Helios

Air Cooled Screw Chillers

ACHX-C 60Hz

Cooling Capacity: 100 to 439 TR (352 to 1545 kW)

R134a

AHRI CERTIFIED®
www.ahridirectory.org
Air-Cooled Water Chilling Packages
AHRI Standards 550/590 and 551/591

ASHRAE 90.1 COMPLIANT

DUNHAM-BUSH®

Products that perform...By people who care

INTRODUCTION

For more than 100 years, Dunham-Bush has focused on innovative product development. Today, we provide a full portfolio of HVAC/R products from Fan Coil Units to large centrifugal chillers as well as many other innovative green solutions. Our commitment to innovation, matched with an aggressive attitude toward growth, makes Dunham-Bush a leader in global markets. Our product development is tailored to meet the specific needs of customers. No other HVAC/R manufacturer takes this approach to meeting your performance expectations.

HELIOS, ACHX-C Air Cooled Screw Flooded Chillers, have a cooling capacity range from 100 to 439 TR [352 to 1545 kW] in 60Hz version using environmentally friendly HFC-134a refrigerant. The entire product line features energy efficiency, installation ease, control flexibility, high reliability and advanced Vision controller. The ACHX-C series are certified to AHRI Standard 550/590 and the unit's performance easily exceeds ASHRAE Standard 90.1-2016.

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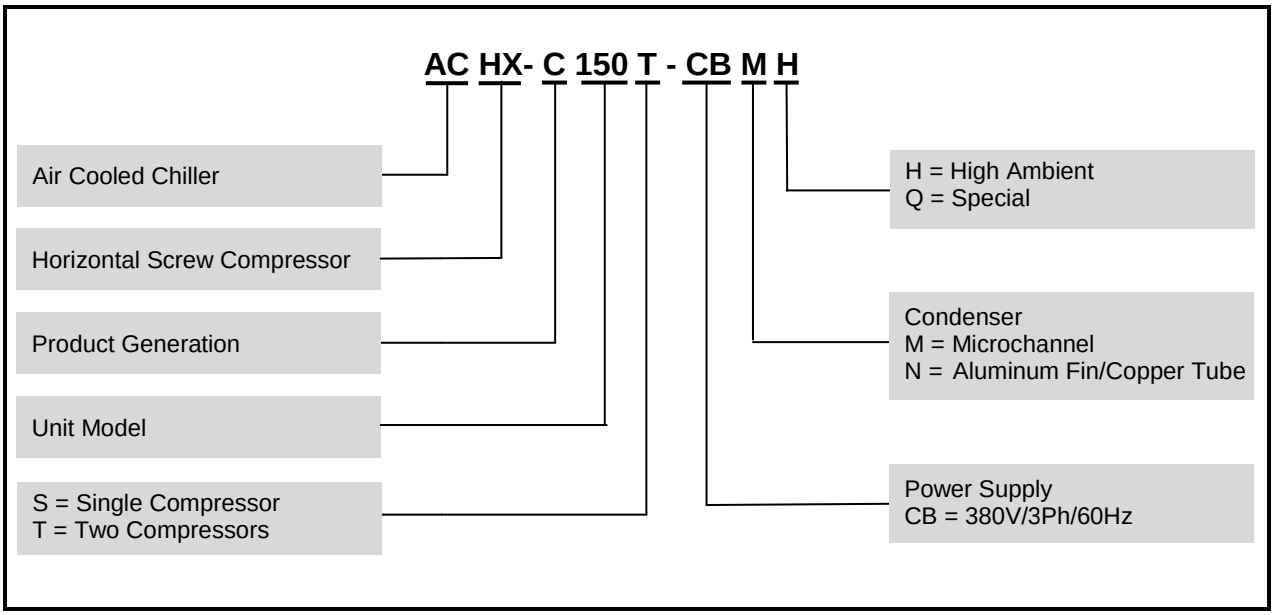
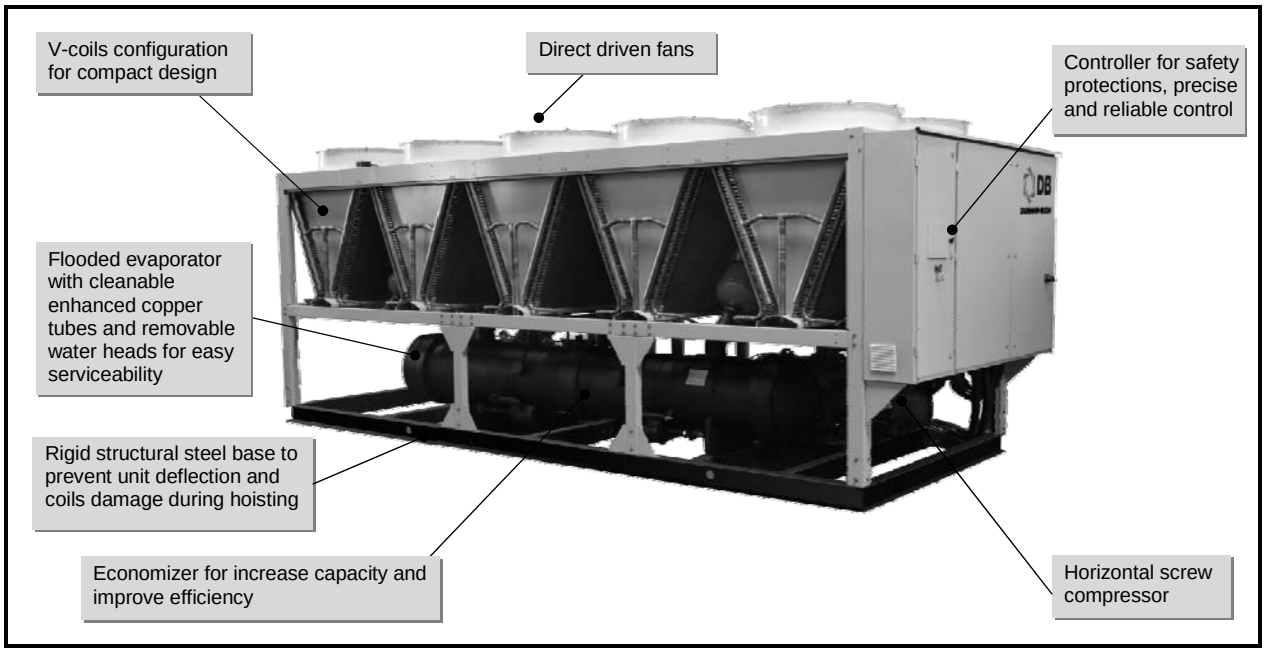
NOMENCLATURE



