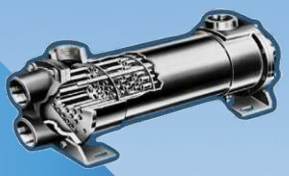
R-134a

Sabro

Air conditioning

WCS Series

Water-cooled Screw Chillers



Screw technology

THE COMPANY 55 Years

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).

63 TR to 490 TR

(220 kW to 1724 kW)

55 Years Of Excellence

ISO 9001:2008 CERTIFIED

UL

AHRI Standards/rating conditions

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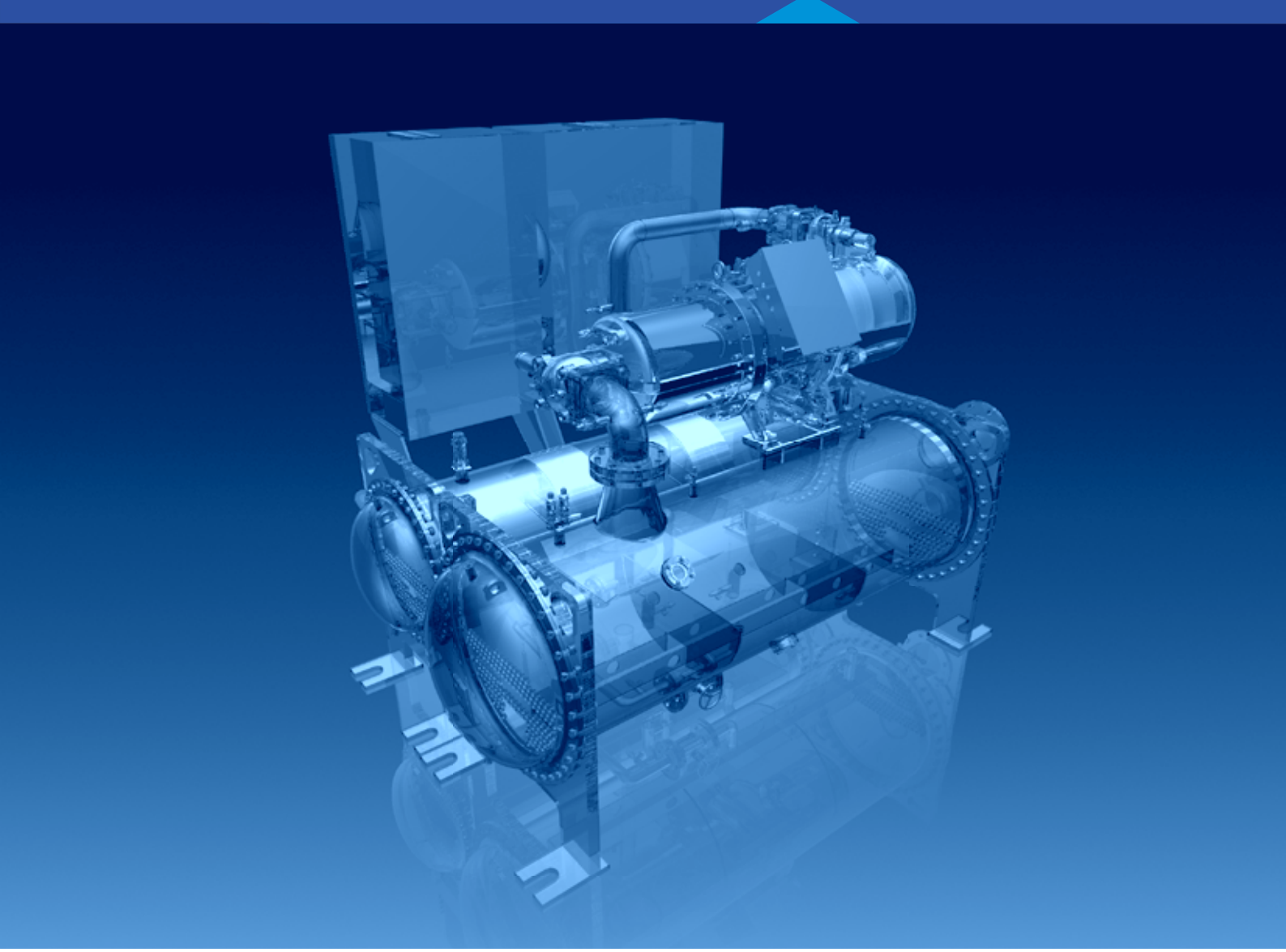
SABRO Compact Screw Chillers
WCS Series - R-134a

Water cooled Screw Chillers

(63 Tons to 490 Tons)

Sabro technologies is a wholly owned subsidiary of **Sabro group Pvt., Ltd.**, specializing in research, development and manufacturing of screw type products. The company sells water cooled screw chillers with optimum COP(HIGH ENERGY EFFICIENCY RATIO).

Adhering to the principle of integrity, innovation and excellence, the company constantly creates new products every year according to the market demands. The water cooled screw chillers/ water source heat pumps have the prime features of high energy efficiency ratio, high reliability, high efficiency, and high automation etc., which continues to lead the domestic refrigeration energy industry, opening a new era of high efficiency screw type of products.



SABRO Water cooled Screw chillers are complete, self-contained automatic units that include the latest technology in engineering components arranged to provide a compact and efficient chiller. Each unit is completely assembled; factory wired, evacuated, charged, tested and comes complete and ready for installation. Each Water cooled screw chiller unit consists of single/multiple Water-cooled condenser shells, single/multiple evaporator shells, one or more accessible semi-hermetic twin screw compressors, star-delta soft 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 screw compressor manufactured by specialized manufacturer, 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 condenser/chiller shells 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 Water-cooled screw chiller accomplishes high performance and reliability for industrial and commercial market.

CONTENTS

LEGENDS

The following abbreviations are used throughout this Catalogue :

AHRI	Air-Conditioning heating&Refr. Institute
CMH	Cubic meter per hr.
COP	Coefficient of performance
CEWT	Condenser Entering Water Temp
CLWT	Condenser Leaving Water Temp
CWFR	Condenser Water Flow Rate
ECWT	Entering Chilled Water Temp.
EER	Energy-Efficiency-Ratio
EWFR	Evaporator Water Flow Rate
FF	Fouling Factor
Hz	Hertz
Kg	Kilograms
kPa	Kilo Pascals
kW	Kilowatts
kCal/hr	Kilo calories/hr
LCWT	Leaving Chilled Water Temp.
mm	Millimeters
Ph	Phase
Psig	Pound per sq. inch gauge
Qty	Quantity
MPA	MegaPascals
TR	Tons of refrigeration = 12 MBH
V	Volts
WPD	Water Pressure Drop
GPM	Gallons per minute

INTRODUCTION

WCSC - Water Cooled Packaged Chillers have been designed and developed to meet high efficiency demands of today and to provide exellent reliability. Quality design and construction makes the WCSC Series a perfect choice for modern air conditioning applications and process cooling. All units are factory assembled, leak tested, evacuated, internally wired and charged with refrigerant R-134a. Every unit is fully tested before delivery and is ready for installation.

WCSC Series are designed and manufactured in accordance with the Sabro Quality Standard, approved by ISO 9001:2008 Standard and is rated in accordance with ARI Standard 550/590. WCSC Series are available in 37 models covering a wide capacity range from 63 to 490 TR (220 to 1724 kW).

Sabro
AIR CONDITIONING EQUIPMENT
Trust the Airxperts

NOMENCLATURE

WC SC - 5 6 4 0 Y

- WC : Water Cooled
- SC: Screw Package Chillers (Screw compressor)
- 5 = 50 Hertz
  6 = 60 Hertz
- Power Supply Code
  Y : 380V/3Ph/50Hz/60Hz
  Y1: 415V/3Ph/50Hz/60Hz
  P : 440V/3Ph/50Hz/60Hz
  (Consult SABRO)
- Nominal Capacity (TR)

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.

GENERAL FEATURES

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 WCS 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 Round-shape condenser shell is designed using numerical and experimental analysis, having optimum water flow path to optimize heat rejection performance.
Also, the enhanced condenser tubes geometry allows the optimum heat transfer performance at small water side pressure drop, and this reduces the pump-motor power consumption.

Low noise and low vibration

The unit is designed with a compact structure and robust assembly.
The unit configures compressor sound insulation box (Option), which makes Sabro WCS 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 evaporator/condenser shells production technology is already well-known to worldwide air conditioning manufacturing industries because of its leading chillers 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 water-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

Fluid flow analysis

Evaporator/Condenser shells part is appropriately designed by fluid flow analysis like inlet and outlet uniform water flow 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).

AHRI Standard 550/590

Providing independent, third-party verification, the AHRI regularly tests chiller to ensure compliance.

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.

