ASTM B117.

ACSC chillers are assembled on rigid structural ms/steel skid channels painted with one coat galvanized primer and one coat black enamel. The package is assembled for easy handling during transportation and robust support during installation and operation.

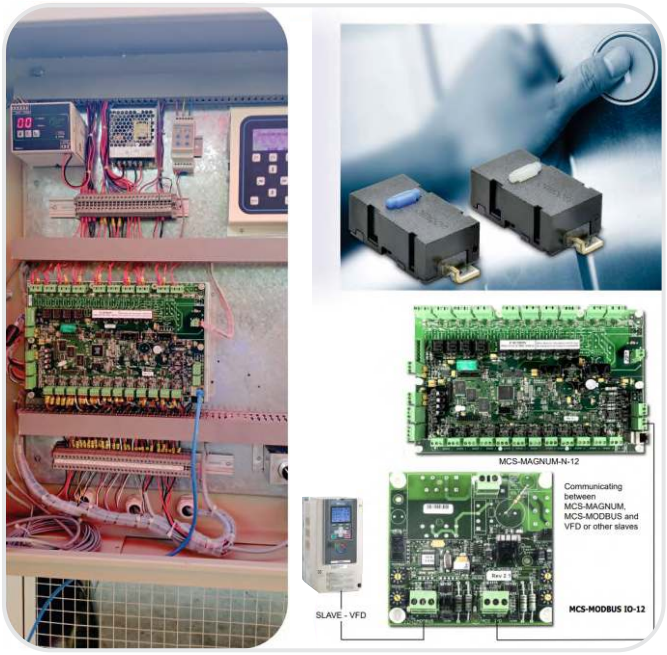
Refrigerant Piping

The refrigeration circuit piping is fabricated from ACR grade copper piping. Each refrigeration circuit includes filter drier, electronic expansion valve, and shut off valve. The refrigeration circuit suction line is insulated with ½" (13mm) wall thickness closed cell pipe insulation.

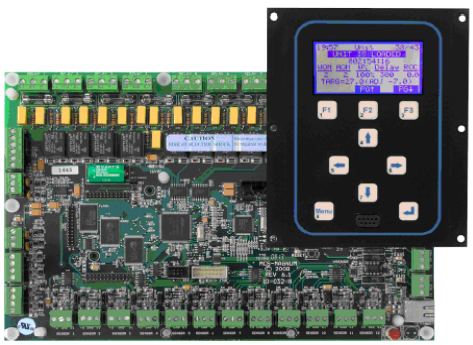
Control Panel

The unit mounted chiller control panel enclosure is fabricated out of heavy gauge sheet steel in phosphatized powder coated baked finish. The enclosure conforms to IP54 as per guidelines in IEC 529. A hinged access door and key-fastener is provided for easy access and security. The panel is factory wired in accordance with NEC 430 & 440, labeled, tagged and features 220V / 240V controls.

- All compressors are with part winding start as standard.
- Individual compressor and condenser fan motor contactors.
- Thermal magnetic circuit breakers for compressors and condenser fan motors.
- Voltage monitoring module for protection against under voltage, over voltage, phase loss, phase reversal and phase unbalance of the incoming voltage.
- Circuit breaker for control circuit.
- Remote/Off/Local selector switch.
- Microprocessor master board with graphical display.
- Microprocessor expansion boards as required.
- Electronic expansion valve control boards.
- Control Relays.
- Control circuit on/off switch and pump down switches.
- Volt free contacts for run, common fault and auto mode indications.
- Provision for accepting volt free contact for remote start/ stop.
- Control terminal blocks and power terminal blocks/bus bars.



Microprocessor Controller



Microprocessor control system is available for **ACSC** series chiller as a standard feature. Our high energy efficient chiller has a full function microprocessor control unit designed to keep the chiller running at its most energy efficient level. It is a rugged microprocessor based controller that is designed for the hostile environment of HVAC industry.

It provides flexibility with set points and control options that can be selected prior to commissioning a system or when the unit is live and functioning. Displays, alarms and other interfaces are accomplished in a clear and simple language that informs the user as to the status of the system. It is designed to safeguard the system that is being controlled, eliminate the need for manual intervention and to provide a simple but meaningful man-machine-interface.

This controller provides complete operational control for the chiller and has built-in auto diagnostic capability that can signal normal operation or alarm conditions as well as shutting down the chiller or system, if necessary.

The Main Features of the controller are as follows:

- A large graphical LCD Display (2.8″ diagonal) with back-lit that can be seen in bright or dim lighting.
- A nine button generic keypad that is so user friendly, it rarely requires a reference manual.
- Battery backed up built in real time clock to program. the chiller for 2 starts & 2 stops daily to provide the information information about the running hours of the compressors.
- Multiple authorization levels to provide tight security of the control system.
- Two operating schedules per each day of the week and 8 holidays.
- The system provides 'last time' enabled & disabled, number of cycles, and total run hours.
- Automatic Lead/Lag changeover of the compressors.
- Pump-down at the beginning and end of every circuit cycle.
- Capacity control based on leaving chilled water temperature. A special control zone based on leaving water temperature that reduces compressor cycling, and improved unit part load efficiency.
- Start/stop facility from remote through Volt Free Contact (VFC).
- Common Run, Fault and remote mode operation status volt free contacts provided for remote signaling.

Display Information

SABRO **ACSC** chillers offer a graphics LCD display which allows the operator to access different parameters of the chiller. Operator can view and change the set point of chiller parameters. The graphical display has lot of features, trending is one of the key features of graphical display, which shows last 25 samples with an appropriate scale to allow it to fit on the display.

The well designed keypad with three function keys, four direction keys and two selection keys allows the operator to navigate through different Menu, such as:

- Status. • Outputs. • Inputs. • Alarms. • Graphs.
- Setpoint. • Service tools. • Lockout Reset.
- Lockout Alarm. • Password .

System Control Philosophy

The unit may be enabled or disabled manually or through the use of an external signal from a building automation system.

Control is based upon leaving chilled water temperature. How fast the temperature changes is calculated and capacity decisions are based upon the rate, the current temperature, and the control temperature zone.

Capacity is never added if the system is moving toward the temperature target at an acceptable rate. The unit will monitor all control functions and stage the compressor to maintain the required operating capacity.

Performance and Technical Features

- Highly efficient/reliable hermetic Screw compressors.
- Specially designed to operate in diverse tropical conditions, ACSC series models have single/multiple compressors with individual refrigerant circuits, equipped with necessary safety devices for smooth and reliable operations.
- ACSC unit is provided with HI-tECH Elec./Electronics control.
- Acrylic-coated alum. fins(optional)for installation at sea-line-areas.
- Economical and energy efficient in operations.
- The ACSC units are passed through rigorous in-house testing which guarantees Smooth and efficient operations at installation sites.
- The unit is equipped with current over-load protections as well other refrigeration, electronics/electrical/mechanical safety devices.
- Fan motors are totally enclosed, weather proof type having class F insulation along with IP-55 protection.
- The unit is provided with micro-processor based electronic digital display micro-processor controller,
  An intelligent programmable temperature control device.

Easy Accessible Measurements Include:

- Status of the chiller.
- Status of each circuit/compressor.
- Status of condenser fans.
- Leaving and Entering chilled water temperature.
- Suction pressure and temperature for each refrigerant circuit.
- Discharge pressure and temperature for each refrigerant circuit.
- Suction and discharge superheat for each refrigerant circuit.
- Oil pressure for each compressor.
- Winding temperature for each compressor.
- Ampere draw for each compressor.
- Expansion valve opening percentage.
- Ambient temperature.
- All active set points.
- Run time for each compressor.
- Number of compressor starts.
- Lockout and alarm status.
- Status of water flow switch, voltage monitor, compressor internal motor protector, oil level switch, run/stop input and pump down switches.
- Log of last 100 alarms.
- Lead compressor identification.
- Date and time.
- Graphs of all inputs and outputs.

System Protection

The following system protection controls will automatically act to insure system reliability and protection of the unit.

- Low suction pressure protection.
- High discharge pressure protection.
- High discharge temperature protection.
- Low discharge pressure protection.
- Low oil pressure protection.
- Low oil level protection.
- High compressor motor winding temperature protection.
- Low superheat protection.
- High compressor ampere protection.
- Compressor internal thermal protection.
- Freeze protection.
- Under voltage, over voltage, phase loss, phase reversal and phase unbalance protection.
- Chilled water flow loss protection.
- Sensor error protection.
- Pump down.
- Anti-recycle.
- Time delay between stages.
- 4-Levels of passwords to restrict the intentional mishandling.

Optional Features available for the Micro Controller

PC Support Software

PC software to communicate with **ACSC** microprocessor is available as an optional feature. Software is named **MCS-Connect** and it can provide both local and remote communications to the chiller microprocessor. This program allows viewing the entire status of chiller, inputs, outputs, set points, alarms, graphs etc. Through proper authorization, changes can be made to the system. Configuration files can be transmitted to or received from the unit. Communication between PC and chiller microprocessor can be made through RS-232 serial port or Ethernet port.

If there is more than one chiller, these chillers can be connected together via Rs-485 network which can support up to 20 chillers. Access to this network can be local, via RS 232 or Ethernet connection, or remote via 14.4K Baud modem. Each chiller in the network must be assigned to a unique address. This address can be changed from the LCD/keypad of the unit or through **MCS-Connect** software. RS 232 transmission should not exceed 50 feet in length and RS 485 transmission should not exceed 1 mile without repeater. For Ethernet communication, it is necessary to use a crossover cable when connected directly to a PC.

This software can run with Windows 2000 or newer version.

BMS Communication

BMS communication with the chiller microprocessor is possible through hardwired signals or major BMS protocols.

Hard wired signals

Volt free contacts for Run, Common fault and Auto mode indications and provision for remote start/stop are provided as standard feature. In addition to these, below options can be provided if specified.

- Emergency Stop – A volt free contact from BMS to chiller, which is normally closed and opens on an emergency shut down condition. It will make the chiller to shut down immed -iately bypassing normal shut down procedure.

- Chilled water reset – A 0-5VDC signal from BMS to chiller, which allows resetting chilled water set point around an acceptable range.

BMS protocols

The chiller controller is capable to interface with four major building management systems, which are BACnet, Modbus, Lonworks and Johnson N2, by adding optional hardware. This interface allows to monitor the status of chiller and individual circuits, all inputs and outputs, chilled water set point etc. The required BMS protocol and number of chillers needs to be specified during the time of order as costing of the BMS interface involves these parameters.

Factory Installed Options

Alternative Condenser Material

Made of copper tubes and alternative fin material and/or protective coats.

- Condenser coil with Pre Coated Aluminum fins, specify
- Condenser coil with acrylic Coated Aluminum fins, specify
- Condenser coil with Copper fins, specify
- Condenser coil with acrylic copper fins, specify
- Electrotinned copper fins for Condenser coil, specify **(Consult SABRO).**

Galvanized Frame

Hot dip galvanized after manufacture, steel frame and base.

Condenser Coil Guard (CGP)
Galvanized wire mesh guard with painted finish for condenser coils. Recommended on ground level installations where coil needs to be protected against vandalism.

Low Noise Fan & Motor (LNF)
Low noise Fan & Motor assembly can be provided for applications where minimal unit sound is required.

Pressure Relief Valve (PRV)
To protect the chiller unit from being over-pressurized.

Marine Paint (MP) - optional
Marine Painting on casing and steel structure, to improve corrosion resistance in coastal environments and off-shore locations.

Compressor Sound Enclosure (CSE)
compressor sound enclosure with insulated panels is mounted around the compressor, to reduce sound.

Pressure Guages (Suction/Discharge) - optional
Suction & discharge pressure indication of each refrigerant circuit. Gauges are mounted outside the Control Panel.

Extra Shut Off Valve (XFV)
Extra Shut off valve in liquid line to fully isolate the filter drier.

Suction Shut off Valve (SSOV)
Screw compressors are with suction shut off valves to isolate the compressor from the evaporator, this may be beneficial when servicing the chiller.

Ammeter & Phase Selector Switch (AMPC) - optional
To indicate running AMPS of each compressor.

Ammeter & Phase Selector switch (AMPI) - optional
To indicate running AMPS on main incomer of a chiller.

BMS Interface thru protocol (BMSP)
For interacting the units with major BMS protocols such as BACNet, Modbus or LON. Extra hardware may be required depending on the protocol .