GENERAL CHARACTERISTICS



UNIT FEATURES

General

- 18 models from 100 to 439 TR [352 to 1545 kW] in accordance with AHRI standard conditions
- Multiple compressors models with independent refrigerant system per compressor provide redundancy, and superior part load efficiency
- The unit is designed to operates with R134a, the environment friendly refrigerant with zero ***ODP*** (Ozone Depletion Potential)
- Unit operating ambient temperature, 45~131°F [7~55°C]

Compressor

- Semi-hermetic Horizontal Screw Compressor
- Suction gas-cooled compressor motor
- Multiple rotary screw compressors design for better reliability and redundancy
- External oil pump not required
- Optimized oil management
- Integrated PTC sensor in each motor winding for thermal motor temperature monitoring
- Infinite variable capacity control with sliding valve mechanism
- Discharge service valve is provided for the ease of servicing

Evaporator

- Shell-and-tube flooded type heat exchanger
- Two pass arrangement
- Integral finned copper tubes to maximized heat transfer area
- Cleanable copper tubes for easy serviceability
- Removable water heads for service
- Victaulic groove water connection comply to ANSI/AWWA C-606
- Standard with 1" thick closed cell insulation
- Standard relief valve(s) – ¾" [19mm] FPT
- Pressure test up to 220psig for refrigerant side, and 195psig for water side
- Isolation valves for refrigerant filter dryers are provided to allow filter core replacement without pump down the chiller. This greatly improve the servicing expenses and time

Condenser and Fans

- The Microchannel condenser coil is an all aluminum coils with multiple flat tubes containing small channels (Microchannels) metallurgically brazed with louvered fin.
- All Microchannel coils come with TCP-Coating which provides an anti-corrosion protective layer for the coil
- "V" coil design to increase condensing surface area to maximize heat rejection
- "V" coils arrangement with internal baffle for fan cycling and staging
- IP55, Class "F" insulation fan motors for outdoor applications

UNIT FEATURES

Electronic Expansion Valve

- Advanced electronic expansion valve (EEV) is used for precise control of liquid refrigerant flow into the evaporator
- Evaporation of liquid refrigerant in evaporator is controlled at precise level for optimum performance

Economizer

- The economizer circuit consists of plate type heat exchanger, expansion valve and solenoid valve
- Refrigerant is sub-cooled at economizer before entering the evaporator
- The economizer increased cooling capacity by means of increasing the sub-cooling
- Cooling capacity is increased significantly with marginal increases in kW-input, thus, unit EER is improved

Control Panel

- Weather tight electrical enclosure fabricated by heavy gauge sheet steel with powder coated baked finishing
- Single point power connection for all models
- Unit mounted reduced inrush starter for compressor motors
- Circuit breaker for compressors and condenser fan motors
- Step down transformer for power supply to control circuit
- Main power supply monitoring module. Protection on under or over voltage, phase reversal, phase losses and imbalance
- Unit mounted Remote/Off/Local (R/O/L) selector, an operation and servicing friendly feature
- Overload protection relay for compressors
- Vision controller – the state-of-art Dunham-Bush proactive advanced controller that adapts to any abnormal operating conditions and for safety protections
- Chilled water pump control

VISION CONTROLLER

Vision controller a flexible and advance programmable microprocessor controller designed specifically for the application and precise control of Dunham-Bush Rotary Screw compressor chillers.