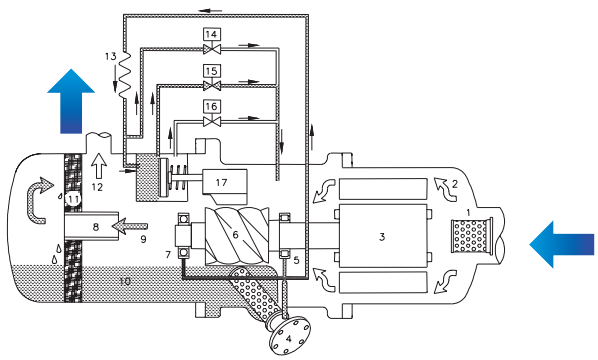
The compressor is equipped with separated radial and axial bearings, liquid injection and economizer connection, PTC motor temperature thermistors and discharge temperature thermistors, a motor protector, and oil level switch and oil pressure differential switch and other accessories.. The complete accessories 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.

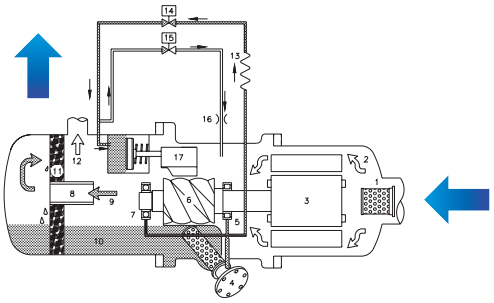
When the slide valve moves toward the right side, the effective compression volume in the compression chamber increases. This means the displacement of refrigerant gas also increases, as a result the refrigeration capacity also increases. However, when any of the step solenoid valve (for 4-step capacity 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.

Water cooled condenser shell

Horizontal shell and tube water cooled condensers are constructed from carbon steel shell, baefals, refrigerant connection, tube sheet headers. Tubes are constructed from copper.

Each condenser is constructed such a way to provide sub cooling circuit as an integral part. The water end cover is removable and the tube can be mechanically cleaned.

Shell and tube condensers are manufactured and constructed in accordance with CE, GOST, RINA, UDT and ASME standard.

Maximum working pressure of water side is 145 psig (1000 kPa). and for refrigerant side is 435 psig (3000 kPa).

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"

High COP

WCSC 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

WCSC Series chillers have compact design and are supplied as a complete package, ready to be wired and piped for operation. Screw compressors in Sabro **WCSC** 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

WCSC chillers are designed, as standard, to operate at a wide range of ambient temperatures from 68°F (20°C) to 129.2°F (54°C)
Consult **SABRO.**

MAIN COMPONENTS FEATURES

Compressors

WCSC 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.

WCSC 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.

Water cooled condenser shell

Horizontal shell and tube water cooled condensers are constructed from carbon steel shell, baffles, refrigerant connection, tube sheet headers. Tubes are constructed from copper.

Each condenser is constructed such a way to provide sub cooling circuit as an integral part. The water end cover is removable and the tube can be mechanically cleaned.

Shell and tube condensers are manufactured and constructed in accordance with CE, GOST, RINA, UDT and ASME standard.

Maximum working pressure of water side is 145 psig (1000 kPa). and for refrigerant side is 435 psig (3000 kPa).

Figure: Condenser shell

For marine type condensers, please consult SABRO

Evaporator

"Flooded" shell and tube type evaporator having refrigerant in the shell and chilled water inside the tubes. The shell is of "Falling film" shell and tube type evaporator having refrigerant in the shell and chilled water inside the tubes.

WCSC 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

WCSC 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 **WCSC** 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.

WCSC chillers and condensers shells are assembled on rigid structural MS/Steel skid channels painted with one coat galvanized 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

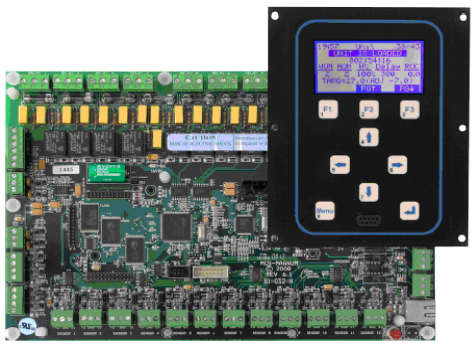
The refrigeration circuit piping is fabricated from ACR grade copper piping. Each refrigeration circuit includes filter drier, electronic expansion valve, and shut off valve. The refrigeration circuit suction line is insulated with ½" (13mm) wall thickness closed cell pipe insulation.

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 **WCSC** 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 **WCSC** 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, WCSC series models have single/multiple compressors with individual refrigerant circuits, equipped with necessary safety devices for smooth and reliable operations.
- WCSC unit is provided with HI-tECH Elec./Electronics control.
- Customized design (optional)for installation at sea-line-areas.
- Economical and energy efficient in operations.
- The WCSC 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.
- 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.
- 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 Micro Processor Controller

PC Support Software

PC software to communicate with **WCSC** 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

For marine type condensers, please consult SABRO

(Consult SABRO).

Galvanized Frame

Hot dip galvanized after manufacture, steel frame and base.

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 .

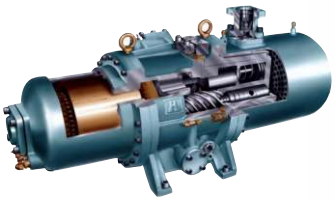
Voltmeter & Selector Switch (VSS)
For incoming line voltage.

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.

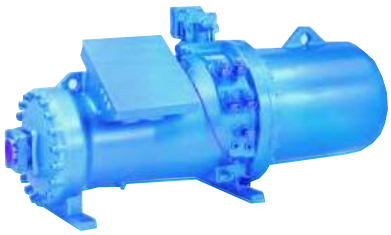
Hi-Lo Pressure Gauges-Loose (CSDG1)
Without piping or isolating pet cocks.



HI-TECH SCREW CHILLER

1- Using R134a refrigerant
2- Positive pressure refrigerant, no need for exhaust device, the design of ventilation is simple
3- Using Hanbell semi-closed double screw compressor
4- Using high efficiency falling film (spray) evaporator
5- Using independent oil return system (ejector pump oil return), which guarantees timely oil return at any loading condition
6- The machine adopts fixed orifice plate as flow control device which has no moving parts. The refrigerant flow can be adjusted in time without delay under variable load and variable conditions, so as to ensure stable operation of the package.
7- The microcomputer control system of the unit uses Hi-Tech UI, which clearly shows the operation data, and the operation is very convenient.

High reliability



1- Professional design

Hanbell specializes in the research and development of the technology of screw compressors. Its main product screw refrigeration compressor is used in large commercial central air conditioning and refrigeration equipment etc.. After
years of development, Hanbell has become one of the most powerful compressor manufacturers in HVAC engineering field. Hanbell screw compressor occupies a larger share in the domestic market of the screw compressor. Since 2006, Hanbell's market share has always been way ahead in the same industry.

2- Authoritative certification

The company has the most advanced water cooled chiller test bench which is certified by the National Quality Supervision and Inspection Center of compressor & refrigeration equipment (Hefei General Machinery Research Institute). The test bench in strictly established accordance with the national standard GB/T10870-2014, GB/T18430.1-2007 and GB/T 19409-2013. Each machine will go through a full set of strict performance test before delivery to ensure the performance of the package.

3- Reliable oil return device-ejector pump

The package uses an ejector pump as oil return component, and it uses medium pressure flash stream as the power, which completes oil return at the low pressure side without the energy loss of the package.

ENGINEERING SPECIFICATIONS

Technical specifications of Water cooled screw flooded chiller (single compressor)