Voltage Monitoring Module
Under/Over voltage relays as per requirement.

Evaporator Freeze Up Protection (EFP)
Heating cable with thermostat to prevent evaporator freeze-up where low ambient temperatures below 32°F (0°C) are anticipated with/out chiller operation.

Ip55 Control Panel Enclosure (ICP)
Control Panel for special applications to meet IP55 requirements.

Main Isolator (ISO)
For main power isolation. (consult SABRO)

Star/Delta Starter For Compressors (SDS)
For models with part winding start to reduce starting current of compressors by reduced voltage starting method. Compressors will be started in star and after few seconds it will be changed over to delta. (Consult SABRO).

Soft Starter (SFS)
To reduce the starting current of compressors using reduced voltage starting method. Compressors will be started using electronic solid state soft starters that will ramp up the speed of the compressors to rated speed within few seconds thus reducing the mechanical & electrical stresses .

Voltmeter & Selector Switch (VSS)
For incoming line voltage.

Options for Field Installation

Chilled Water Flow Switch (CWFS)
To control the chilled water flow.

Anti-vibration mounts, spring type (CAVM)
Recommended for roof mounted units or other locations in the vicinity of occupied spaces, where noise/vibration is objectionable Can be supplied loose for site installation.

Hi-Lo Pressure Gauges-Loose (CSDG1)
Without piping or isolating pet cocks.

Technical specification of air-cooled screw chiller (50Hz) (Single compressor)

Model Number ACS			127-S	180-S	216-S	265-S	310-S	373-S	445-S	520-S	600-S
Nominal cooling capacity Standard conditions		Tons	36	50.7	61.4	75.3	88	106	126.5	148	170
		KW	126.5	178	216	265	309	373	445	520	598
Compressor Power input		KW	39	54	65.5	80.5	90	111	132	153	178
Compressor EER/COP			11.0/3.2	11.3/3.3	11.3/3.3	11.2/3.3	11.6/3.4	11.6/3.4	11.5/3.4	11.5/3.4	11.5/3.4
Compressor r ated current		Amps.	70	94	113	136	150	188	230	270	318
Chiller Water flow rate		GPM / l/s	86/5.45	122/7.7	147/9.3	181/11.4	211/13.3	254/16	303/19.1	355/22.3	408/25.7
Cooling capacity High ambient conditions		Tons	31.8	44.9	54.3	66.6	77.7	94.0	112.0	131.0	150.0
		KW	112	158	191	234	273	330	394.0	460.5	527.5
Compressor Power input		KW	51	70	85	102	114	142	168	196	225
EER/COP			7.5/2.2	7.7/2.26	7.6/2.22	7.6/2.3	8.0/2.34	8.0/2.32	8.0/2.34	8.0/2.34	8.0/2.34
Compressor r ated current		Amps.	88.0	116	142.0	172	190	236	285	330	390
Chiller Water flow rate		GPM / l/s	76/4.8	108/6.8	130/8.2	160/10.0	187/11.7	225/14.3	269/16.9	314/19.8	360/22.7
Compressor		Type	Semi hermetic Twin screw								
Compressor qty/ numbers of refrigerant circuits			1	1	1	1	1	1	1	1	1
Capacity steps		%	35-50-75-100 / stepless								
Starting method			y-Δ(star - delta)								
Refrigerant			R134-a								
Power supply			380-415-3-50Hz								
Refrigerant control			electronic expansion valve								
Evaporator (cooler)	Type		Shell and bundle of tubes								
	Water Pr. drop app.	KPa/feet	27/9	30/10	35.8/12	41.84/14	47.8/16	51/17	47.8/16	53.8/18	59.7/20
	working pressure	KPa/PSI	1000/145	1000/145	1000/145	1000/145	1000/145	1000/145	1000/145	1000/145	1000/145
	Water connection	mm	DN76	DN100	DN100	DN100	DN100	DN125	DN125	DN125	DN125
		Inch	3	4	4	4	4	5	5	5	5
Condenser Coil	Material		Copper tube mechanically expanded into aluminum fins								
	Copper tube	Size	3/8"OD (Rifled)								
	Fins/inch	FPI	14	14	14	14	14	14	14	14	14
	Coil test pressure	KPa/PSI	3100/450 under water.								
Condenser Fan	Type		Propeller direct drive								
		Qty	2	4	4	6	6	8	8	10	12
	Fan diameter	MM/inch	762/30	762/30	762/30	762/30	762/30	762/30	762/30	762/30	762/30
	Motor power (each)	Watts	1500	1500	1500	1500	1500	1500	1500	1500	1500
Dimensions (MM)		length	1200	2000	2000	3000	3000	4000	4000	5000	6000
		width	2286	2286	2286	2286	2286	2286	2286	2286	2286
		Height	2446	2446	2446	2446	2446	2446	2446	2446	2446
Protection devices			High pressure cut out, low pressure cut out, power phase protection, anti- freeze protection, frequent start protection, over current protection, over heat protection Comp., water flow protection, reverse phase protection,								
Operating limits	Leaving Chilled water temp.		5°C-15 °C (42 °F – 59 °F)								
	Entering condenser air temp.		20 °C-51.6 °C (68 °F – 125 °F)								

Specifications are based on following conditions,
Entering/leaving chilled water 12.7°C/7.2°C (55°F/45°F)
* Nominal cooling capacity at 35°C (95°F) and high temperature capacity at 46°C (115°F) condenser enter air temp.
Fouling factor 0.0001Btu/hr/ft²/°F
Specifications are subject to change keeping in view improvement in product.

Technical specification of air-cooled screw chiller (50Hz) (Double compressor)

Model Number ACS			432-D	492-D	530-D	580-D	620-D	650-D
Nominal cooling capacity		Tons	122.8	140	150.6	165	176	185
Standard conditions		KW	432	492	530	580	618	650.5
Compressor Power input		KW	66 x 2	74 x2	80.5 x2	88 x2	90 x2	97 x2
Compressor EER/COP			11.3/3.3	11.3/3.3	11.3/3.3	11.3/3.3	11.6/3.4	11.4/3.35
Compressor rated current		Amps.	113x 2	126X2	136 x2	146 x2	150 x2	166 x2
Chiller Water flow rate		GPM / l/s	295/18.6	336/21.1	361/22.7	396/24.9	422/26.6	444/27.9
Cooling capacity		Tons	108.6	123.8	133	146	155.0	163.7
High ambient conditions		KW	382	435.4	468	513	545	575.8
Compressor Power input		KW	84x2	95 X 2	102 x2	112 x2	114 x2	123 x2
Compressor EER/COP			7.8/2.3	7.8/2.3	7.8/2.3	8.0/2.3	8.0/2.34	8.0/2.34
Compressor rated current		Amps.	140.0 x2	160 x2	172 x2	186 x2	190 x2	208 x2
Chiller Water flow rate		GPM / l/s	260/16.4	297/18.7	319/20.1	350/22.0	372/ 23.4	393/24.7
Compressor		Type	Semi hermetic Twin screw					
Compressor qty/ numbers of refrigerant circuits			2	2	2	2	2	2
Capacity steps		%	35-50-75-100 / step less					
Starting method			y-Δ (star-delta)					
Refrigerant			R134a					
Power supply			380-415-3-50Hz					
Refrigerant control			electronic expansion valve					
Evaporator (cooler)	Type		Shell and bundle of tubes					
	Water pressure drop app.	KPa/feet	35.8/12	41.84/14	47.8/16	51/17	47.8/16	53.8/18
	working pressure	KPa/PSI	1000/145	1000/145	1000/145	1000/145	1000/145	1000/145
	Water connection	mm	DN125	DN125	DN125	DN125	DN125	DN150
		Inch	5	5	5	5	5	6
Condenser Coil	Material		Copper tube mechanically expanded into aluminum fins					
	Copper tube	Size	3/8"OD (Rifled)					
	Fins/inch	FPI	14	14	14	14	14	14
	Coil test pressure	KPa /PSI	3100/450 under water.					
Condenser Fan	Type		Propeller direct drive					
		Qty	8	8	12	12	12	12
	Fan diameter	MM/inch	762/30	762/30	762/30	762/30	762/30	762/30
	Motor power (each)	Watts	1500	1500	1500	1500	1500	1500
Dimensions (MM)		Length	4000	6000	6000	6000	6000	6000
		width	2286	2286	2286	2286	2286	2286
		Height	2446	2446	2446	2446	2446	2446
Protection devices			High pressure cut out, low pressure cut out, power phase protection, anti-freeze protection, frequent start protection, over current protection, over heat protection Comp., water flow protection, reverse phase protection,					
Operating limits	Leaving Chilled water temp.		5°C-15°C (42°F – 59°F)					
	Entering condenser air temp.		20°C-51.6°C (68°F – 125°F)					

Specifications are based on following conditions,

Entering/leaving chilled water 12.7°C/7.2°C (55°F/45°F)

* Nominal cooling capacity at 35°C (95°F) and high temperature capacity at 46°C (115°F) condenser enter air temp.

Fouling factor 0.0001Btu/hr/ft²/°F

Specifications are subject to change keeping in view improvement in product.

Technical specification of air-cooled screw chiller (50Hz) (Double compressor)

Model Number ACS			745-D	830-D	890-D	1040-D	1196-D
Nominal cooling capacity Standard conditions		Tons	212	235.8	253	296	340
		KW	745.4	829	890	1041	1196
Compressor Power input		KW	111 x2	121 x 2	132 x2	153 x2	178 x2
Compressor EER/COP			11.6/3.4	11.6/3.4	11.6/3.4	11.6/3.4	12.3/3.6
Compressor rated current		Amps.	188 x2	208x 2	230 x2	270 x2	318 x2
Chiller Water flow rate		GPM / l/s	509/32	566/35.6	607/38.2	710/44.7	816/25.7
Cooling capacity High ambient conditions		Tons	188	208	224	262	300
		KW	661	731	787.6	921	1055
Compressor Power input		KW	142	156 x2	168 x2	196 x2	225 x2
Compressor EER/COP			8.0/2.32	8.0/2.34	8.0/2.34	8.0/2.35	8.0/2.34
Compressor rated current		Amps.	236 x2	260 x2	285 x2	330 x2	390 x2
Chiller Water flow rate		GPM / l/s	451/28.4	499/31.4	538/33.9	629/39.6	720/45.3
Compressor		Type	Semi hermetic Twin screw				
Compressor qty/ numbers of refrigerant circuits			2	2	2	2	2
Capacity steps		%	35-50-75-100 / step less				
Starting method			y-Δ (star-delta)				
Refrigerant			R134a				
Power supply			380-415-3-50Hz				
Refrigerant control			electronic expansion valve				
Evaporator (cooler)	Type		Direct expansion Shell and bundle of tubes				
	Water pressure drop app.	KPa/feet	47.8/16	51/17	47.8/16	53.8/18	59.7/20
	working pressure	KPa/PSI	1000/145	1000/145	1000/145	1000/145	1000/145
	Water connection	mm	DN150	DN150	DN150	DN150	DN200
		Inch	6	6	6	6	8
Condenser Coil	Material		Copper tube mechanically expanded into aluminum fins				
	Copper tube	Size	3/8"OD (Rifled)				
	Fins/inch	FPI	14	14	14	14	14
	Coil test pressure	KPa /PSI	3100/450 under water.				
Condenser Fan	Type		Propeller direct drive				
		Qty	16	16	16	20	24
	Fan diameter	MM/inch	762/30	762/30	762/30	762/30	762/30
	Motor power each	Watts	1500	1500	1500	1500	1500
Dimensions (MM)		length	8000	8000	8000	10000	12000
		width	2286	2286	2286	2286	2286
		Height	2497	2497	2497	2547	2547
Protection devices			High pressure cut out, low pressure cut out, power phase protection, anti-freeze protection, frequent start protection, over current protection, over heat protection Comp., water flow protection, reverse phase protection,				
Operating limits	Leaving Chilled water temp.		5°C-15°C (42°F – 59°F)				
	Entering condenser air temp.		20°C-51.6°C (68°F – 125°F)				

Specifications are based on following conditions,
Entering/leaving chilled water 12.7°C/7.2°C (55°F/45°F)

* Nominal cooling capacity at 35°C (95°F) and high temperature capacity at 46°C (115°F) condenser enter air temp.