The controller is provided with a set of terminals that connect to various devices such as temperature sensors, pressure and current transducers, solenoid valves, compressors and fans starters, control relays, etc. Three sizes of controller boards are provided to handle different number of input and output requirements: DB5-S small, DB5-M medium and DB5-L large board.

The unit algorithm program and operating parameters are stored in FLASH-MEMORY that does not require a back-up battery. The program can be loaded through PC or programming key.

Vision controller is equipped with a user friendly terminal with a semi-graphic display and dedicated keys that provides easy access to the unit operating conditions, control set points and alarm histories.

Each unit's controller can be configured and connected to the Dunham-Bush DBLAN network that allows multiple chillers sequencing control without additional controller or panel. Dunham-Bush DBLAN is the local area network made up of several chillers' controller.

Display and User Terminal

The Vision controller is designed to work with a user friendly back-lit 132 by 64 pixels DBGe Semi-Graphic Display panel connected with the controller through a telephone cable. The terminal display allows carrying out of the unit operations, and also allows the unit working conditions, compressor run times and alarm history to be displayed. Set points and other parameters can be modified via the user terminal. The display has an automatic self-test of the controller on system start-up. Multiple messages will be displayed automatically by scrolling from each message to the next. All of these messages are spelled out in English on the display terminal.

Easily accessible measurements include:

- Leaving and entering chilled water temperature
- Rate of Change for leaving chilled water temperature
- Evaporator and condenser pressure
- Compressor discharge temperature and superheat
- Ambient temperature
- Current drawn by each compressor
- Compressor capacity (percentage of FLA, Full Load Amps)
- Run hours of each compressor
- Number of starts of each compressor
- Electronic Expansion Valve (EEV) Opening Percentage
- Compressors and condenser fans motors status
- Oil Level Status, Water Flow Switch Status, Remote Start/Stop Command Status

UNIT FEATURES

Capacity Control

Leaving chilled water temperature control is accomplished by entering the water temperature setpoint and placing the controller in automatic control. Vision controller monitors all control functions and moves the compressors slide valve to the required position to match the building cooling load demand.

The compressor ramp (loading) cycle is programmable and may be set for specific building requirements. Remote adjustment of the leaving chilled water setpoint is accomplished either through High Level Interfacing (HLI) via BMS communication, or Low Level Interfacing (LLI) via an external hardwired, 4 to 20mA chilled water reset control signal. Remote reset of compressor current limiting function can be accomplished in a similar fashion.

System Control

The unit may be started or stopped manually, or through the use of an external signal from a Building Automation System. In addition, the controller may be programmed with seven-day operating cycle or other Dunham-Bush control packages may start and stop the system through inter-connecting wiring.

System Protection

The following system protection controls will automatically act to ensure system reliability:

- Low evaporator pressure
- High condenser pressure
- Freeze protection
- Low suction-discharge pressure differential
- Low compressor oil level
- Compressor run error
- Power loss
- Chilled water flow loss
- Sensor error
- Compressor over current
- Compressor Anti-recycle
- High motor temperature
- Compressor overload

The controller can retain up to 99 alarm histories complete with time of failure together with data stamping on critical sensor readings in an alarm condition. This tool will aid service technicians in troubleshooting tasks enabling downtime and nuisance trip-outs to be minimized.

Remote Monitoring And Control (Option)

Dunham-Bush, the leader of HVAC solution provider understands the arising focus on chiller plant performance and optimization. Several solutions as below are offered to the building owner to achieved optimized chiller plant room controls, operation and performance.

Dunham-Bush Chiller Plant Manager (CPM)

DB Chiller Plant Manager (***CPM***) is a trustworthy and headache-free solution for building owners and users on chiller plant control and automation system. ***CPM***'s advanced controllers monitor and control equipments in chiller plant such as chillers, primary and secondary chilled water pumps, variable frequency drives (VFD), motorized valves, bypass modulating valves, and etc. Field devices such as flow meters, BTU meters, digital power meters, sensors & transducers can be interfaced with ***CPM*** via HLI or LLI. CPM controls chillers and pumps sequencing, as well as lead-lag, duty-standby and alarm changeover operations.

NetVisorPRO – Monitoring software of ***CPM*** system which allows system monitoring, historical trending, and alarm logging to be carry out at a PC terminal. Graphical animations on system operation, temperature and flow rate trend graphs, historical data and alarm history logs, settings changes are all available with ***NetVisorPRO***.

Chiller plantroom control and automation by Dunham-Bush ***CPM*** provides the owners with a chiller system in stable operation, optimized performance and energy efficiency.

DB-LAN Master Slave Sequencing Control (MSS)

In a chiller system with multiple Dunham-Bush chillers, Vision controller of each chiller can be connected to the DB-LAN network via a communication bus without additional controller, to enable Master-Slave Sequencing Control of this chiller system. ***MSS*** will stage in/out chiller in operation to match building required cooling capacity. Chiller Lead-lag, duty-standby and alarm changeover controls are come with ***MSS***, as well as the chilled water pumps control. Each ***MSS*** DB-LAN network can be connected up to 8 numbers of chillers.