Model Number			WFSC-234-S	WFSC-260-S	WFSC-280-S	WFSC-298-S	WFSC-323-S	WFSC-348-S	WFSC-380-S	WFSC-406-S
Nominal cooling capacity		Tons(RT)	66.5	74	80.4	85	92	98.6	108	115
		KW	234	260	283	298	323	346.7	380.7	405.7
		kCal/h x1000	201	224	243	257	278	211	326	348
Power input		KW	44.5	48.1	53.8	57.8	60.5	65.8	71.0	73.1
Rated current		Amps.	79.9	85.2	92.2	98.1	105	112.4	121.2	125
Power supply		Voltage	380-415-3-50Hz							
Energy efficiency ratio		EER (COP)	17.9 (5.25)	18.5 (5.40)	17.9 (5.26)	17.64 (5.15)	18.24 (5.33)	18 (5.26)	18.25 (5.36)	19 (5.54)
Capacity steps		%	25-50-75-100 OR step less as optional							
Compressor	Type		Semi-hermetic twin screw							
	Quantity		One	One	One	One	One	One	One	One
	Starting Method		y-Δ	y-Δ	y-Δ	y-Δ	y-Δ	y-Δ	y-Δ	y-Δ
	Rated speed (RPM)		2950	2950	2950	2950	2950	2950	2950	2950
Refrigerant			134a	134a	134a	134a	134a	134a	134a	134a
No. of refrigerant circuits			One	One	One	One	One	One	One	One
Refrigerant control			Orifice + electronic expansion valve							
Evaporator (cooler)	Type		Shell and Tube Flooded							
	Water passes		2	2	2	2	2	2	2	2
	Water flow rate EWFR	USGPM	159.6	177.6	193	204	221	237	259	276
		m^3/h	36.2	40.3	43.8	46.3	50.2	53.8	59	62.3
	Water pressure drop	KPa/feet	34/11	36/12	38/13	41/14	43/14	45/15	45/15	46/15
	Water side working pressure	MPa/PSI	1/145	1/145	1/145	1/145	1/145	1/145	1/145	1/145
	Water connection	mm	DN76	DN76	DN102	DN102	DN102	DN102	DN102	DN102
		Inch	3	3	4	4	4	4	4	4
Condenser	Type		Shell and tube							
	Water passes		2	2	2	2	2	2	2	2
	Water flow rate CWFR	USGPM	199.5	222	241.2	255	276	296	324	345
		m^3/h	45.3	50.42	55	58	62.7	67.2	73.6	78
	Water pressure drop	KPa/feet	36/12	38/13	40/13	43/14	44/14	47/16	48/16	48/16
	Water side working pressure	MPa/Psi	1/145	1/145	1/145	1/145	1/145	1/145	1/145	1/145
	Water connection	mm	DN76	DN76	DN102	DN102	DN102	DN102	DN102	DN102
		Inch	3	3	4	4	4	4	4	4
Dimensions (mm)		Length	3450	3450	3450	3450	3650	3640	3640	3640
		width	1500	1500	1500	1500	1550	1550	1550	1600
		height	1600	1600	1600	1600	1650	1650	1650	1700
Operating weight		Kg	2800	3000	3200	3450	3450	3450	3550	3550
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 (41°F – 59°F)							
	Entering condenser water temp.		20°C-35°C (68°F – 95°F)							

Specifications are based on standard conditions,
(ECWT/LCWT)Entering/leaving chilled water 12.7 °C/7.2 °C (55°F/45 °F)
(CEWT/CLWT)Entering/leaving condenser water 30 °C/35 °C (85°F/95 °F)
(FF)Fouling factor 0.0005Btu/hr/S qft/ °F
Specification s are subject to change keeping in view improvement in product.

ENGINEERING SPECIFICATIONS

Technical specifications of Water cooled screw flooded chiller (single compressor)

Model Number			WFSC-430-S	WFSC-490-S	WFSC-545-S	WFSC-585-S	WFSC-684-S	WFSC-785-S	WFSC-860-S
Nominal cooling capacity		Tons(RT)	121	139	155	166	194.5	223	245
		KW	427.3	490.3	544	585	684	783	862
		kCal/h x1000	366	420	469	502	588	674	741
Power input		KW	79	90.5	99.5	107.4	122	142	154.5
Rated current		Amps.	136.4	157	172	186.4	210	251	270
Power supply		Voltage	380-415-3-50Hz						
Energy efficiency ratio		EER (COP)	18.4 (5.4)	18.4 (5.41)	18.7 (5.46)	18.54 (5.45)	19.13 (5.6)	19 (5.5)	19 (5.6)
Capacity steps		%	25-50-75-100 OR step less as optional						
Compressor	Type		Semi-hermetic twin screw						
	Quantity		One	One	One	One	One	One	One
	Starting Method		y-Δ	y-Δ	y-Δ	y-Δ	y-Δ	y-Δ	y-Δ
	Rated speed (RPM)		2950	2950	2950	2950	2950	2950	2950
Refrigerant			134a	134a	134a	134a	134a	134a	134a
No. of refrigerant circuits			One	One	One	One	One	One	One
Refrigerant control			Orifice + electronic expansion valve						
Evaporator (cooler)	Type		Shell and Tube Flooded						
	Water passes		2	2	2	2	2	2	2
	Water flow rate EWFR	USGPM	290.4	333.6	372	398.4	467	535	588
		m^3/h	66	76	84.5	89.3	106	121.5	133.5
	Water pressure drop	KPa/feet	50/17	53/18	56/19	58/19	60/20	63/21	65/22
	Water side working pressure	MPa/Psi	1/145	1/145	1/145	1/145	1/145	1/145	1/145
	Water connection	mm	DN125	DN125	DN125	DN150	DN150	DN150	DN150
		Inch	5	5	5	6	6	6	6
Condenser	Type		Shell and tube						
	Water passes		2	2	2	2	2	2	2
	Water flow rate CWFR	USGPM	363	417	465	498	583.5	669	735
		m^3/h	82.4	95	105.6	113	132.5	152	167
	Water pressure drop	KPa/feet	52/18	55/18	58/19	59/20	60/20	62/21	66/22
	Water side working pressure	MPa/Psi	1/145	1/145	1/145	1/145	1/145	1/145	1/145
	Water connection	mm	DN125	DN125	DN125	DN150	DN150	DN150	DN150
		Inch	5	5	5	6	6	6	6
Dimensions (mm)		Length	3640	3640	3640	3640	3640	3640	3640
		width	1600	1600	1700	1700	1800	1800	1850
		height	1850	1850	1900	2000	2200	2200	2200
Operating weight		Kg	4000	4800	5500	5900	6200	6500	7000
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 (41°F – 59°F)						
	Entering condenser water temp.		20°C-35°C (68°F – 95°F)						

Specifications are based on standard conditions,

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

(CEWT/CLWT)Entering/leaving condenser water 30°C/35°C (85°F/95°F)

(FF)Fouling factor 0.0005Btu/hr/S qft/°F

Specification s are subject to change keeping in view improvement in product.

ENGINEERING SPECIFICATIONS

Technical specifications of Water cooled screw flooded chiller (double compressor)

Model Number (WFSC)			850-D	980-D	1088-D	1170-D	1370-D	1570-D	1725-D
Nominal cooling capacity @65HZ		Tons(RT)	243	278	309	332	389	445	490
		KW	854	980	1087	1169	1368	1566	1724
		KCal/hx1000	735	841	934	1004	1177	1346	1482
Power input (each comp.)		KW	79 +79	90 + 90	99 + 99	107+107	122+122	142+142	155+155
Rated current (each)		Amps.	136+136	157+157	172+172	187+187	211+211	252 +252	270+270
Power supply		Voltage	380-415-3-50Hz						
Energy efficiency ratio		EER COP	18.4 5.4	18.5 5.4	18.7 5.5	18.6 5.5	19.1 5.6	18.8 5.5	18.9 5.6
Capacity control		%	25-50-75-100% OR step less as optional						
Compressor	Type		Semi-hermetic twin screw						
	Quantity		two						
	Starting Method		Y-Δ						
	Rated speed		2950RPM						
Refrigerant			134a						
No. of refrigerant circuits			Two						
Refrigerant control			Orifice + electronic expansion valve						
Evaporator (cooler)	Type		Shell and tube flooded						
	Water passes		2						
	Water flow rate EWFR	USGPM	583	667	742	797	943	1068	1176
		m^3/h	134.4	151.5	168.5	181	214	242.5	267
	Water pr. drop	Kpa/feet	55/18	58/19	60/20	60/20	65/22	70/23.5	72 / 24
	Water side working Pr.	Mpa/PSI	1.0MPa/145						
	Water connection	MM	DN150	DN150	DN200	DN200	DN200	DN200	DN 200
		Inch	6	6	8	8	8	8	8
Condenser	Type		Shell and tube						
	Water passes		2	2	2	2	2	2	2
	Water flow rate CWFR	USGPM	729	834	927	996	1167	1335	1470
		m^3/h	165.6	189.4	210.5	226	265	303	334
	Water pr. drop	Kpa/feet	58/19	62/21	65/22	70/23	70/23	74/25	80/26
	Water side working pr.	Mpa/PSI	1.0MPa/145						
	Water connection	MM	DN150	DN150	DN200	DN200	DN200	DN200	DN 200
		Inch	6	6	8	8	8	8	8
Dimensions MM (inches)		Length	4600 (181)			4650(183)			
		width	1750 (69)			1800 (72)			
		height	2000 (79)			2210 (87)			
Operating weight APP.		Kg	6500	6850	7200	7400	7800	8500	9200
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 (41°F – 59°F)						
	Entering condenser water temp.		20°C-35°C (68°F – 95°F)						

Specifications are based on standard conditions,

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

(CEWT/CLWT)Entering/leaving condenser water 30 °C/35 °C (85°F/95 °F)

(FF)Fouling factor 0.0005Btu/hr/S qft/ °F

Specification s are subject to change keeping in view improvement in product.