Fouling factor 0.0001Btu/hr/ft²/°F

Specifications are subject to change keeping in view improvement in product.

Technical specification of air-cooled screw chiller (50Hz) (Double compressor)

Model Number ACS			1310-D	1415-D	1515-D	1610-D	1700-D
Nominal cooling capacity Standard conditions		Tons	373	402	431	457	483
		KW	1311	1413	1515	1607	1698
Compressor Power input		KW	193 x 2	193+ 216	216 x2	216 +243	243 x2
Compressor EER/COP			11.6/3.4	11.8 / 3.45	11.96 /3.5	11.95/ 3.5	11.95/ 3.5
Compressor rated current		Amps.	340 x2	340 +380	380 x2	380 +430	430 x2
Chiller Water flow rate		GPM / l/s	895 /56.4	965 /60.7	1034 /65.1	1097 /69.0	1159 /73.0
Cooling capacity High ambient conditions		Tons	330	355	381	403	426
		KW	1160	1248	1340	1417	1498
Compressor Power input		KW	248 x2	248 +278	278 x2	278 +312	312 x2
Compressor EER/COP			8.0/ 2.34	8.18987	8.2 /2.4	8.2 /2.4	8.2 /2.4
Compressor rated current		Amps.	430	430 +475	475	475 +540	540 x2
Chiller Water flow rate		GPM / l/s	792 /49.9	852 /53.7	914 /57.6	967 /61.0	1022 /64.4
Compressor		Type	Semi hermetic Twin screw				
Compressor qty/ numbers of refrigerant circuits			2	2	2	2	2
Capacity steps		%	35-50-75-100 / step less				
Starting method			y-Δ (star-delta)				
Refrigerant			R134a				
Power supply			380-415-3-50Hz				
Refrigerant control			electronic expansion valve				
Evaporator (cooler)	Type		Direct expansion Shell and bundle of tubes				
	Water pressure drop app.	KPa/feet	47.8/16	51/17	47.8/16	53.8/18	59.7/20
	working pressure	KPa/PSI	1000/145	1000/145	1000/145	1000/145	1000/145
	Water connection	mm	DN150 x2	DN150 x2	DN150 x2	DN150 x2	DN150 x2
		Inch	6 x2	6 x2	6 x2	6 x2	6 x2
Condenser Coil	Material		Copper tube mechanically expanded into aluminum fins				
	Copper tube	Size	3/8"OD (Rifled)				
	Fins/inch	FPI	14	14	14	14	14
	Coil test pressure	KPa /PSI	3100/450 under water.				
Condenser Fan	Type		Propeller direct drive				
		Qty	24	28	28	32	32
	Fan diameter	MM/inch	762/30	762/30	762/30	762/30	762/30
	Motor power each	Watts	1500	1500	1500	1500	1500
Dimensions (MM)		length	12000	14000	14000	16000	16000
		width	2286	2286	2286	2286	2286
		Height	2547	2547	2547	2547	2547
Protection devices			High pressure cut out, low pressure cut out, power phase protection, anti-freeze protection, frequent start protection, over current protection, over heat protection Comp., water flow protection, reverse phase protection,				
Operating limits	Leaving Chilled water temp.		5°C-15°C (42°F – 59°F)				
	Entering condenser air temp.		20°C-51.6°C (68°F – 125°F)				

Specifications are based on following conditions,
Entering/leaving chilled water 12.7°C/7.2°C (55°F/45°F)
* Nominal cooling capacity at 35°C (95°F) and high temperature capacity at 46°C (115°F) condenser enter air temp.
Fouling factor 0.0001Btu/hr/ft²/°F
Specifications are subject to change keeping in view improvement in product.

Larger Capacities Models are available On Demand

Capacity Correction & Limits

Evaporator Chiller Limits of Operation

Maximum LCWT : 60.5°F (15°C)
Maximum ECWT : 76°F (24.4°C)*
Minimum LCWT : 41°F (5°C)

For Lower LCWT ethylene glycol solution to be used, consult SABRO.
(**For short periods.)*

Range & Flow Limits

Range limit 8°F - 16°F (4.4°C - 8.9°C) except where limited by water flow rate limits for evaporator.

Evaporator Pressure		Refrigerant	Water
Maximum Working Pressure	psig	230	145
	kPa	1586	1000
Test Pressure	psig	300	200
	kPa	2068	1379

Condenser Pressure		Refrigerant
Maximum Working Pressure	psig	300
	kPa	2068
Test Pressure	psig	450
	kPa	3102

Cooler Fouling Factors

The units are rated at 0.0001 ft^2.h.°F/Btu(0.018m^2.°C/KW).Other than this fouling factor use Sabro Air Cooled Chiller Selection Software to determine the unit performance.

An increase in the fouling factor, results in decrease in the unit capacity and efficiency.

Altitude Correction Factor

The units ratings are based on sea level. Above sea level apply the following correction factors:

Altitude		Capacity Multiplier	Power Multiplier
Feet	Meters		
0	0	1	1
2000	610	0.99	1.01
4000	1219	0.98	1.02
6000	1829	0.97	1.03
8000	2438	0.96	1.04
10000	3048	0.95	1.05

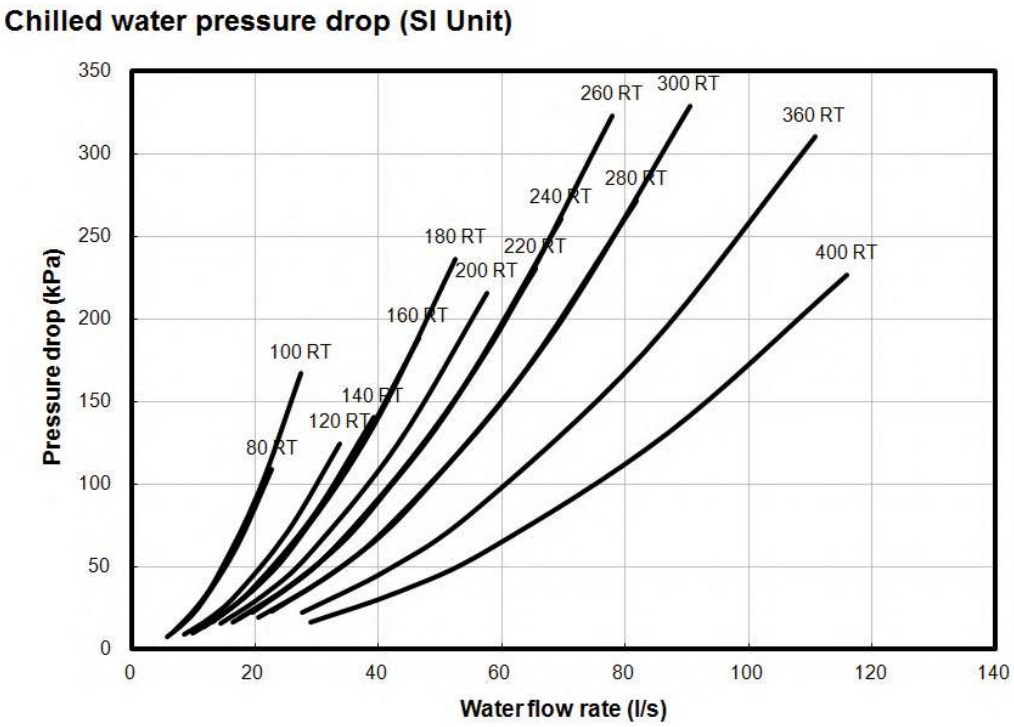
Range Correction Factors

Capacity ratings based on 10°F (IP) and 5°C (SI) chilled water range. For other than this range please use correction factor below.

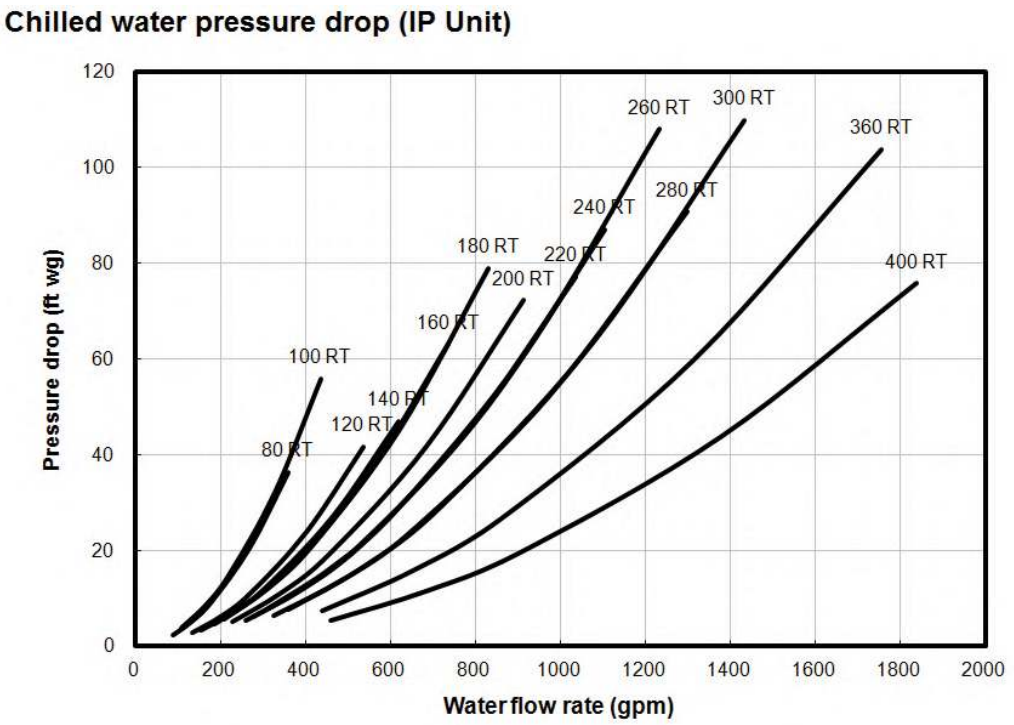
Range		Capacity Multiplier	Power Multiplier
°F (IP)	°C (SI)		
8	3.9	0.995	0.998
10	5	1	1
12	6.1	1.005	1.002
14	7.2	1.01	1.004
16	8.3	1.015	1.006

Water Pressure Drop

Chilled water pressure drop (SI Unit)



Chilled water pressure drop (English Unit)



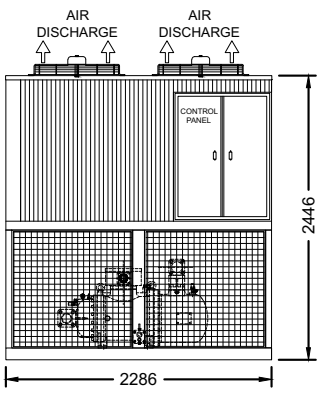
Electrical data,- (Single & Double compressor)
380V/3P/50HZ

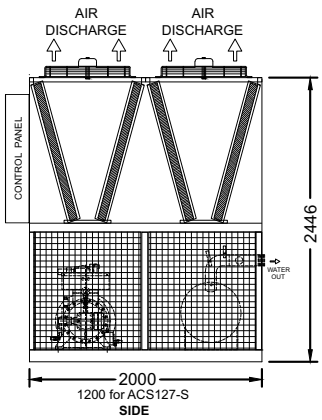
Model	circuit	Compressor		Cond. Fan Motor		Unit	
		RLA	FLA	No	RLA	FLA	MCB
ACS 127-S	Circuit 1	70	100	2	4	104	130
ACS 180-S	Circuit 1	94	145	4	4	161	200
ACS 216-S	Circuit 1	113	162	4	4	178	225
ACS 265-S	Circuit 1	136	199	6	4	215	260
ACS 310-S	Circuit 1	150	222	6	4	238	300
ACS 373-S	Circuit 1	188	272	8	4	304	360
ACS 445-S	Circuit 1	230	328	8	4	360	450
ACS 520-S	Circuit 1	270	377	10	4	417	500
ACS 600-S	Circuit 1	318	450	12	4	498	600
ACS 432-D	Circuit 1	113	162	8	4	356	430
	Circuit 2	113	162				
ACS 492-D	Circuit 1	126	184	12	4	416	500
	Circuit 2	126	184				
ACS 530-D	Circuit 1	136	199	12	4	446	540
	Circuit 2	136	199				
ACS 580-D	Circuit 1	146	215	12	4	478	575
	Circuit 2	146	215				
ACS 620-D	Circuit 1	150	222	12	4	492	650
	Circuit 2	150	222				
ACS 650-D	Circuit 1	166	240	12	4	528	650
	Circuit 2	166	240				
ACS 745-D	Circuit 1	188	272	16	4	608	730
	Circuit 2	188	272				
ACS 830-D	Circuit 1	208	298	16	4	660	850
	Circuit 2	208	298				
ACS 890-D	Circuit 1	230	328	16	4	720	900
	Circuit 2	230	328				
ACS 1040-D	Circuit 1	270	377	20	4	834	1000
	Circuit 2	270	377				
ACS 1196-D	Circuit 1	318	450	24	4	996	1200
	Circuit 2	318	450				
ACS 1310-D	Circuit 1	340	490	24	4	1076	1300
	Circuit 2	340	490				
ACS 1415-D	Circuit 1	340	490	28	4	1142	1400
	Circuit 2	380	540				
ACS 1515-D	Circuit 1	380	540	28	4	1192	1450
	Circuit 2	380	540				
ACS 1610-D	Circuit 1	380	540	32	4	1278	1550
	Circuit 2	430	610				
ASC 1700-D	Circuit 1	430	610	32	4	1348	1600
	Circuit 2	430	610				

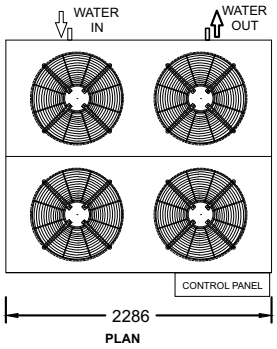
RLA= rated load amperes at nominal conditions,
FLA= full load amperes at 125°F ambient temperature.
MCB= maximum circuit breaker size.