Building Management System (BMS) Communication

Vision controller is able to communicate to BMS through the add-on communication card via various common protocols as:

- Modbus RTU RS485, ModBus TCPIP
- BACnet over IP, MS/TP, or PTP
- LONworks FTT10

OPTIONS AND ACCESSORIES

- **Heat Recovery** – The hot gas desuperheater; a shell-and-tube heat exchanger that reclaims 'waste' heat from compressor to produce hot water up to 55°C
- **Microchannel Condenser Enhanced Corrosion Protection** – Optional E-Coating which provides an enhanced anti-corrosion protective layer for microchannel coil for harsh environment
- **Fin and Tube Condenser** – Coil constructed of seamless inner grooved copper tubes expanded into die-formed aluminium slit fins
- **Fin and Tube Condenser Corrosion Protection** – Copper (CU) fin or coated fin for fin and tube coil are provided to give better corrosion protection.
- **Service valve** – Compressor suction service valve is supplied to further isolate the compressor from evaporator
- **Hotgas Bypass** – To maintain unit operation below minimum unloaded capacity
- **Low Ambient Operation (LA 1)** – Variable frequency drive (VFD) is incorporated to the condenser fan motor to allow unit operation down to 14 ^{o}F [-10 ^{o}C] ambient temperature
- **Extra Low Ambient Operation (LA 2)** – Add-on low ambient kit to allow unit operation down to -20°F [-29°C] ambient temperature

  Note: Please consult factory for this option
- **Double Thick Insulation** – Evaporator with double thick 2" [50mm] closed cell insulation, for extra resistance to condensation
- **Evaporator Anti-Freeze Protection** – When chiller is not operating at ambient temperature 32°F [0°C] or below, the immersion heater and circulating pump will be in operation to prevent water freezing in evaporator **(Some of the model unit dimension may change for this option)**
- **250psig Working Pressure Vessel** – Evaporator with 250psig working pressure on water side
- **Condenser Coil Guard** – To protects condenser coil from unauthorized access
- **Evaporator Flanged Water Connection** – Flanged water connection is available as option
- **Dual Mode Operation** – The unit with dual mode operation can deliver chilled fluid temperature down to 18^{o}F [-7.8^{o}C] during ice making mode. Units with Dual Mode Operation is used for Ice Thermal Storage System
- **Low Temp. Operation** – The unit with Low Temp. Operation can deliver chilled fluid temperature down to 18^{o}F [-7.8^{o}C] for process cooling application
- **ASME/ PED Compliance** – Evaporator with ASME/ PED approval is available
- **Thermal Dispersion Flow Switch** – Optional thermal dispersion flow switch (TDFS) can be installed at the evaporator leaving fluid connector. The TDFS function is to provide evaporator fluid flow indication for chiller startup.
- **BMS Communication** – Various add-on communication cards provide BMS communication via common protocols: Modbus RTU RS485 / TCPIP, LONworks FTT10, BACnet over IP / MSTP / PTP
- **CE Compliance** – Unit with CE compliance is available on request

Electrical And Controls

- **Unit Mounted Main Disconnect Switch –** Non-fused disconnect switch with external lockable handle is furnished to isolate unit main incoming power supply for servicing
- **Softstarter For Compressor Motors** – Solid State starter comes with bypass contactor to reduced mechanical stress and inrush current at compressor start-up
- **Ground Fault Interrupt (GFI)** – Provides equipment with ground fault protection
- **Ammeter/ Voltmeter** – Analog ammeter and voltmeter with 3 phase selector switch for indication, located inside the control panel
- **Chilled Water Reset/ Demand Limiting** – Low level interfacing with Building Automation System (BAS). Chilled Water Reset allows controlled temperature setpoint to be reset by a 4-20mA signal from BAS; while Demand Limiting will limit the maximum current drawn by the compressors by 4-20mA signal from BAS
- **Ambient Temperature Monitoring** – Temperature sensor to monitor unit operating ambient temperature
- **System Voltage Measurement** – System voltage option is a safety features to protect system from high and low voltage due to unbalance power supply. The controller will trigger alarm high or low voltage and cut-off running system
- **IP55 Control Panel** – IP55 rated control panel can be supplied for harsh working environment
- **Vision Controller Touch Screen** – 7" touch screen for display and user configuration
- **BMS Communication** – Various add-on communication cards provide BMS communication via common protocols: Modbus RTU RS485 / TCPIP, LONworks FTT10, BACnet over IP / MSTP / PTP

OPTIONS AND ACCESSORIES

Factory Supplied, Field Installed By The Customer

- **Evaporator Water Flow Switch**– Flow switch to be installed at evaporator and condenser outlet piping as safety interlock to evaporator and condenser water flow status. Three options are available: Weather tight flow switch with CE mark; NEMA 1, and NEMA 4 rated flow switch
- **Rubber-In-Shear Isolators** – Designed for ease of installation. These one-piece molded rubber isolators are applicable for most installations
- **Spring Isolators** – These housed spring assemblies have a neoprene friction pad at the bottom to prevent the passage of noise, and a spring locking levering bolt at the top. Neoprene inserts prevent contact between the steel upper and lower housings. Suitable for more critical application as compared to rubber-in-shear isolator
- **DB-LAN Master Slave Sequencing Control (*MSS*) –** Pre-programmed at factory; field supplied and installed inter-connection wiring between chillers to provide communication bus among chillers' controllers to enable Master-Slave Sequencing Control
- **Chiller Plant Manager (CPM) –** Factory supplied control panel; field supplied and installed interconnection wiring and field devices; for complete chiller plantroom automation