ENGINEERING SPECIFICATIONS

Technical specifications of Water cooled inverter screw flooded chiller (single compressor)

Model Number (WFSC)			220-SV	260-SV	304-SV	370-SV	420-SV	500-SV	556-SV	760-SV
Nominal cooling capacity @65HZ		Tons(RT)	63.4	74.8	86.4	104.8	119.5	140.8	158.0	216
		KW	223	263	304	368.6	420	495	556.0	760
		KCal/hx1000	192	226	261	317	361	426	478	653
Power input		KW	45	51.2	59.1	71.0	80.4	94	104	142.4
Rated current		Amps.	76	87	101	122	137.2	160	179	242.5
Power supply		Voltage	380-415-3-50Hz							
Energy efficiency ratio		EER COP	16.98 4.9	17.5 5.13	17.5 5.14	17.7 5.19	17.8 5.22	17.97 5.26	18.2 5.34	18.2 5.34
Capacity control			(Modulating) variable speed							
Compressor	Type		Semi-hermetic twin screw							
	Quantity		one							
	Starting Method		By inverter, speed up 0HZ to 65HZ							
	Rated speed @ 65HZ		3840RPM							
Refrigerant			134a							
No. of refrigerant circuits			one							
Refrigerant control			Orifice + electronic expansion valve							
Evaporator (cooler)	Type		Shell and tube flooded							
	Water passes		2							
	Water flow rate	USGPM	152	179.5	207	252	287	338	380	518
	EWFR	m³/h	43.5	40.8	47.0	57.2	65.2	76.8	86.3	117.6
	Water pr. drop	Kpa/feet	34/11	36/12	41/14	45/15	47/16	53/18	56 / 19	63/21
	Water side working Pr.	Mpa/PSI	1.0MPa/145							
	Water connection	MM	DN76	DN76	DN102	DN102	DN125	DN125	DN 125	DN150
		Inch	3	3	4	4	5	5	5	6
Condenser	Type		Shell and tube							
	Water passes		2	2	2	2	2	2	2	2
	Water flow rate CWFR	USGPM	190	224	259	314	358	422	474	648
		m³/h	43.2	50.9	58.8	71.3	81.3	95.8	108	147
	Water pr. drop	Kpa/feet	36/12	38/13	43/14	48/16	48/16	55/18	60/20	62/21
	Water side working pr.	Mpa/PSI	1.0MPa/145							
	Water connection	MM	DN76	DN76	DN102	DN102	DN125	DN125	DN 125	DN150
		Inch	3	3	4	4	4	5	5	6
Dimensions MM (inches)		Length	3450 (136)			3640 (136)		3640 (136)		
		width	1500 (59)			1550 (61)		1700 (67)		
		height	1600 (63)			1650 (65)		2200 (87)		
Operating weight APP.		Kg	2800	3000	3500	3550	4000	4800	5500	6200
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 (41°F – 59°F)							
		Entering condenser water temp.	20°C-35°C (68°F – 95°F)							

Specifications are based on standard conditions,
(ECWT/LCWT)Entering/leaving chilled water 12.7 °C/7.2 °C (55°F/45 °F)
(CEWT/CLWT)Entering/leaving condenser water 30 °C/35 °C (85°F/95 °F)
(FF)Fouling factor 0.0005Btu/hr/S qft/ °F
Specification s are subject to change keeping in view improvement in product.

ENGINEERING SPECIFICATIONS

Technical specifications of Water cooled inverter screw flooded chiller (double compressor)

Model Number (WFSC)			840-DV	915-DV	990-DV	1050-DV	1110-DV	1315-DV	1520-DV
Nominal cooling capacity @65HZ		Tons(RT)	239	260	281	298	316	374	432
		KW	840	915	990	1050	1110	1315	1520
		KCal/hx1000	723	786	850	901	956	1131	1306
Power input (each comp.)		KW	80 +80	80 + 94	94 + 94	94+ 104	104+104	104+142	142+142
Rated current (each)		Amps.	137+137	137+160	160+160	160179	179+179	179 +243	243+243
Power supply		Voltage	380-415-3-50Hz						
Energy efficiency ratio		EER COP	16.93 5.2	17.9 5.25	17.9 5.25	18.0 5.3	18.2 5.33	18.5 5.43	18.25 5.35
Capacity control			(Modulating) variable speed						
Compressor	Type		Semi-hermetic twin screw						
	Quantity		two						
	Starting Method		By inverter, speed up 0HZ to 65HZ						
	Rated speed @ 65HZ		3840RPM						
Refrigerant			134a						
No. of refrigerant circuits			Two						
Refrigerant control			Orifice + electronic expansion valve						
Evaporator (cooler)	Type		Shell and tube flooded						
	Water passes		2						
	Water flow rate EWFR	USGPM	574	624	675	715	758	898	1037
		m³/h(CMH)	130.4	142	153	162.3	172	204	236
	Water pr. drop	Kpa/feet	55/18	58/19	60/20	60/20	65/22	70/23.5	72 / 24
	Water side working Pr.	Mpa/PSI	1.0MPa/145						
	Water connection	MM	DN150	DN150	DN200	DN200	DN200	DN200	DN 200
		Inch	6	6	8	8	8	8	8
Condenser	Type		Shell and tube						
	Water passes		2	2	2	2	2	2	2
	Water flow rate CWFR	USGPM	717	780	843	894	948	1122	1296
		m³/h	163	177	191	203	215	255	294
	Water pr. drop	Kpa/feet	58/19	62/21	65/22	70/23	70/23	74/25	80/26
	Water side working pr.	Mpa/PSI	1.0MPa/145						
	Water connection	MM	DN150	DN150	DN200	DN200	DN200	DN200	DN 200
		Inch	6	6	8	8	8	8	8
Dimensions MM (inches)		Length	4600 (181)			4650(183)			
		width	1750 (69)			1800 (71)			
		height	2000 (79)			2210 (87)			
Operating weight APP.		Kg	6500	6850	7200	7400	7600	7900	8200
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 (41°F – 59°F)							
	Entering condenser water temp.	20°C-35°C (68°F – 95°F)							

Specifications are based on standard conditions,
(ECWT/LCWT)Entering/leaving chilled water 12.7 °C/7.2 °C (55°F/45 °F)
(CEWT/CLWT)Entering/leaving condenser water 30 °C/35 °C (85°F/95 °F)
(FF)Fouling factor 0.0005Btu/hr/S qft/ °F
Specification s 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	Water
Maximum Working Pressure	psig	300	145
	kPa	2068	1000
Test Pressure	psig	450	200
	kPa	3102	1379

Cooler Fouling Factors

The units are rated at 0.0001 ft².h.°F/Btu (0.018m².°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.

	Fouling Factor		Capacity Multiplier	Power Multiplier
	ft².h°F/Btu	m².°C/kW		
Evaporator	**0.00010**	**0.018**	1.00	1.00
	0.00025	0.044	0.99	1.00
	0.00050	0.088	0.98	0.99
	0.00100	0.176	0.95	0.98
	0.00200	0.352	0.90	0.96
Condenser	**0.00025**	**0.044**	1.00	1.00
	0.00050	0.088	0.99	1.00
	0.00100	0.176	0.96	1.03
	0.00200	0.352	0.91	1.09