ACSC MODELS with SINGLE COMPRESSOR

127-S, 180-S, 216-S, 265-S & 310-S — **Dimensions in MM**

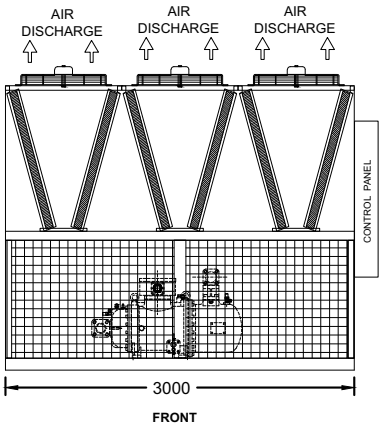


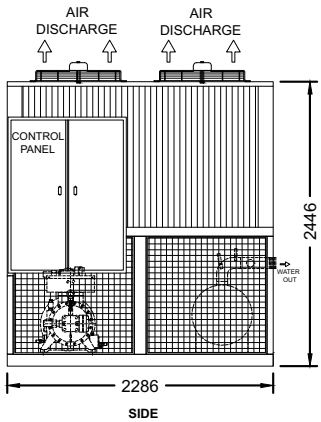


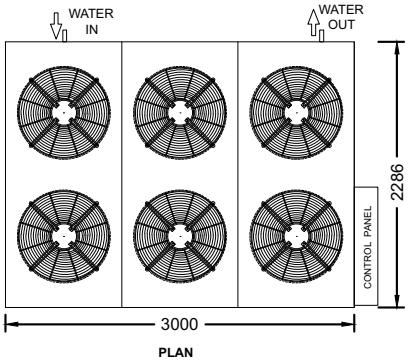


MODELS-ACS 127-S
ACS 180-S
ACS 216-S

NOTE:
Two Cond. Fan For ACS 127-S







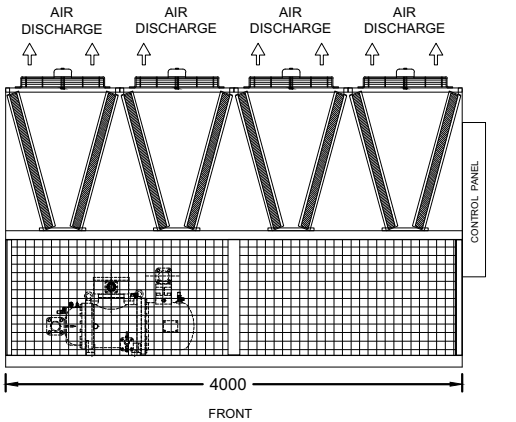
MODELS-ACS 265-S
ACS 310-S

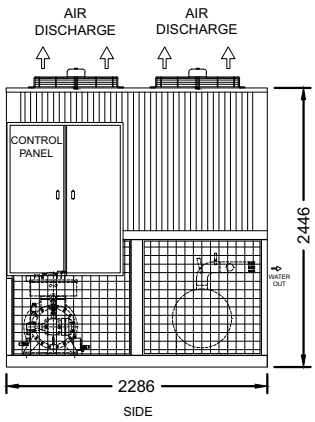
NOTE:-
DIMENSIONS ARE IN MM
DIMENSIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE

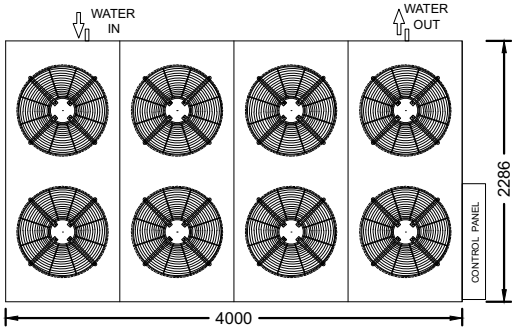
ACSC MODELS with SINGLE COMPRESSOR

373-S, 445-S & 520-S

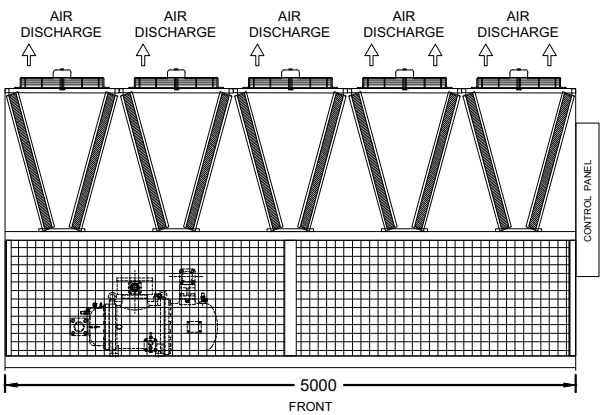
Dimensions in MM

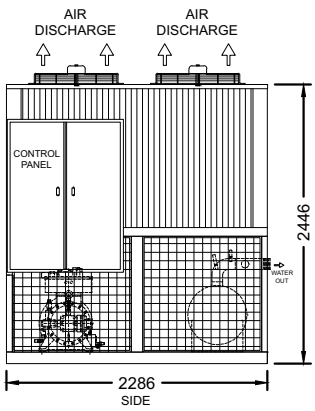


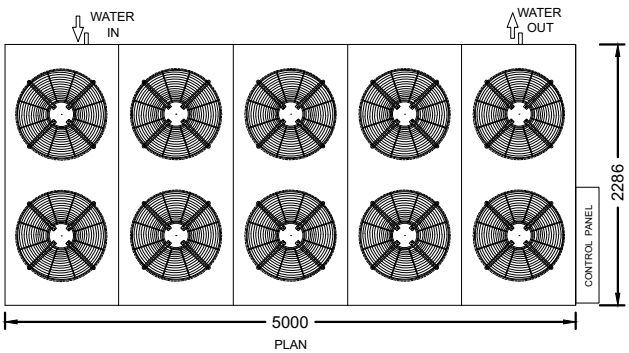




MODELS-ACS 373-S
ACS 445-S







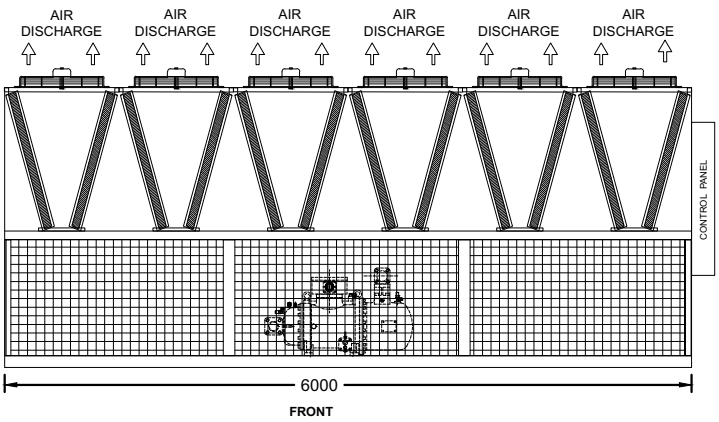
MODEL-ACS 520 S

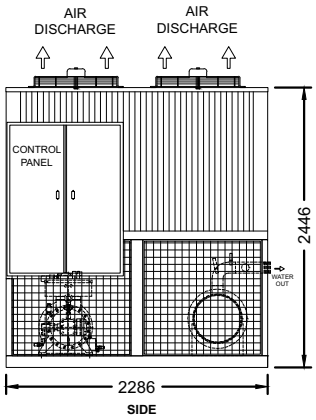
NOTE:-
DIMENSIONS ARE IN MM
DIMENSIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE

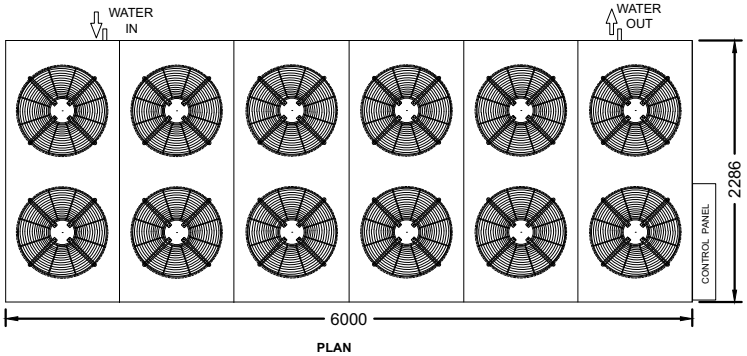
ACSC MODELS with SINGLE / DOUBLE COMPRESSOR

600-S & 432-D

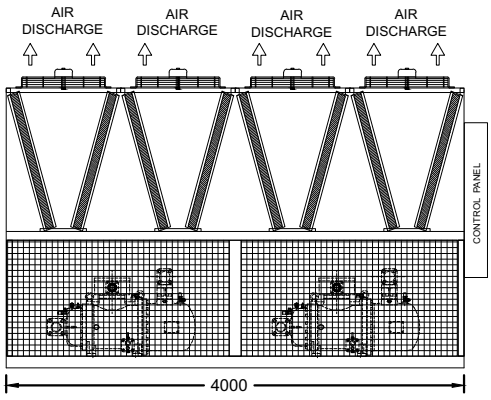
Dimensions in MM

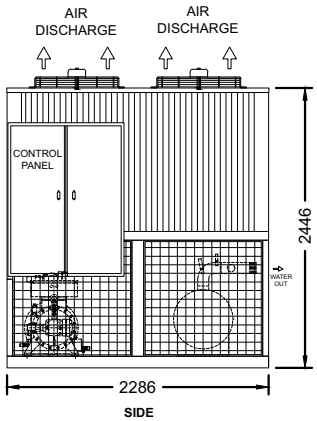


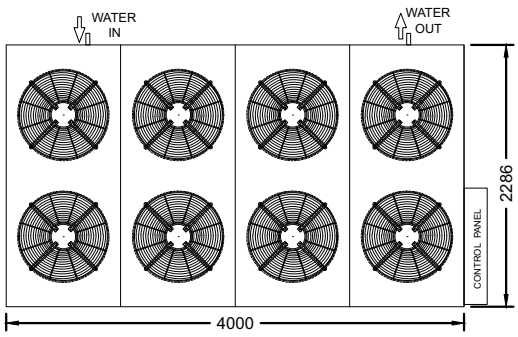




MODEL-ACS 600-S





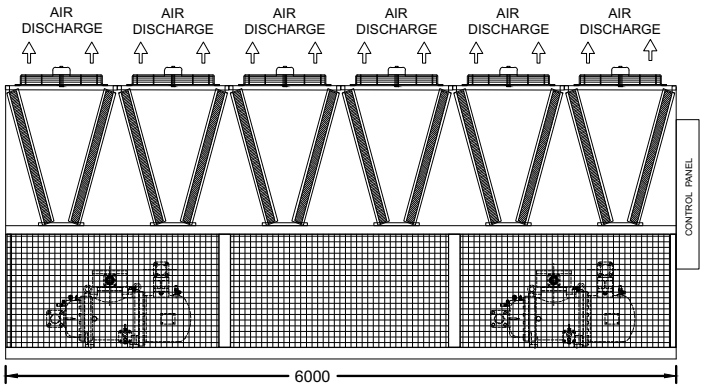


MODEL-ACS 432-D

NOTE:-
DIMENSIONS ARE IN MM
DIMENSIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE

ACSC MODELS with DOUBLE COMPRESSOR

492-D, 530-D, 580-D, 620-D, 650-D, 745-D, 830-D & 890-D — **Dimensions in MM**



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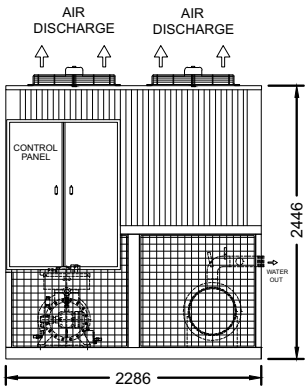

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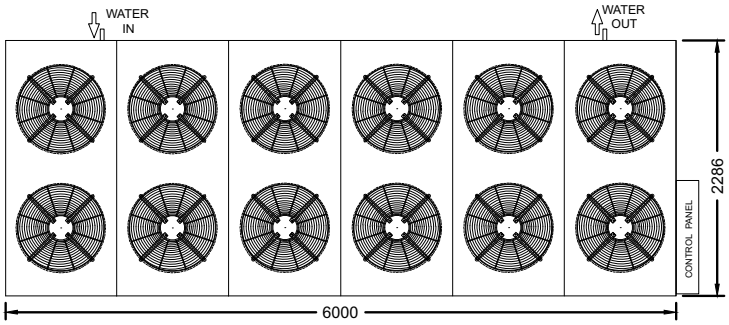
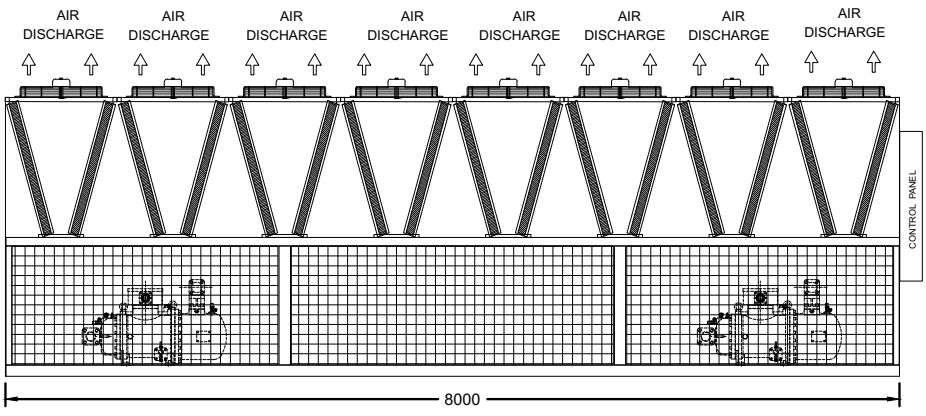


PLAN

MODELS-ACS 492-D
ACS 530-D
ACS 580-D
ACS 620-D
ACS 650-D



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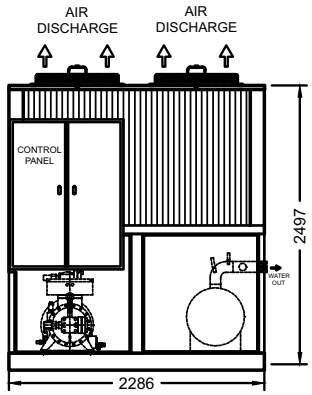

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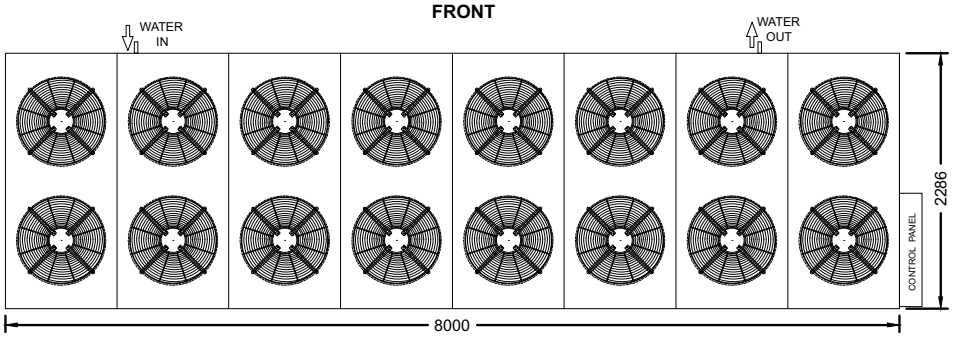


PLAN

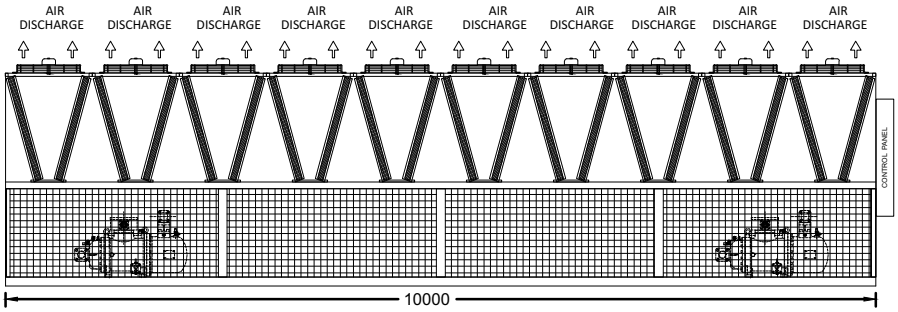
MODELS-ACS 745-D
ACS 830-D
ACS 890-D

NOTE:-
DIMENSIONS ARE IN MM
DIMENSIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE

ACSC MODELS with SINGLE / DOUBLE COMPRESSOR

1040-D, 1096-D & 1310-D

Dimensions in MM



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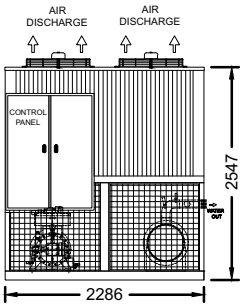

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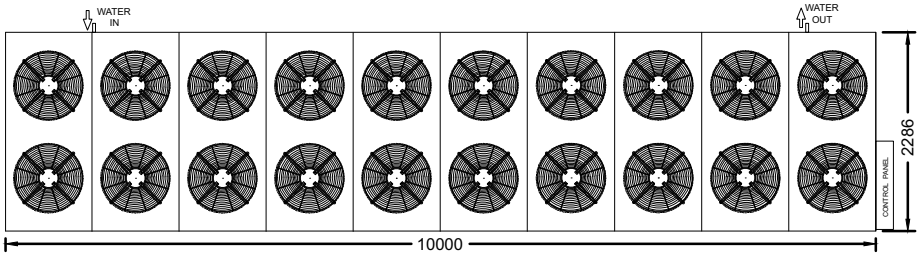
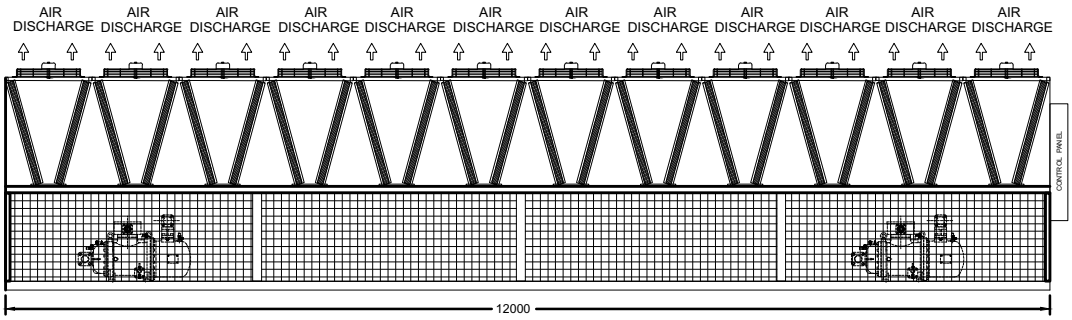


PLAN

MODEL- ACS 1040-D



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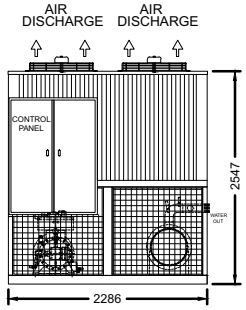

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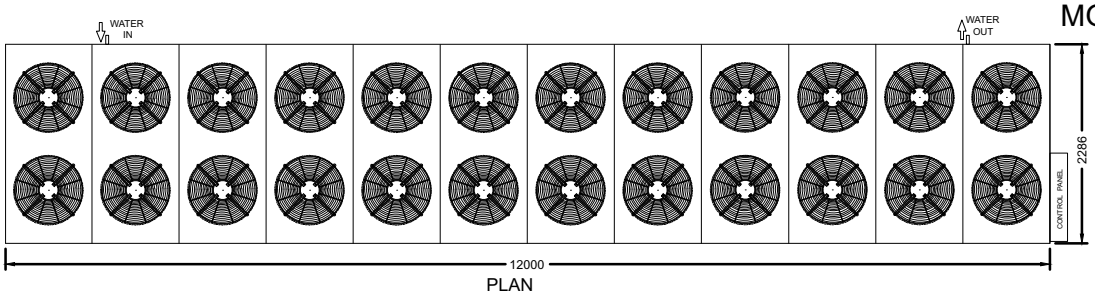


PLAN

MODELS-ACS 1196-D
ACS 1310-D

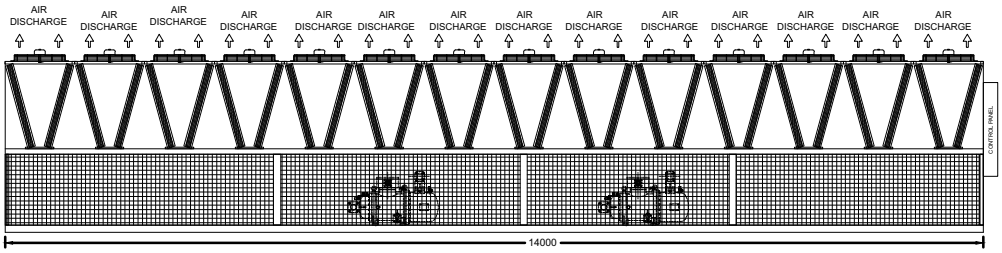
NOTE:-

DIMENSIONS ARE IN MM

DIMENSIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE

ACSC MODELS with DOUBLE COMPRESSOR

1415-D, 1515-D, 1610-D & 1700-D — **Dimensions in MM**



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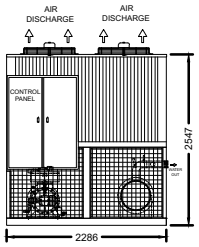

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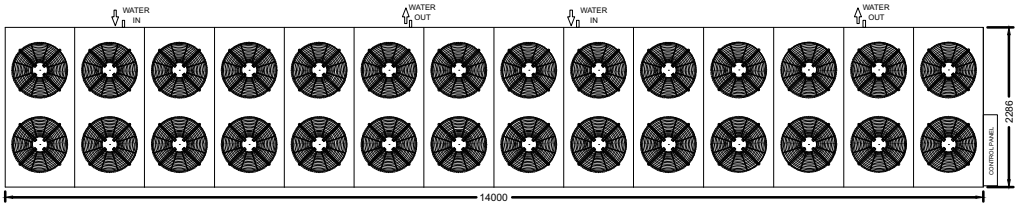
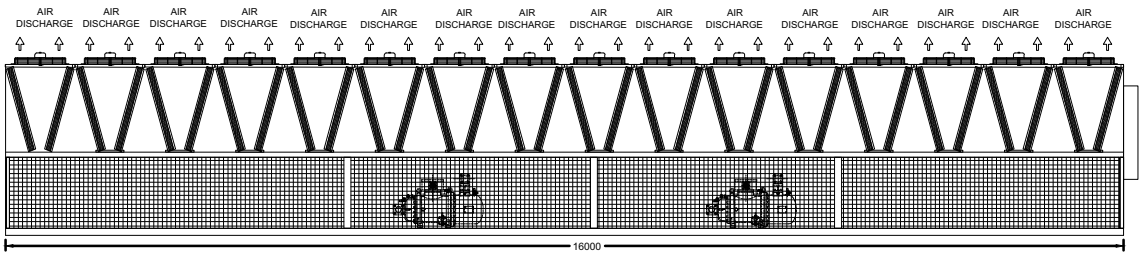