OPERATING BENEFITS

EFFICIENCY AND RELIABILITY

Energy Efficiency

- Designed to provide the greatest amount of cooling for the least power input over the entire operating range of your building
- Delivers outstanding efficiency and total energy savings through the utilization of economizer cycle and advanced controller staging; to produce greater capacity with fewer compressors
- Maximized performance through computer-matched components and multiple compressors
- High efficiency oil recovery system guarantees removal of oil carried over in the refrigerant and maintains the heat exchangers at their maximum efficiency at both full and part load

Refrigerant Compatibility

- Designed to operate with environmentally sound and economically smart HFC-134a with proven efficiency and reliability
- Consult Factory for use of other HFC refrigerants.

Flooded Evaporator

- Flooded evaporator design that fully utilized and maximized the heat transfer area available in the evaporator; operates with lower suction superheat, smaller evaporator approach. These have greatly improved efficiency of chiller with flooded evaporator.
- Flooded evaporator water heads can be removed easily without dismantling the chilled water piping connections, for inspection and for mechanical tubes cleaning with brushes or auto-brush. This will enable low tube fouling factor in the evaporator to be ensured, thus maintaining system efficiency

Operational Advantages

- Dramatic payback in reduced maintenance and overhaul costs both in downtime and in labor expenditures
- Ease of troubleshooting through controller retention of monitored functions

Factory Testing

- Each chiller undergoes the factory testing prior to unit shipment. This assures consistencies of workmanship at highest quality
- Thus, all units shipped are completely factory tested; charged and adjusted according to the design parameters, for ease of installation and minimal field start-up adjustments

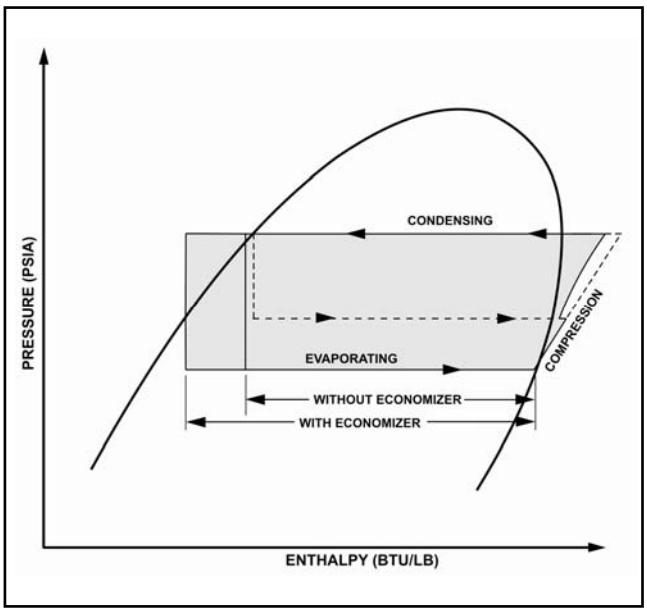
Control Flexibility

- Controller-based with DDC controller (direct digital control) features precise push button control over every aspect of operation with built-in standard features that maximized energy savings on start-up and throughout the life of your equipment
- Ensured uniform compressor loading and optimal energy efficiency through controller to controls which utilize pressure transducers to measure evaporator and condenser pressure
- Lower energy costs resulting from automatic load monitoring and increased accuracy and efficiency in compressor staging
- Various communication options for remote monitoring of the unit operation
- Proactive control anticipates problems and takes corrective action before they occur. Controls will unload compressor(s) if head or suction pressure approach limits. This will enable unit to stay on line while warning operator of potential problems
- Stable and efficient operation with precise chilled water temperature control. Chilled water temperature is controlled at ±0.8 ^{o}F [0.5 ^{o}C] range for your comfort cooling, with best energy saving

REFRIGERATION CYCLE

Dunham-Bush rotary screw air cooled chillers are designed for efficiency and reliability. The rotary screw compressor is a positive displacement, variable capacity compressor that will allow operation over a wide variety of conditions.

The refrigerant management system is shown in the refrigerant cycle diagram.



OPERATING BENEFITS

Liquid refrigerant enters the flooded evaporator uniformly where it absorbs heat from water flowing through the evaporator tubes. The vaporized refrigerant is then drawn into the suction port of the compressor where the positive displacement compression begins.

This partially compressed gas is then combined with additional gas from the vapor injection port at an intermediate pressure. Compressed gaseous refrigerant is then discharged into the integral oil separator where oil, which is contained in the refrigerant vapor, is removed and returned to the oil sump.