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

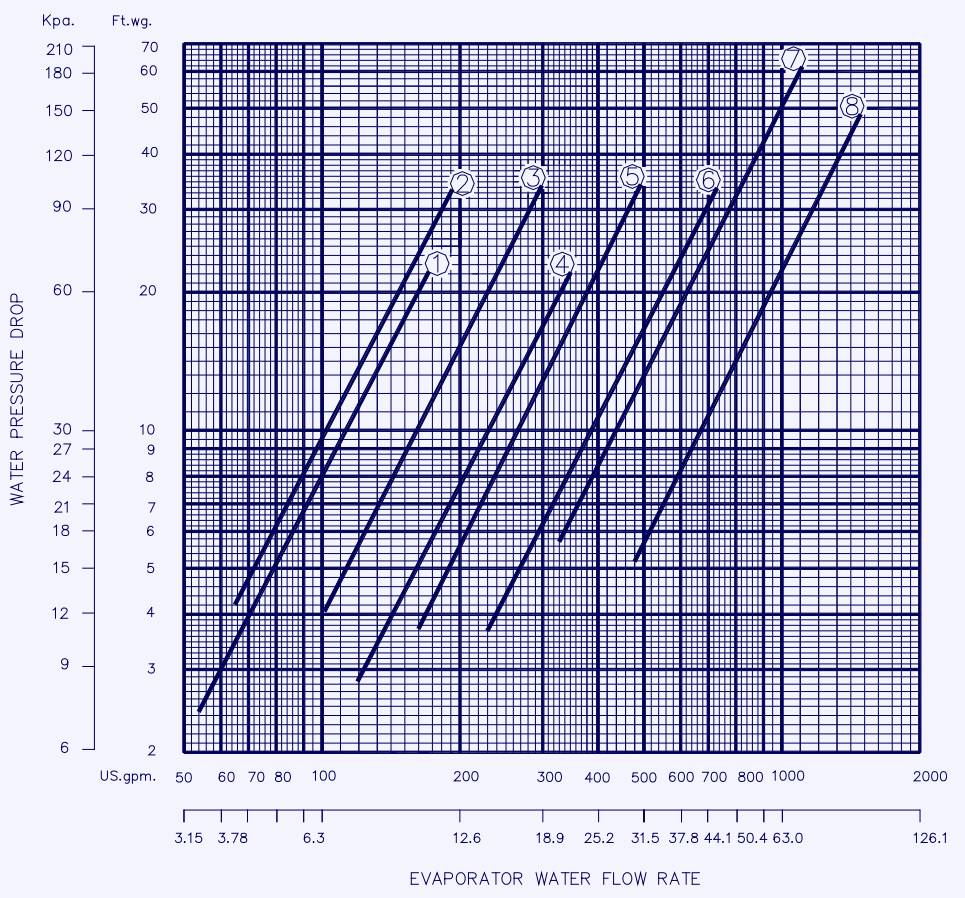
Range Correction Factors

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	°C		
Evaporator	8	4.4	0.995	0.998
	10	**5.5**	1.000	1.000
	12	6.7	1.005	1.002
	14	7.8	1.010	1.004
	16	8.9	1.015	1.006
Condenser	8	4.4	1.020	0.988
	10	**5.5**	1.000	1.000
	12	6.7	0.980	1.012
	14	7.8	0.970	1.030
	16	8.9	0.960	1.045

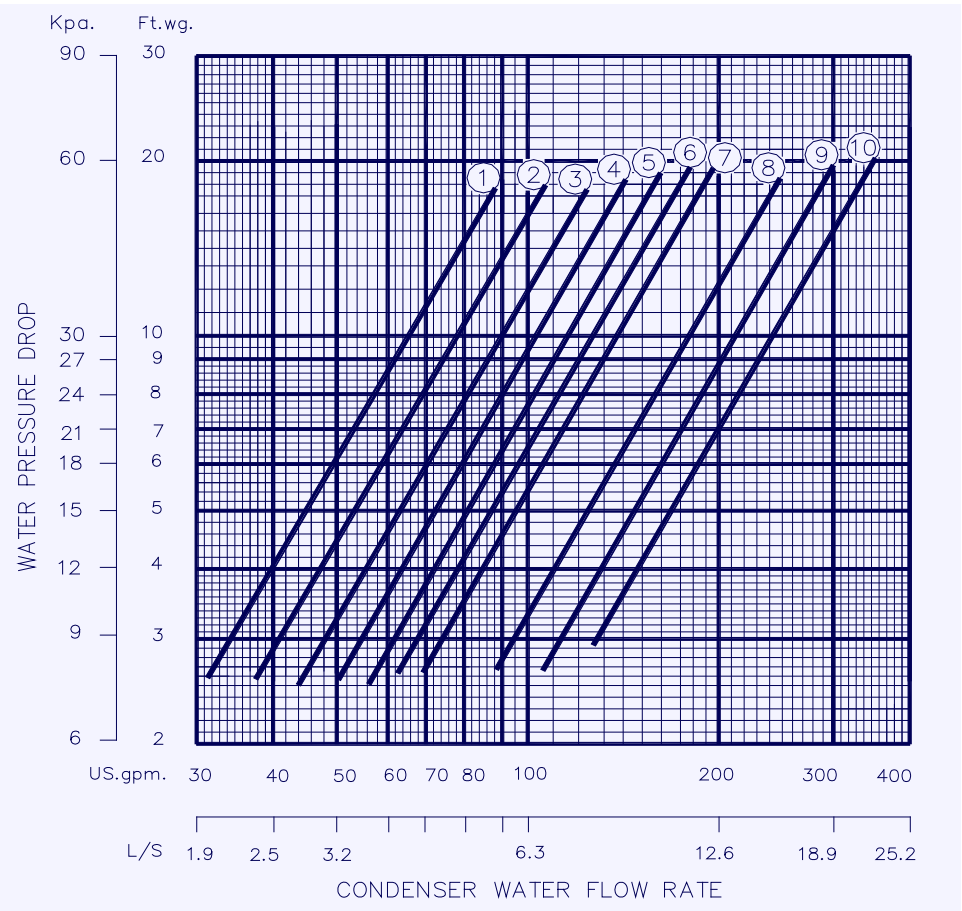
WPD-Evaporator

Evaporator water pressure drop



WPD-Condenser

Condenser water pressure drop



ELECTRICAL DATA
(Single & Double compressor)

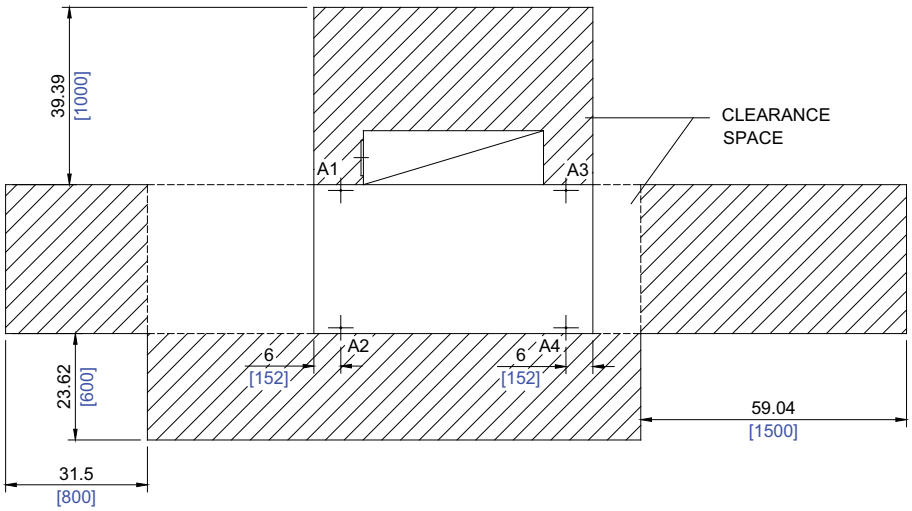
Model WWC	Screw Compressor (Each.)					Unit total current & fuse size		
	Qty	Starting method	RLA	FLA	LRA	RLA	FLA	MFA
234-S	1	y-Δ	79.90	114.3	368.0	79.90	114.3	140.0
260-S	1	y-Δ	85.20	121.8	392.0	85.20	121.8	150.0
280-S	1	y-Δ	92.20	131.8	424.0	92.20	131.8	160.0
298-S	1	y-Δ	98.10	140.4	452.0	98.10	140.4	180.0
323-S	1	y-Δ	105.0	150.0	483.0	105.0	150.0	190.0
348-S	1	y-Δ	112.4	161.0	517.0	112.4	161.0	200.0
380-S	1	y-Δ	121.2	173.5	558.0	121.2	173.5	220.0
406-S	1	y-Δ	125.0	179.0	575.0	125.0	179.0	230.0
430-S	1	y-Δ	136.4	195.0	626.0	136.4	195.0	250.0
490-S	1	y-Δ	157.0	224.5	723.0	157.0	224.5	280.0
545-S	1	y-Δ	172.0	246.0	792.0	172.0	246.0	310.0
585-S	1	y-Δ	186.4	266.0	858.0	186.4	266.0	330.0
684-S	1	y-Δ	210.0	300.0	966.0	210.0	300.0	380.0
785-S	1	y-Δ	251.0	359.0	1155.0	251.0	359.0	450.0
860-S	1	y-Δ	270.0	386.0	1242.0	270.0	386.0	480.0
220-SV	1	y-Δ	76.00	109.0	350.0	76.00	109.0	140.0
260-SV	1	y-Δ	87.00	124.0	400.0	87.00	124.0	160.0
304-SV	1	y-Δ	101.0	144.0	465.0	101.0	144.0	180.0
370-SV	1	y-Δ	122.0	174.0	562.0	122.0	174.0	220.0
420-SV	1	y-Δ	137.2	196.0	632.0	137.2	196.0	250.0
500-SV	1	y-Δ	160.0	229.0	736.0	160.0	229.0	290.0
556-SV	1	y-Δ	179.0	256.0	824.0	179.0	256.0	320.0
760-SV	1	y-Δ	242.5	347.0	1116.0	242.5	347.0	440.0
850-D	2	y-Δ	136+136	200+200	626+626	136+136	200+200	250+250
980-D	2	y-Δ	157+157	224+224	722+722	157+157	224+224	280+280
1088-D	2	y-Δ	172+172	246+246	792+792	172+172	246+246	310+310
1170-D	2	y-Δ	187+187	267+267	860+860	187+187	267+267	340+340
1370-D	2	y-Δ	211+211	301+301	971+971	211+211	301+301	380+380
1570-D	2	y-Δ	252+252	360+360	1160+1160	252+252	360+360	450+450
1725-D	2	y-Δ	270+270	386+386	1242+1242	270+270	386+386	480+480
840-DV	2	y-Δ	137+137	196+196	631+631	137+137	196+196	250+250
915-DV	2	y-Δ	137+160	196+229	631+736	137+160	196+229	250+290
990-DV	2	y-Δ	160+160	229+229	736+736	160+160	229+229	290+290
1050-DV	2	y-Δ	160+179	229+256	736+824	160+179	229+256	290+320
1110-DV	2	y-Δ	179+179	256+256	824+824	179+179	256+256	320+320
1315-DV	2	y-Δ	179 +243	256 +347	824+1118	179 +243	256 +347	320+440
1520-DV	2	y-Δ	243+243	347+347	1118+1118	243+243	347+347	440+440

y-Δ = Star-delta / Soft Starter,
R L A = Rated load amps at Entering/leaving condenser water 30°C/35°C (85°F/95°F)
F L A = Full load amps at Entering/leaving condenser water 30°C/35°C (85°F/95°F)
L R A = Locked Rotor Amps
M F A = Maximum fuse amps