PLAN

MODELS-ACS 1415-D
ACS 1515-D



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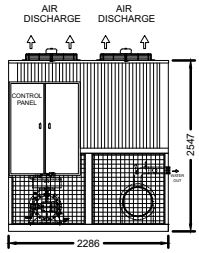

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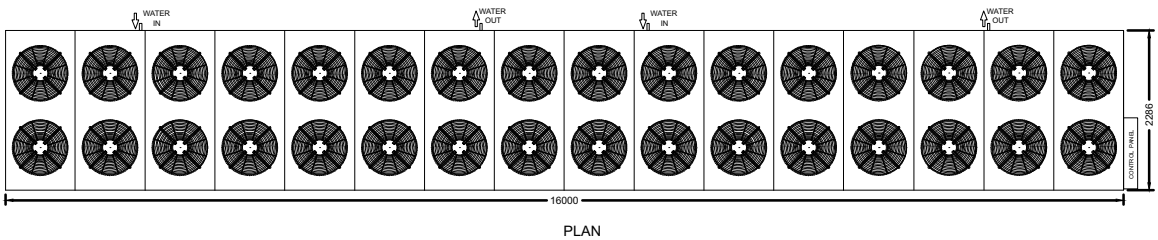


PLAN

MODELS-ACS 1610-D
ACS 1700-D

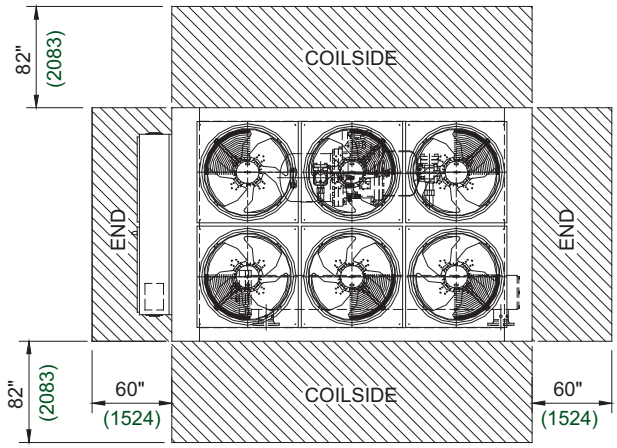
NOTE:-
DIMENSIONS ARE IN MM
DIMENSIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE

Location And Space Requirements

To enhance chiller system performance & operating economy, certain precautions should be followed before installation.

1. There should be no obstruction on the air discharge.
2. Unit must not be installed in a pit or near a parapet wall that is taller than the unit height.
3. Orient the unit so that prevailing winds blow parallel to unit length. If it is not practical to orient in this manner, a wind deflecting shield should be considered.
4. Provide adequate clearance on all-sides-of-unit-for-service service access and avoid coil starvation. Refer to the figure below for recommended clearances.

SINGLE UNIT INSTALLATION



Recommended Clearances

It is a necessity that the units are installed with adequate free space around them to ensure proper circulation of air that is rejected by the condensers and to provide adequate space for unit access for servicing and maintenance. There is a possibility of recycling of air if the rejected air from condenser encounters any obstacles leading to an increase in the ambient air temperature surrounding the units.

Air distribution across the entire heat exchange area will be impaired if the air outlet is obstructed. These conditions lead to a reduction in the heat exchange capacity of the coils causing an increase in discharge pressure of the compressors. This leads to a loss of capacity & increase in compressor power input.

Units should not be completely shrouded with higher uninterupted wind shield in order to prevent reversing of airflow. In case, such a configuration cannot be avoided , a properly designed exhaust duct or hood that does not influence any additional pressure on the fans and which is of the same height as surrounding shield to be installed. For installation involving more than 3 chillers, consult SABRO for acceptable clearance.

MULTIPLE UNITS INSTALLATION

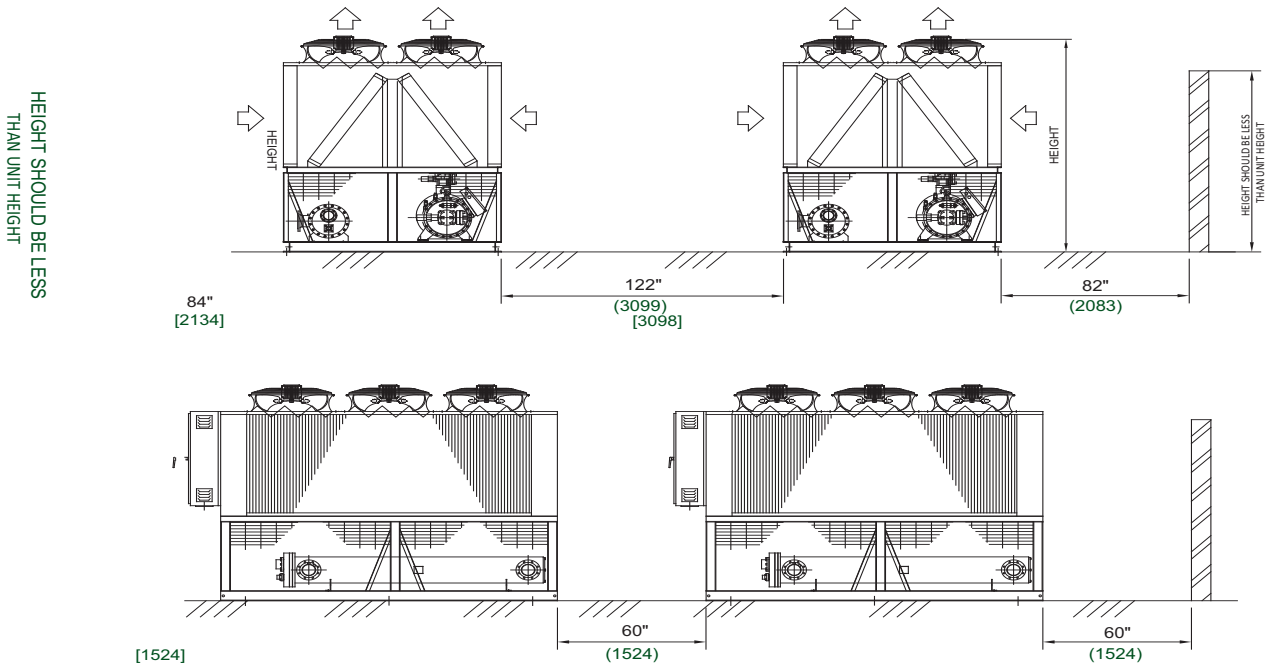


Figure A

Foundation

Provide a level and rigid concrete foundation or a steel platform that is strong enough to carry the operating weight of the unit. SABRO Air Conditioning is not liable for any damages and problems in the equipment caused by erroneous design in the foundation.

Water Piping Practices

SABRO suggests abiding by the local authorities' chilled water piping recommendations and practices as they can provide the installer the building and safety codes required for the installation.

Water piping should be designed to have a minimum number of bends & horizontal piping levels. Below are the following components it should have:

1. Temperature & pressure gauges in entering and leaving chiller water piping for unit servicing and commissioning. Pressure gauges must be installed on the same level.

2. Vibration eliminators in entering and leaving chilled water piping to lessen the sound and vibration transmitted to the building.

3. Pipe strainer in the evaporator entering piping to protect the evaporator from water debris and maintain chiller efficiency.

4. Water flow switch in the leaving chilled water piping, wired to the terminals provided in the control panel, to make sure that it has sufficient flow of water in the evaporator. This will prevent the evaporator from freezing up when the water flow is interrupted and avoid compressor slugging on start-up.

5. To isolate the unit from the piping system when servicing or during maintenance, install a shut off valve on the entering and leaving chilled water piping.

6. Expansion Tank provides additional space in the chilled water piping system as temperature rises and furthermore, it maintains a positive pressure within the working limitations of the system.

7. Air Vents at high points in the chilled water system to bleed air from the system.

8. Vapor barrier on the outside of the insulation to avoid condensation in the cold surface of the pipe that may cause damage on the building structure. A thorough leak test should be made before insulating the pipe.

Flush all chilled water piping before making final connection to the unit. SABRO recommends hiring services of water treatment specialist to determine the type of necessary treatment. Improper or untreated chilled water leads to scaling, erosion, corrosion or algae that can cause inefficient operation & tube damage. SABRO will not be liable for damages caused by improper or untreated chilled water.

Run the pumps 2 to 3 minutes before starting the chiller to ensure no freezing occurs that may damage the evaporator.

TYPICAL CHILLED WATER-PIPING

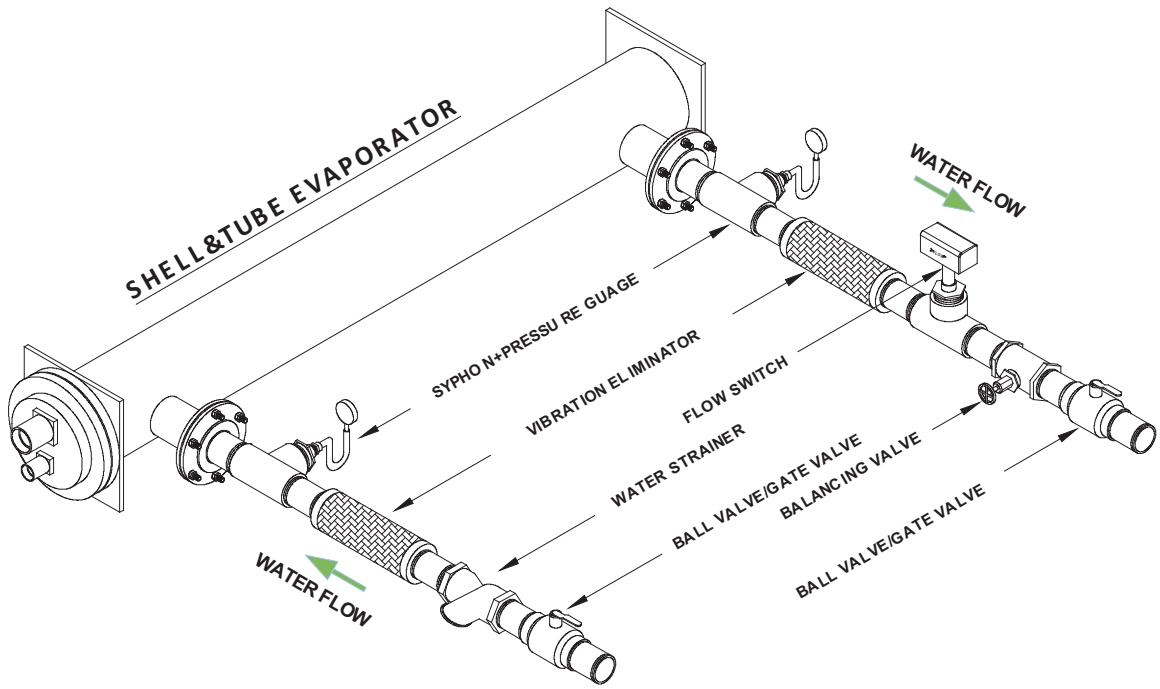
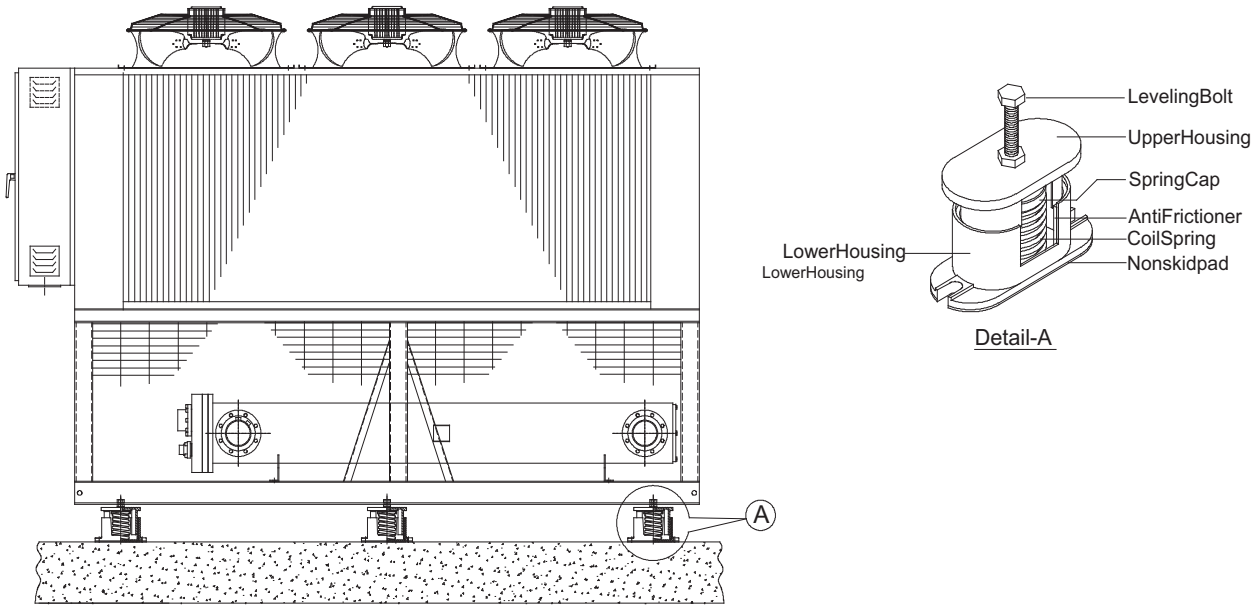