Fully compressed and superheated refrigerant is then discharged into the condenser, where air is being drawn through the condenser tube by the propeller fan cools and condenses the refrigerant. The liquid refrigerant then passes through the economizer. A portion of liquid refrigerant is tapped passes through the expansion valve back into the economizer for further subcooling of main liquid refrigerant flow.

The gaseous refrigerant is then drawn out of the economizer and into the vapor injection port of the compressor. The remaining subcooled liquid refrigerant then passes through electronic expansion valve which reduces refrigerant pressure to evaporator levels where it is then distributed evenly into the evaporator.

With the additional subcooling, the enthalpy of the refrigerant flowing into the evaporator is reduced which increases the refrigeration effect and improves the efficiency of the refrigeration cycle.

Economizer/ Vapor Injection Cycle for Increase Capacity and Higher EER

The renowned Dunham-Bush screw compressor allows for economizer vapor injection cycle to be incorporated, increasing capacity by significantly with marginal increase in kW-input. Thus, unit EER is improved!

PART-LOAD PERFORMANCE

Through the use of economizer, electronic expansion valve and multiple compressors, Dunham-Bush air cooled chillers have some of the best part-load performance characteristics in the industry when measured in accordance with AHRI Standard 550/590.

In most cases, actual building system loads are significantly less than full load design conditions, therefore chillers operate at part load most of the time.

Dunham-Bush air cooled chillers combine the efficient operation of compressors with economizer cycle and advanced controller to yield the best total energy efficiency and significant operating saving under any load.

When specifying air conditioning equipment, it is important to consider the system load characteristics for the building application. In a typical city, the air conditioning load will vary according to changes in the ambient temperature. Weather data compiled over many years will predict the number of hours that equipment will operate at various load percentages.

The Air Conditioning and Refrigeration Institute (AHRI) has established a system, in AHRI Standard 550/590, for measuring total chiller performance over full and part-load conditions. It defines the Integrated Part-Load Value (IPLV) as an excellent method of comparing diverse types of equipment on an equal basis. The IPLV is a single number estimate of a chiller's power use weighted for the number of hours the unit might spend at each part-load point. IPLV's are based on Standard Rating Conditions.

The formula for calculating an IPLV is:

$$IPLV = \frac{1}{\frac{0.01}{A} + \frac{0.42}{B} + \frac{0.45}{C} + \frac{0.12}{D}}$$

where: A= kW/ton at 100% load point
B= kW/ton at 75% load point
C= kW/ton at 50% load point
D= kW/ton at 25% load point

PHYSICAL SPECIFICATIONS

Microchannel Condenser (Standard)

Model ACHX-C		100S	130S	130T	150S	150T	170S	180T	200S	200T
Cooling Capacity	TR	100.50	126.49	132.57	146.29	155.34	166.25	178.05	192.65	200.46
	kW	353	445	466	514	546	585	626	678	705
Power Input	kW	116.3	141.1	146.6	169.6	175.4	183.1	200.4	222.9	232.0
Energy efficiency	kW/TR	1.157	1.116	1.106	1.159	1.129	1.101	1.126	1.157	1.157
COP	kW_o/kWi	3.039	3.153	3.180	3.034	3.115	3.193	3.125	3.040	3.039
Compressor										
QTY.		1	1	2	1	2	1	2	1	2
RPM		3550	3550	3550	3550	3550	3550	3550	3550	3550
Oil Charge	Litres	16	19	32	23	32	26	32	28	32
Min. % Unit Capacity Reduction		25	25	12.5	25	12.5	25	12.5	25	12.5
No. Of Refrigerant Circuit		1	1	2	1	2	1	2	1	2
Evaporator										
Model		Q2R	1DR	1DR(T)	1DR	1DR(T)	2ER	2FR(T)	2FR	2FR(T)
(Qty)		1	1	1	1	1	1	1	1	1
Water Connector	inches	3	5	5	5	5	6	6	6	6
	mm	76.2	127	127	127	127	152.4	152.4	152.4	152.4
Nominal Water Flow	Usgpm	241.2	303.6	318.2	351.1	372.8	399.0	427.3	462.4	481.1
	l/s	15.2	19.2	20.1	22.2	23.5	25.2	27.0	29.2	30.4
Nominal Water Pressure Drop	ft.wg	28.5	18.3	21.6	23.8	28.7	22.1	20.1	22.5	24.9
	kPa	85.2	54.8	64.5	71.2	85.8	66.0	60.1	67.3	74.4
Min. Water Flow	Usgpm	83	138	138	138	138	163	188	188	188
	l/s	5.2	8.7	8.7	8.7	8.7	10.3	11.8	11.8	11.8
Max. Water Flow	Usgpm	277	461	461	461	461	543	625	625	625
	l/s	17.5	29.1	29.1	29.1	29.1	34.3	39.4	39.4	39.4
Min. Water Pressure Drop	ft.wg	4.2	4.5	4.8	4.5	4.8	4.4	4.6	4.4	4.6
	kPa	12.5	13.3	14.4	13.5	14.4	13.2	13.6	13.3	13.6
Max. Water Pressure Drop	ft.wg	36.5	38.9	42.1	38.9	42.1	38.5	39.9	38.7	39.9
	kPa	109.0	116.3	125.8	116.3	125.8	115.1	119.1	115.8	119.1
Condenser										
Total Air Flow	CFM	49,140	73,710	98,280	73,710	98,280	98,280	98,280	98,280	98,280
	CMH	83,489	125,233	166,978	125,233	166,978	166,978	166,978	166,978	166,978
Total Face Area	sq.ft	94.1	141.2	188.2	141.2	188.2	188.2	188.2	188.2	188.2
	sq.m	8.74	13.11	17.49	13.11	17.49	17.49	17.49	17.49	17.49
No. of Fans		4	6	8	6	8	8	8	8	8
Fan Dia	mm	900	900	900	900	900	900	900	900	900
Fan Motor HP		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
General										
Unit Length	inches	125 5/8	170 7/8	197 1/4	170 7/8	197 1/4	197 1/4	197 1/4	197 1/4	197 1/4
	mm	3190	4340	5010	4340	5010	5010	5010	5010	5010
Unit Width	inches	89	89	89	89	89	89	89	89	89
	mm	2260	2260	2260	2260	2260	2260	2260	2260	2260
Unit Height	inches	96	96	96	96	96	96	96	96	96
	mm	2440	2440	2440	2440	2440	2440	2440	2440	2440
Shipping Weight	lbs	5911	7160	8611	7754	8951	8615	9338	9005	9793
	kg	2681	3248	3906	3517	4060	3908	4236	4085	4442
Operating Weight	lbs	6100	7386	8837	7980	9177	8887	9610	9276	10064
	kg	2767	3350	4009	3620	4163	4031	4359	4208	4565
Operating Charge R134a	lbs	170	216	216	247	247	278	293	324	324
	kg	77	98	98	112	112	126	133	147	147