DIMENSIONAL DATA

WCSC Models with Single Compressor

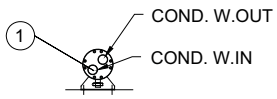
234-S, 260-S, 280-S, 298-S, 323-S, 348-S, 380-S, 406-S, 430-S, 490-S, 545-S, 585-S, 684-S, 785-S, 860-S, 220-SV, 260-SV, 304-SV, 370-SV, 420-SV, 500-SV, 556-SV, 760-SV — Dimensions in MM



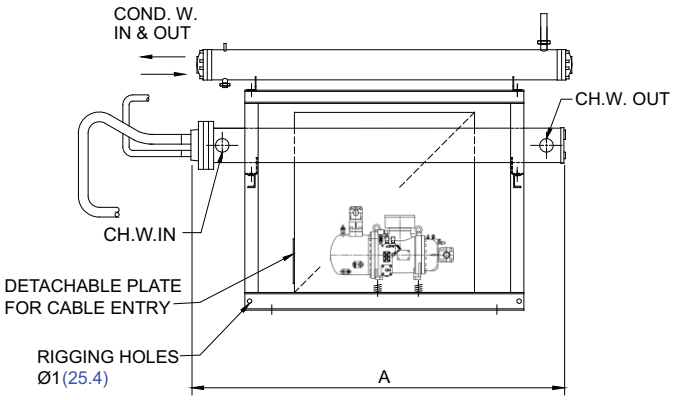
LEGEND

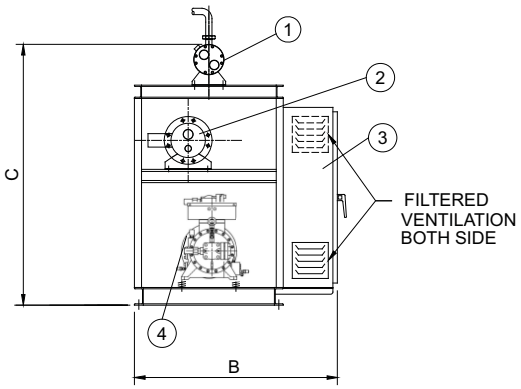
1. WATER COOLED CONDENSER
2. EVAPORATOR
3. CONTROL PANEL
4. COMPRESSOR

ALL DIMENSIONS ARE IN INCHES (MM)
A1-A4 ARE LOADING POINTS Ø3/4 (19)



TYPICAL CONNECTION
REFER TO ACTUAL LAYOUT





MODEL	WIDTH (A)	DEPTH (B)	HEIGHT (C)
WCSC 234-S	3450	1500	1600
WCSC 260-S	3450	1500	1600
WCSC 280-S	3450	1500	1600
WCSC 298-S	3450	1500	1600
WCSC 323-S	3650	1550	1650
WCSC 348-S	3640	1550	1650
WCSC 380-S	3640	1550	1650
WCSC 406-S	3640	1600	1700
WCSC 430-S	3640	1600	1850
WCSC 490-S	3640	1600	1850
WCSC 545-S	3640	1700	1900
WCSC 585-S	3640	1700	2000

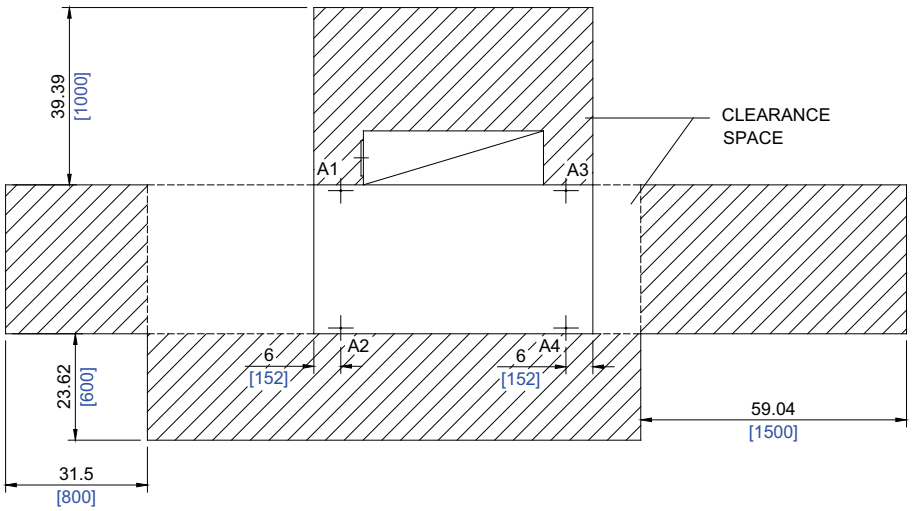
MODEL	WIDTH (A)	DEPTH (B)	HEIGHT (C)
WCSC 684-S	3640	1800	2200
WCSC 785-S	3640	1800	2200
WCSC 860-S	3640	1850	2200
WCSC 220-SV	3450	1500	1600
WCSC 260-SV	3450	1500	1600
WCSC 304-SV	3450	1500	1600
WCSC 370-SV	3640	1550	1650
WCSC 420-SV	3640	1550	1650
WCSC 500-SV	3640	1700	2200
WCSC 556-SV	3640	1700	2200
WCSC 760-SV	3640	1700	2200

DIMENSIONAL DATA

WCSC Models with Double Compressor

850-D, 980-D, 1088-D, 500-D, 1170-D, 1370-D, 1570-D,
840-DV, 915-DV, 990-DV, 1050-DV, 1110-DV, 1315-DV & 1520-DV

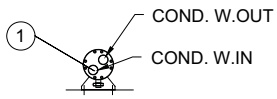
Dimensions in MM



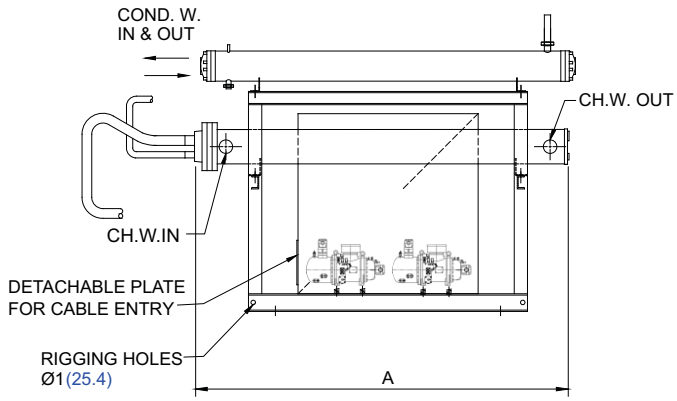
LEGEND

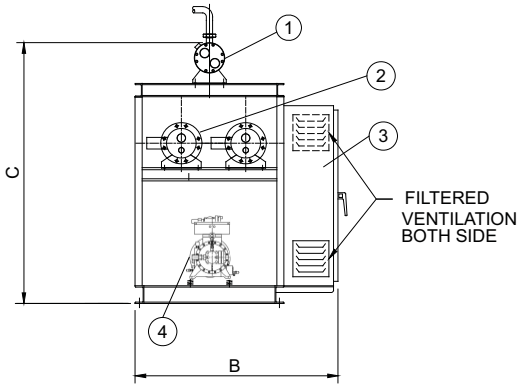
1. WATER COOLED CONDENSER
2. EVAPORATOR
3. CONTROL PANEL
4. COMPRESSOR

ALL DIMENSIONS ARE IN INCHES (MM)
A1-A4 ARE LOADING POINTS Ø3/4 (19)



TYPICAL CONNECTION
REFER TO ACTUAL LAYOUT





MODEL	WIDTH (A)	DEPTH (B)	HEIGHT (C)
WCSC 850-D	4600	1750	2000
WCSC 980-D	4600	1750	2000
WCSC 1088-D	4600	1750	2000
WCSC 1170-D	4650	1800	2210
WCSC 1370-D	4650	1800	2210
WCSC 1570-D	4650	1800	2210
WCSC 1725-D	4650	1800	2210

MODEL	WIDTH (A)	DEPTH (B)	HEIGHT (C)
WCSC 840-DV	4600	1750	2000
WCSC 915-DV	4600	1750	2000
WCSC 990-DV	4600	1750	2000
WCSC 1050-DV	4650	1800	2210
WCSC 1110-DV	4650	1800	2210
WCSC 1315-DV	4650	1800	2210
WCSC 1520-DV	4650	1800	2210

APPLICATION / INSTALLATION

Checking of the site information

Before installing the chiller unit, check the site in advance, review the necessary details and coordinate the followings with the site personnel so that the installation can be performed safely and accurately.