Figure B

Vibration Isolation

It is recommended to install under the base of the unit a vibration isolation of rubber-in-shear or spring type for further reduction of sound and vibration transmission to building structures . Vibration isolators must be correctly designed for each mounting loads of the unit. Refer to unit certified drawing for operating weight at each mounting points.



Note :

SABRO can supply CAVM Spring type Anti-vibration mounts (optional). The CAVM has a deflection of 25mm and each rated load can be distinguished easily as it is represented by different colours.

Water Loop Volume

In chilled water system, presence of sufficient volume of water in the piping system is crucial to achieve proper operation, unfortunately, some systems will run with less water volume than needed, this will result in inconsistence system operation, and uncontrolled compressor cycling, this condition is called " short water loop".

If our building for example didn't provide enough water volume to achieve stable controls, a storage tank should be installed to increase the water volume.

In a standard air conditioning application, the tank should be sized to attain at least 2 minute water loop and 2.5-4 minute water loop for process cooling systems.

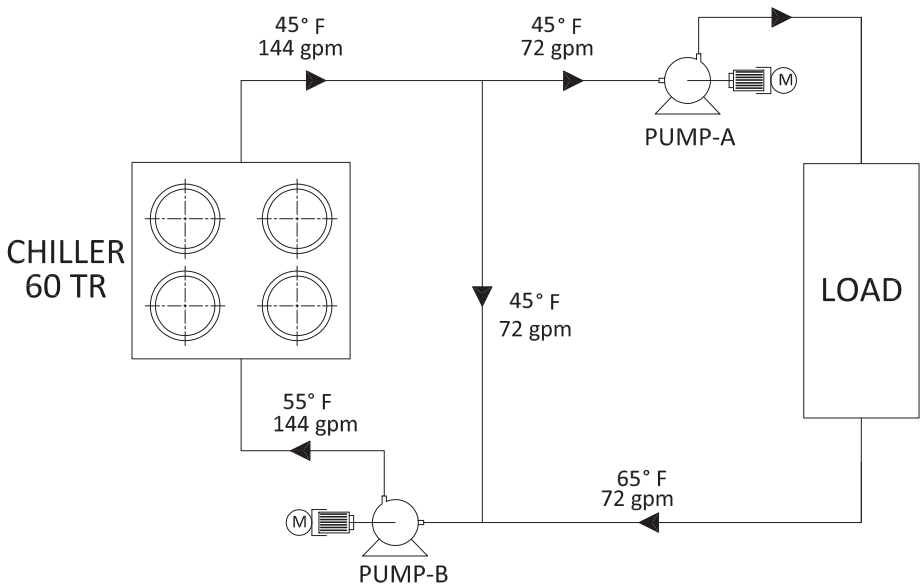
Having enough water loop time, hence enough water volume in the evaporator loop will prevent irregular compressor cycling, which means smoother operation.

Evaporator Water Flow Rate and Temperature Range

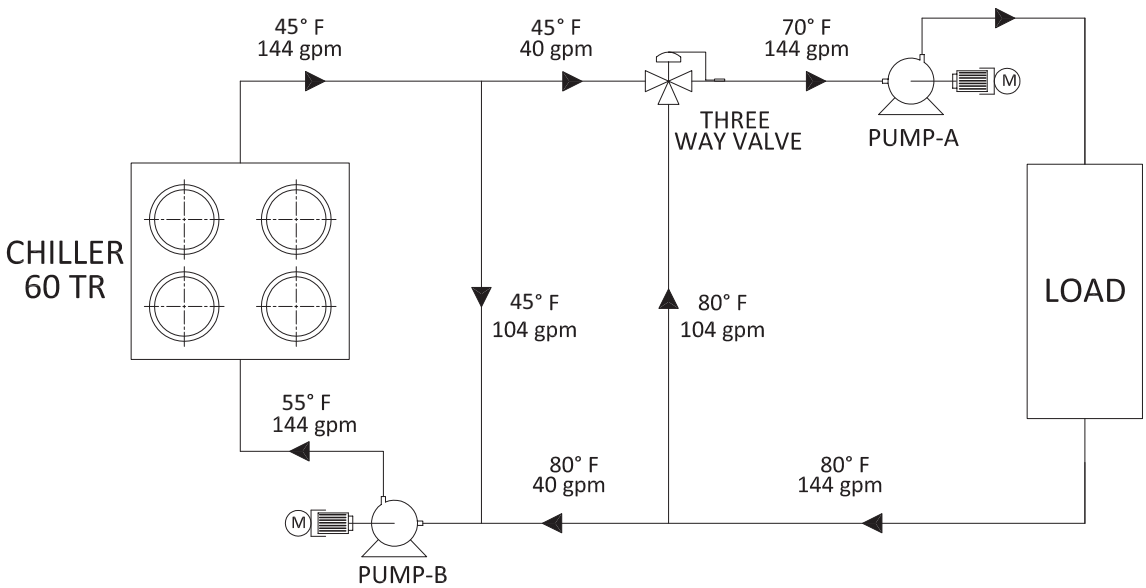
ACSC Series can operate at wide evaporator temperature range, within the water flow rate limits, Flexible enough to permit leaving water temperatures ranging from 41ºF (5ºC) to 60.5ºF (15ºC). The minimum and maximum water flow rates of each evaporator are shown in the Evaporator Water Pressure Drop table.

Although in a lot of process cooling applications, it could be found that the flow rates or leaving temperatures are outside the specified limits, however this can be solve by making changes in the chilled water piping arrangement.

EVAPORATOR WATER FLOW RATE OUTSIDE OF SPECIFIED LIMITS



EVAPORATOR WATER TEMPERATURE OUTSIDE OF SPECIFIED LIMITS



Unit Sizing

It is strongly recommended to size the chiller for the present load. For future expansion, it is recommended to install another chiller to meet the additional load demand.

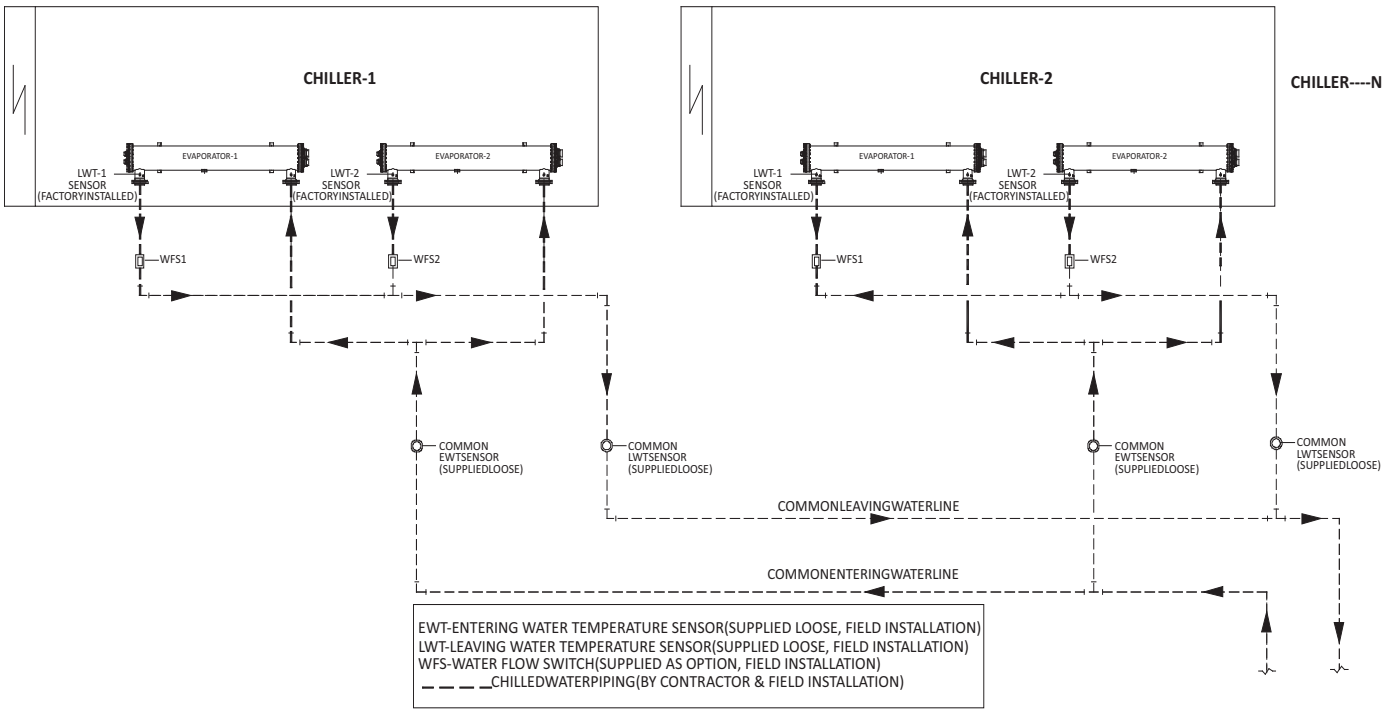
Over sizing of chillers by more than 10% at design conditions must be avoided. Over sizing causes energy inefficiency (more power consumption), erratic system operation and shortened compressor life due to excessive cycling of compressors.

Multiple Chiller Operation

If the capacity requires installing more than one chiller unit or where standby units are desired, units should be of equal size (or near) to ensure balanced water flow.

SABRO recommends - water flow supply & return are connected either parallel in case of range < 16°F (8.9°C) or in series if range > 16°F (8.9°C) .

Chilled Water Piping for Typical Multiple Chiller Installation



For chillers with two evaporators, pipes for leaving and entering water, from one evaporator should be joined to the corresponding pipe from the other evaporator, before connecting to the main header of the installation.

GUIDE SPECIFICATIONS

GENERAL

The contractor shall supply and install factory assembled air-cooled packaged water chillers, the number and capacity of which shall be as indicated in the capacity schedule shown on the drawings.

Each machine shall consist of at least one refrigerating circuit comprising of semi hermetic compact screw compressor(s), air-cooled condenser, evaporator, interconnecting refrigerant piping, controls, safety devices and accessories.

The machine shall be factory assembled, leak tested, evacuated and completely charged with refrigerant R-134a. All factory wiring and piping shall be contained within the machine enclosure. All electrical components shall be protected from the weather.

Air cooled chillers shall be rated in accordance with AHRI-550/590. Each machine shall be capable of operating satisfactorily in a wide range of ambient air temperatures ranging from 68°F (20°C) to 129.2°F(54 °C) .

Unless indicated otherwise on electrical wiring diagram, each unit shall be factory equipped to connect to only one electrical power feeder with the necessary circuit breakers.