Notes: 1. Nominal capacity is based on evaporator in/out fluid temperature at 54/44°F, ambient temperature 95°F, evaporator fouling factor 0.0001ft².h.°F/Btu.
2. To consult nearest Dunham-Bush sales office for computer selections other than above operating conditions

PHYSICAL SPECIFICATIONS

Microchannel Condenser (Standard)

Model ACHX-C		220T	250T	280T	300T	330T	360T	390T	420T	440T
Cooling Capacity	TR	222.65	253.02	276.28	300.44	330.10	364.44	387.75	418.32	439.37
	kW	783	890	972	1057	1161	1282	1364	1471	1545
Power Input	kW	252.2	281.8	310.3	338.8	366.2	407.1	447.0	464.1	481.4
Energy efficiency	kW/TR	1.133	1.114	1.123	1.128	1.109	1.117	1.153	1.109	1.096
COP	kW_o/kWi	3.105	3.158	3.131	3.119	3.170	3.148	3.051	3.170	3.210
Compressor										
QTY.		2	2	2	2	2	2	2	2	2
RPM		3550	3550	3550	3550	3550	3550	3550	3550	3550
Oil Charge	Litres	34	38	42	46	52	54	56	56	56
Min. % Unit Capacity Reduction		12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
No. Of Refrigerant Circuit		2	2	2	2	2	2	2	2	2
Evaporator										
Model		EBR(T)	JCR(T)	JCR(T)	JCR(T)	Q1R(T)	S2R(T)	S3R(T)	S3R(T)	S3R(T)
(Qty)		1	1	1	1	1	1	1	1	1
Water Connector	inches	6	8	8	8	8	8	8	8	8
	mm	152.4	203.2	203.2	203.2	203.2	203.2	203.2	203.2	203.2
Nominal Water Flow	Usgpm	534.4	607.3	663.1	721.0	792.2	874.7	930.6	1004.0	1054.5
	l/s	33.7	38.3	41.8	45.5	50.0	55.2	58.7	63.3	66.5
Nominal Water Pressure Drop	ft.wg	21.4	21.3	25.0	29.0	30.4	21.8	22.4	25.7	28.0
	kPa	64.1	63.7	74.6	86.8	90.9	65.2	66.9	76.7	83.8
Min. Water Flow	Usgpm	211	252	252	252	280	375	393	393	393
	l/s	13.3	15.9	15.9	15.9	17.6	23.7	24.8	24.8	24.8
Max. Water Flow	Usgpm	702	840	840	840	932	1250	1312	1312	1312
	l/s	44.3	53.0	53.0	53.0	58.8	78.9	82.8	82.8	82.8
Min. Water Pressure Drop	ft.wg	4.0	4.4	4.4	4.4	4.7	4.7	4.8	4.8	4.8
	kPa	12.0	13.1	13.1	13.1	14.0	14.2	14.2	14.2	14.2
Max. Water Pressure Drop	ft.wg	35.0	38.2	38.2	38.2	40.8	41.5	41.5	41.5	41.5
	kPa	104.7	114.3	114.3	114.3	121.9	124.0	124.1	124.1	124.1
Condenser										
Total Air Flow	CFM	122,850	147,420	147,420	147,420	196,560	196,560	196,560	221,130	245,700
	CMH	208,722	250,467	250,467	250,467	333,955	333,955	333,955	375,700	417,444
Total Face Area	sq.ft	235.3	282.3	282.3	282.3	376.4	376.4	376.4	423.5	470.6
	sq.m	21.86	26.23	26.23	26.23	34.97	34.97	34.97	39.34	43.72
No. of Fans		10	12	12	12	16	16	16	18	20
Fan Dia	mm	900	900	900	900	900	900	900	900	900
Fan Motor HP		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
General										
Unit Length	inches	287 13/16	287 13/16	287 13/16	287 13/16	378 3/8	378 3/8	378 3/8	423 5/8	468 7/8
	mm	7310	7310	7310	7310	9610	9610	9610	10760	11910
Unit Width	inches	89	89	89	89	89	89	89	89	89
	mm	2260	2260	2260	2260	2260	2260	2260	2260	2260
Unit Height	inches	96	96	96	96	96	96	96	96	96
	mm	2440	2440	2440	2440	2440	2440	2440	2440	2440
Shipping Weight	lbs	11610	12870	13458	14008	16165	17130	17640	18872	19900
	kg	5266	5838	6104	6354	7332	7770	8001	8560	9027
Operating Weight	lbs	11956	13286	13874	14424	16629	17737	18269	19502	20530
	kg	5423	6026	6293	6542	7543	8045	8287	8846	9312
Operating Charge R134a	lbs	355	401	448	478	525	571	617	664	694
	kg	161	182	203	217	238	259	280	301	315