1) Work scope and unit data: Check the site installation work scope and approved documents.
2) Installation location: Check the environmental condition to install the chiller.
3) Check the entrance size(width, length and height) to the installing site in advance not to have any trouble in moving. Then check and review the detail method and order for moving the unit.

The environmental condition of installation site

The site space to install or store the product along with the following environmental condition should be considered.

1) Be careful not to damage the piping, insulation materials and wires of the chiller unit when storing and installing.
   The site should have ventilation measures for the refrigerant leakage.
2) Select site with good ventilation.
   If the chiller unit is charged with
   refrigerant and the pressure of the unit exceeds the limit, the pressure relief valve will be operated and discharge the refrigerant gas resulting in the loss of refrigerant gas along with potential loss of lives. If the machine room temperature is over 40°C, the pressure vessel should be reconfigured. Check the set pressure for the relief valve of the chiller unit and maintain the room below the relief valve operating temperature consulting the authorized service engineer of Sabro.
3) Store the chiller unit in dry and safe location without any vibration.
4) The floor surface to install the chiller unit should be flat and of sufficient strength and mass to support the chiller operating weight.
5) Avoid place of any fire or flammable materials near. When installed in parallel to the heating object such as a boiler, sufficient care to the radiation heat is required.
6) Be careful with high humidity as it causes the electric error and the corrosion of the chiller unit.
7) Select the site with less dust as the dust cause electric error.
8) Provide enough space around the unit to allow the installation and maintenance personnel access to all service points such as replacing heat exchanger tubes and waterbox to open.
9) Secure maximum or safe height to fit to the crane for easy lifting and lowering of the chiller unit.
10) Secure good drainage from the machine room.
11) Secure sufficient lighting considering the repair and maintenance.
12) This chiller unit is manufactured for indoor use. Therefore avoid installing outdoors or a place under direct sunlight.
13) Protect the unit by vinyl cover form dust and rains.
14) When installing the chiller unit, plan appropriately in accordance with the installation of High Pressure Gas Safety Control Act. (Local standard)

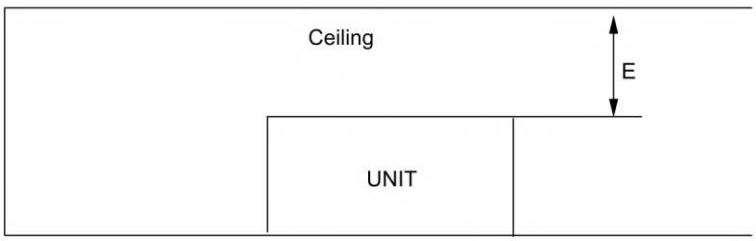
APPLICATION / INSTALLATION

Securing service space

1) Before installation, provide enough space for the service and maintenance as indicated on the foundation drawing.
This is the minimum required space for the maintenance.

Shutting down.

4) To ensure stable operation of the chiller, level the chiller by adjusting the level plate within 1/16”



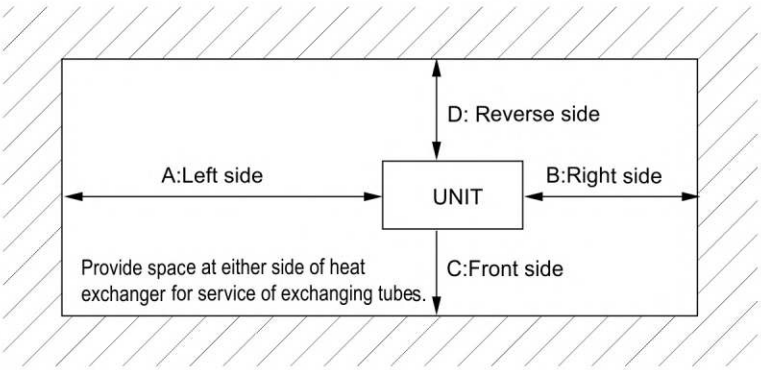


Figure. Minimum space requirement for installation

Dimensions in “MM”

Model	A	B	C	D	E
WCS-SINGLE CIRCUIT	2,500	1,500	1,500	1,500	1,000
WCS-DOUBLE CIRCUIT	3,100	1,500	1,500	1,500	1,000

APPLICATION / INSTALLATION

Foundation

A f at concrete foundation or floor which can support the operating weight of the equipment must be provided and the unit must be level for proper operation and functioning of controls.

Vibration Isolation

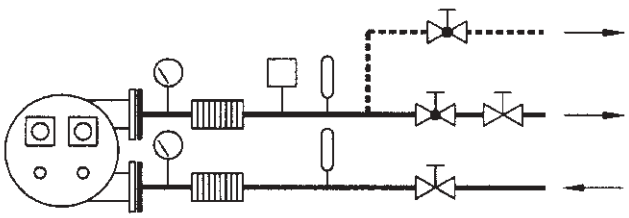
Under certain critical conditions it is recommended that vibration isolators of rubber-in-shear or spring type be installed under the base.
The isolators must be designed for the operating weight of the unit. For operating load points refer to the Dimensional Data. Correct selection of types of isolators depends upon application and structure.

To further reduce the transmission of vibration, it is recommended that flexible water connections suitable for the system pressure be installed on the water inlet and outlet connections of the chiller. For critical applications or locations, services of a noise and vibration expert is recommended.

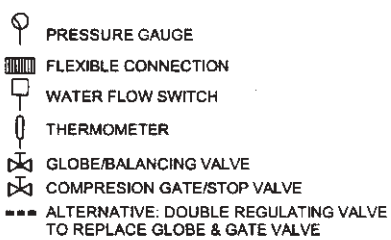
Water Piping Practices

Due to the variety of piping practices, it is advisable to follow the recommendations of local authorities. They can supply the installer with the proper building and safety codes required for a safe and proper installation. Basically the piping should be designed with a minimum number of bends and changes in elevation to keep the system cost down and performance up. It should contain :

1. Vibration eliminators to reduce vibration and noise transmission to the building.
2. Shut-off valves to isolate the unit from the piping system during unit servicing.
3. Manual or automatic air vent valves at the high points of the system so that the air can be vented.
4. An expansion tank to control system pressure allowing water to expand on increase of water temperature.
5. Make necessary arrangements to install a water flow switch on the leaving water connection to ensure adequate water flow and wire it with the terminals provided in the unit control panel. This will safeguard against slugging the compressor on start-up and shut down the unit should the water flow be interrupted. Refer to the Installation instruction sheet furnished with the water flow switch.
6. Temperature and pressure indicators located at the unit to aid in unit servicing.
7. A strainer or some means of removing foreign matter from the water before it enters the pump. It should be placed far enough upstream to prevent cavitation at the pump inlet (consult pump manufacturer for recommendations). The use of a strainer will prolong pump life and thus keep system performance up. All building water piping must be flushed prior to making final connection to the chiller.
8. Prior to insulating the piping and filling the system a preliminary leak check should be made.
9. Piping insulation should include a vapor barrier to prevent moisture condensation and possible damage to the building structure. It is important to have the vapor barrier on the outside of the insulation to prevent condensation within the insulation on the cold surface of the pipe.



TYPICAL CHILLED WATER PIPING



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.