Each unit shall be mounted on anti vibration isolators flexible enough to dampen any vibrations.

COMPRESSOR

Compressor shall be high performance and high efficiency screw type. The compressor shall be driven by an electric motor in a single housing. For stability and additional sound attenuation, the rotors shall be mounted in a double wall housing.

The compressor motor shall be refrigerant gas cooled. Each compressor shall be mounted on anti-vibration mounts to minimize vibration transmission.

Compressor shall have discharge stop off valves, built in three-stage oil separator, oil heater, oil sight glass, oil drain service valves and discharge check valve.

Compressor shall have automatic start unloading and shall have infinite capacity control. Each compressor shall be provided with safety devices including check valve in discharge gas outlet, motor winding temperature protection by integrated PTC sensors in each winding, phase sequence protection for direction of rotation, discharge temperature protection, oil pressure and oil level protection.

All compressors shall be provided with an individual 3 pole MCCB for short circuit protection & Isolation. Individual 3 pole contactors for switching of the compressors shall be rated for AC3 duty. To reduce the starting inrush on the power supply system, compressors shall be provided with part winding start or star-delta start depending on the models.

EVAPORATOR

Evaporator shall be of direct expansion, shell & tube type with removable head and 1, 2, or 3 refrigeration circuits. The bundle shall be made of copper tubes, expanded into steel tube sheets, with brass baffles located into a steel shell.

The evaporator shall be provided with water drain, air vent and fittings for temperature sensors. The shell shall be insulated with 1" (25mm) thick flexible closed cell insulation with a maximum K factor of 0.28 Btu.in/ft ^{2}.hr.°F (0.04 W/m.°K).

The evaporator shall be designed for 239.3 psig (1650 kPa) refrigerant side working pressure and 145 psig (1000 kPa) waterside working pressure.

CONDENSER COIL

Condenser coil shall be air cooled and shall be constructed of seamless Hi-X copper tubes, maximum 3 rows deep, 3/8" (9.52 mm) O.D. and mechanically bonded to the wavy type aluminum fins .

Fins spacing shall be maximum 14/15 FPI(1.59 mm) . Slit fins shall not be accepted. Precoated fins shall be used for saline and corrosive environment.

The coils shall be tested against leakage by air pressure of 450 psig (3102 kPa) under water.

CONDENSER FANS & MOTORS

The machine shall be furnished with direct driven propeller type discharging air upward condenser fans. Fans shall be constructed of corrosion resistant blades such as heavy gauge aluminum. The fan and drive shall be held in proper alignment. Fan assemblies shall be provided with heavy gauge, rust resistant steel. The fan assembly shall be protected with an acrylic coated steel wire fan guard. All condenser fans shall be individually statically and dynamically balanced for vibration free operation.

Condenser fan motor shall be Totally Enclosed Air Over, with Class F insulation, Class B temperature rise and IP55 protection. Also, Motor shall be with permanently lubricated bearings and inherent corrosion resistance shaft.

Condenser fan motors shall be provided with individual motor protector circuit breakers and contactor rated for Ac3 duty operation.

REFRIGERATION CIRCUITS

Refrigeration circuits piping shall be fabricated from ACR grade copper pipes and each refrigeration circuit shall include a removable core filter drier, electronic expansion valve, and shut off valve.

GUIDE SPECIFICATIONS

Suction line shall be insulated with ½" (13mm) wall thickness closed cell pipe insulation with maximum k factor 0.26 Btu.in/ft ^{2}.hr.°F (0.038 W/m.°K) .

CASING

Machine casing shall be made of heavy gauge zinc coated galvanized steel sheets conforming to JIS-G 3302 and ASTM-A 635.

To provide an extremely tough, scratch resistance, excellent anti-corrosive protection, fabricated steel shall be thoroughly de-greased and then phosphatized before application of an average 60 micron backed electrostatic polyester dry powder coating in RAL 7032 color scheme. This finish shall pass 1000 hour, 5% salt spray test at 95°F (35°C) and 95% relative humidity as per (ASTM B 117).

The machine shall be fully assembled on welded rigid structural steel skid painted with one coat primer and minimum one coat of rust-preventing black enamel.

CONTROL PANEL & CONTROLS

Control panel enclosure shall be fabricated out of heavy gauge steel in phosphatized, powder coated baked finish. The enclosure shall be conformed to IP54 as per guidelines in IEC 529. A hinged access door and key fastener shall be provided for easy access and security.

The control panel shall be ventilated using louvers and filters. The panel shall be factory wired in accordance with NEC 430 & 440, labeled, tagged and have 1 phase, 220 / 240 V for controls.

Control Panel should include the following components as minimum :

- Individual compressor and condenser fan motor contactors.
- Thermal magnetic circuit breakers for compressors and condenser fan motors.
- Voltage monitoring module for protection against under voltage, over voltage, phase loss, phase reversal and phase unbalance of the incoming voltage.
- Circuit breaker for control circuit.
- Remote/Off/Local selector switch.
- Microprocessor master board with graphical display.
- Microprocessor expansion boards as required.
- Electronic expansion valve control boards.
- Control Relays.
- Control circuit on/off switch and pump down switches.
- Volt free contacts for run, common fault and auto mode indications.
- Provision for accepting volt free contact for remote start/ stop.
- Control terminal blocks and power terminal blocks/bus bars.

A Microprocessor must be provided to control the chiller as a standard. The controller shall provide the flexibility with set points and control options that can be selected prior to the commisioning. The microprocessor shall provide a complete operational control for the chiller and shall have built-in auto diagnostic capability that can signal off normal operation or alarm conditions as well as shutting down the chiller.

The Master Micro Controller board shall have sensor inputs, digital inputs, relay outputs 0-10 Vdc analog outputs, keypad, graphics LCD with 2.8" diagonal viewing area, real time clock, RS-232, RS-485 and ethernet communication ports.

The main features of the Controller shall be as follows :

- A large graphical display with backlit that can be seen in bright or dim lighting.
- A user friendly nine button generic keypad.
- Battery backed up built-in real time clock to program two start/step daily and provide the information of running hours of the compressors.
- A multiple level passwords for security.
- Automatic lead/lag changeover of the compressors.
- Pump down at the beginning and end of every circuit cycle.
- Capacity control based on leaving chilled water temperature.
- Remote Start/Stop facility through Volt Free Contact.
- Volt Free Contacts for common Run, Fault and Remote mode operation status.

GUIDE SPECIFICATIONS

EASY ACCESSIBLE MEASUREMENTS SHALL INCLUDE THE FOLLOWING :

- Status of the chiller.
- Status of each circuit/compressor.
- Status of condenser fans.
- Leaving and Entering chilled water temperature.
- Suction pressure and temperature for each refrigerant circuit.
- Discharge pressure and temperature for each refrigerant circuit.
- Suction and discharge superheat for each refrigerant circuit.
- Oil pressure for each compressor.
- Winding temperature for each compressor.
- Ampere draw for each compressor.
- Expansion valve opening percentage.
- Ambient temperature.
- All active set points.
- Run time for each compressor.
- Number of compressor starts.
- Lockout and alarm status.
- Status of water flow switch, voltage monitor, compressor internal motor protector, oil level switch, run/stop input and pump down switches.
- Log of last 100 alarms.
- Lead compressor identification.
- Date and time.
- Graphs of all inputs and outputs.

THE FOLLOWING SYSTEM PROTECTION CONTROLS SHALL AUTOMATICALLY ACT TO ENSURE SYSTEM RELIABILITY AND PROTECTION OF THE UNIT THROUGH THE MICROPROCESSOR:

- Low suction pressure protection.
- High discharge pressure protection.
- High discharge temperature protection.
- Low discharge pressure protection.
- Low oil pressure protection.
- Low oil level protection.
- High compressor motor winding temperature protection.
- Low superheat protection.
- High compressor ampere protection.
- Compressor internal thermal protection.
- Freeze protection.
- Under voltage, over voltage, phase loss, phase reversal and phase unbalance protection.
- Chilled water flow loss protection.
- Sensor error protection.
- Pump down.
- Anti-recycle.
- Time delay between stages.
- 4-Levels of passwords to restrict the intentional mishandling.

Metric/Imperial Unit Conversion Table

Imperial → Metric

Linear Measure (Length/Distance)

Imperial	Metric
1 inch	25.4 millimetres
1 foot (=12 inches)	0.3048 metre
1 yard (=3 feet)	0.9144 metre
1 (statute) mile (=1760 yards)	1.6093 kilometres
1 (nautical) mile (=1.150779 miles)	1.852 kilometres

Square Measure (Area)

Imperial	Metric
1 square inch	6.4516 sq. centimeters
1 square foot (=144 square inches)	9.29 square decimeters
1 square yard (=9 square feet)	0.8361 square metres
1 acre (=4840 square yards)	0.40469 hectare
1 square mile (=640 acres)	259 hectares

Cubic Measure (Volume)

Imperial	Metric
1 cubic inch	16.4 cubic centimeters
1 cubic foot (=1728 cubic inches)	0.0283 cubic metres
1 cubic yard (=27 cubic feet)	0.765 cubic metres

Capacity Measure (Volume)

Imperial	Metric
1 (imperial) fl. oz. (=1/20 imperial pint)	28.41 ml
1 (US liquid) fl. oz. (=1/16 US pint)	29.57 ml
1 (imperial) gill (=1/4 imperial pint)	142.07 ml
1 (US liquid) gill (=1/4 US pint)	118.29 ml
1 (imperial) pint (=20 fl. imperial oz.)	568.26 ml
1 (US liquid) pint(=16 fl. US oz.)	473.18 ml
1 (US dry) pint (= 1/2 quart)	550.61 ml
1 (imperial) gallon (=4 quarts)	4.546 litres
1 (US liquid) gallon (=4 quarts)	3.785 litres
1 (imperial) peck (=2 gallons)	9.092 litres
1 (US dry) peck (=8 quarts)	8.810 litres
1 (imperial) bushel (=4 pecks)	36.369 litres
1 (US dry) bushel (=4 pecks)	35.239 litres

Mass (Weight)

Imperial	Metric
1 grain	0.065 gram
1 dram	1.772 grams
1 ounce (=16 drams)	28.35 grams
1 pound (=16 ounces =7000 grains)	0.45359237 kilogram
1 stone (=14 pounds)	6.35 kilograms
1 quarter (=2 stones)	12.70 kilograms
1 hundred weight (=4 quarters =112 lb.)	50.80 kilograms
1 (long) ton (=2240 lbs)	1.016 tonnes
1 (short) ton (=2, 000 lbs)	0.907 tonne

Metric → Imperial

Linear Measure (Length/Distance)

Metric	Imperial
1 millimetre	0.0394 inch
1 centimetre (=10 mm)	0.3937 inch
1 decimetre (=10 cm)	3.937 inches
1 metre (=100 cm)	1.0936 yards
1 decametre (=10 m)	10.936 yards
1 hectometre (=100 m)	109.36 yards
1 kilometre (=1000 m)	0.6214 miles

Square Measure (Area)

Metric	Imperial
1 square centire metre	0.1550 sq. inch
1 square metre (=10 000 sq. cm)	1.1960 sq. yards
1 are (=100 sq. metres)	119.60 sq. yards
1 hectare (=100 ares)	2.4711 acres
1 square kilometer (=100 hectares)	0.3861 sq. mile

Cubic Measure (Volume)

Metric	Imperial
1 cubic centimeter	0.0610 cubic inch
1 cubic metre (one million cu. cm)	1.308 cubic yards

Capacity Measure (Volume)

Metric	Imperial
1 millilitre	0.002 (imperial) pint
1 centilitre (=10 ml)	0.018 pint
1 decilitre (=100 ml)	0.176 pint
1 litre (=1000 ml)	1.76 pints
1 decalitre (=10 l)	2.20 (imperial) gallons
1 hectolitre (=100 l)	2.75 (imperial) bushels

Mass (Weight)

Metric	Imperial
1 milligram	0.015 grain
1 centigram (=10 mg)	0.154 grain
1 decigram (=100 mg)	1.543 grain
1 gram (=1000 mg)	15.43 grain
1 decagram (=10 g)	5.64 drams
1 hectogram (=100 g)	3.527 ounces
1 kilogram (=1000 g)	2.205 pounds
1 tonne (=1000 kg)	0.984 (long) ton

R-134a

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