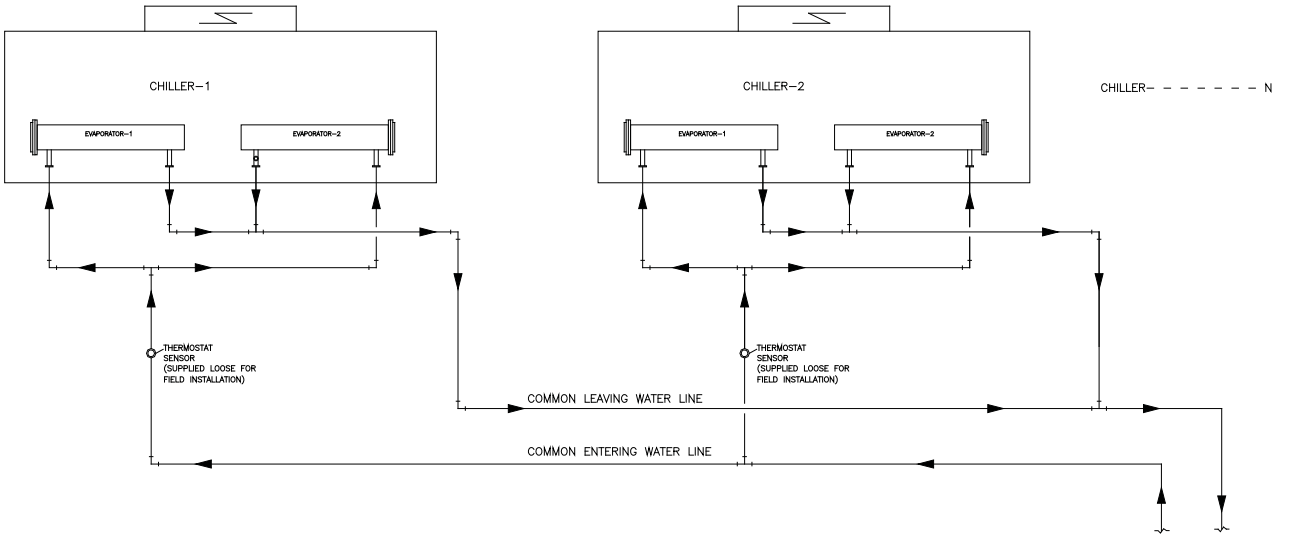
Over sizing of chillers by more than 10% at design conditions must be avoided. Over sizing causes energy inefficiency (more power consumption), erratic system operation and shortened compressor life due to excessive cycling of compressors.

Multiple Chiller Operation

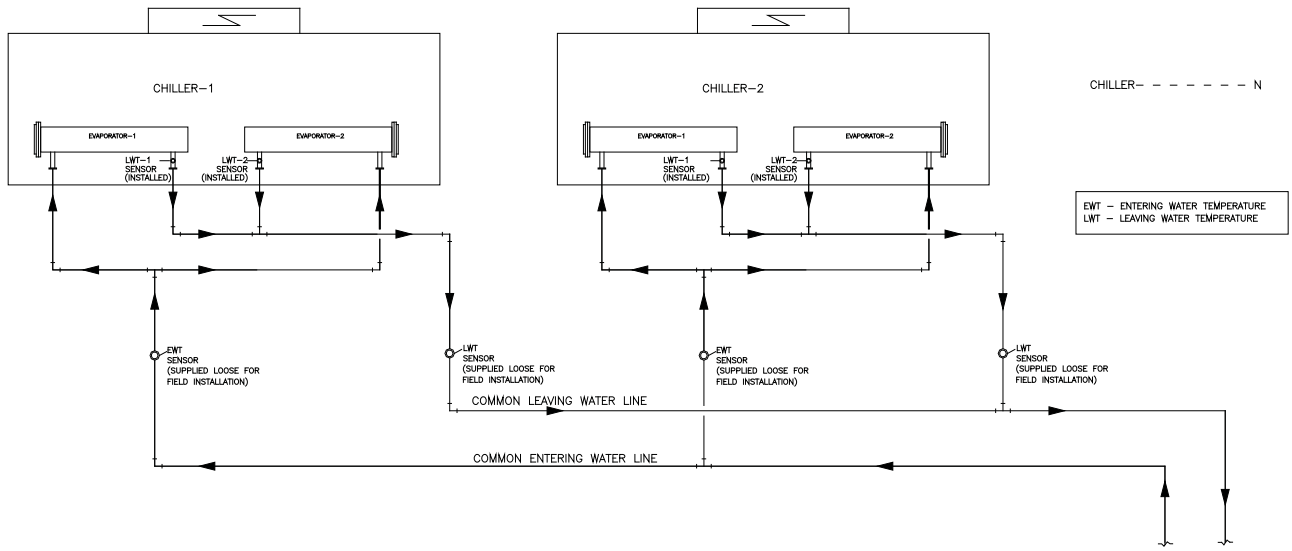
If the capacity requires installing more than one chiller unit or where standby units are desired, units should be of equal size (or near) to ensure balanced water flow.

Sabro recommends that 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).

TYPICAL MULTIPLE CHILLER (WITH TWO EVAPORATORS) PIPING (WITH STANDARD CONTROL)



TYPICAL MULTIPLE CHILLER (WITH TWO EVAPORATORS) PIPING (WITH MCS CONTROL)



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 water-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 single / multiple screw type high efficiency compressor(s), water-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.

Water-cooled chillers shall be rated in accordance with ARI - 550/590. Each machine shall be capable of operating satisfactorily in a wide range of water temperatures ranging up to 100°F (37.8°C).

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

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

Compressor

WCSC 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.

Evaporator

Evaporator shall be of direct expansion, shell & tube type with removable head and 1, 2 or 3 refrigeration circuits. The tube 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" (25 mm) thick flexible closed cell insulation with a maximum K factor of 0.26 Btu.in/ft^2.hr.°F (0.038 W/m.^{O}K). The evaporator shall be designed for 421 psig (2900 kPa) refrigerant side maximum working pressure and 145 psig (1000 kPa) water side maximum working pressure.

Shell and tube evaporator design, materials specifications of the assembly process shall be in compliance with the codes CE, GOST, RINA, UDT and ASME Standard.

Condenser

Water-cooled Condensers shall be horizontal, shell and tube type, constructed from carbon steel shell, baf fes, refrigerant connection and tube sheet headers.Tubes shall be constructed from copper. Water end covers shall be removable and the tubes can be mechanically cleaned.

Condensers shall be constructed such a way to provide sub-cooling circuit as an integral part of the condenser.

Maximum working pressure of the water side shall be 145 psig (1000 kPa) and refrigerant side shall be 435 psig (3000 kPa) .

Water-cooled shell and tube type condensers shall be manufactured and constructed in accordance with CE, GOST, RINA, UDT and ASME standard.

Marine type condensers shall be provided if so specified.

Refrigerant Circuits

Refrigeration circuits piping shall be fabricated from ACR grade copper pipes and each refrigeration circuit shall include a removable core filter drier, liquid line solenoid valve, thermostatic expansion valve, shut off valve, sight glass and hot gas muffler. For single compressor circuits, vibration absorbers on suction and discharge lines shall be provided. Suction line shall be insulated with ½" (13 mm) wall thickness closed cell pipe insulation.

Structure Frame

WCS chillers shall be fully assembled on a rigid structural steel skid channels painted with one coat galvanized primer and one coat black enamel. The package shall be assembled for easy handling during transportation and robust support during installation and operation.

GUIDE SPECIFICATIONS

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 motor contactors.
- Thermal magnetic circuit breakers for compressors.
- 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.

Easy Accessible Measurements Shall Include the FOLLOWING :

- Status of the chiller.
- Status of each circuit/compressor.
- Status of condenser.
- 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

Water cooled Screw Chillers

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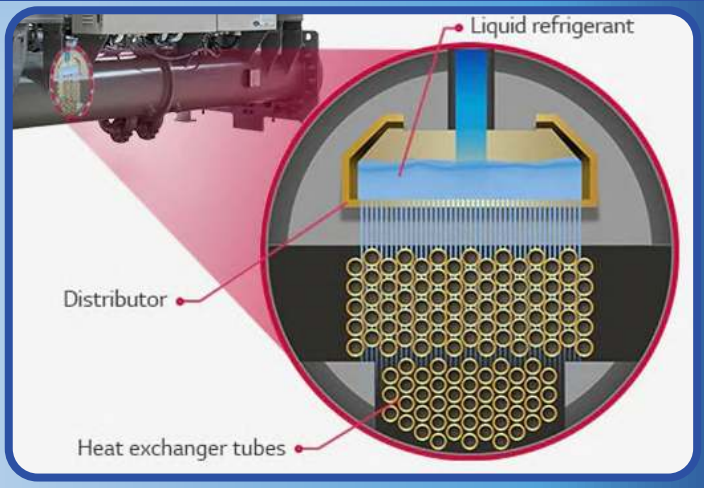

It was the fruit of commitment, hope and hard work that enabled us to be the pioneers of HVAC manufacturing in Pakistan, exporting to over 22 countries, encapsulating 3 continents. We now thrive as an agile manufacturer for a complete range of HVAC manfacture including Chillers, Self-Contained units, Air-Side Equipment, Mini Split Units & a menagerie of customised HVAC manufacture tailored to suit every HVAC requirement of the customer.

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