Notes: 1. Nominal capacity is based on evaporator in/out fluid temperature at 54/44°F, ambient temperature 95°F, evaporator fouling factor 0.0001ft².h.°F/Btu.
2. To consult nearest Dunham-Bush sales office for computer selections other than above operating conditions

PHYSICAL SPECIFICATIONS

Aluminum Fin/Copper Tube Condenser (Option)

Model ACHX-C		100S	130S	130T	150S	150T	170S	180T	200S	200T
Cooling Capacity	TR	100.5	126.5	132.6	146.3	155.3	166.3	178.1	192.7	200.5
	kW	353	445	466	514	546	585	626	678	705
Power Input	kW	116.8	141.8	147.6	170.3	176.4	184.1	201.4	223.9	233.0
Energy efficiency	kW/TR	1.162	1.121	1.113	1.164	1.135	1.107	1.131	1.162	1.162
COP	kW_o/kWi	3.027	3.137	3.160	3.021	3.098	3.177	3.110	3.027	3.026
Compressor										
QTY.		1	1	2	1	2	1	2	1	2
RPM		3550	3550	3550	3550	3550	3550	3550	3550	3550
Oil Charge	Litres	16	19	32	23	32	26	32	28	32
Min. % Unit Capacity Reduction		25	25	12.5	25	12.5	25	12.5	25	12.5
No. Of Refrigerant Circuit		1	1	2	1	2	1	2	1	2
Evaporator										
Model		Q2R	1DR	1DR(T)	1DR	1DR(T)	2ER	2FR(T)	2FR	2FR(T)
Quantity		1	1	1	1	1	1	1	1	1
Water Connector	inches	3	5	5	5	5	6	6	6	6
	mm	76.2	127	127	127	127	152.4	152.4	152.4	152.4
Nominal Water Flow	Usgpm	241.2	303.6	318.2	351.1	372.8	399.0	427.3	462.4	481.1
	l/s	15.2	19.2	20.1	22.2	23.5	25.2	27.0	29.2	30.4
Nominal Water Pressure Drop	ft.wg	28.5	18.3	21.6	23.8	28.7	22.1	20.1	22.5	24.9
	kPa	85.2	54.8	64.5	71.2	85.8	66.0	60.1	67.3	74.4
Min. Water Flow	Usgpm	83	138	138	138	138	163	188	188	188
	l/s	5.2	8.7	8.7	8.7	8.7	10.3	11.8	11.8	11.8
Max. Water Flow	Usgpm	277	461	461	461	461	543	625	625	625
	l/s	17.5	29.1	29.1	29.1	29.1	34.3	39.4	39.4	39.4
Min. Water Pressure Drop	ft.wg	4.2	4.5	4.8	4.5	4.8	4.4	4.6	4.4	4.6
	kPa	12.5	13.3	14.4	13.5	14.4	13.2	13.6	13.3	13.6
Max. Water Pressure Drop	ft.wg	36.5	38.9	42.1	38.9	42.1	38.5	39.9	38.7	39.9
	kPa	109.0	116.3	125.8	116.3	125.8	115.1	119.1	115.8	119.1
Condenser										
Total Air Flow	CFM	51,387	77,081	102,774	77,081	102,774	102,774	102,774	102,774	102,774
	CMH	87,307	130,960	174,613	130,960	174,613	174,613	174,613	174,613	174,613
Total Face Area	sq.ft	94.1	141.2	188.2	141.2	188.2	188.2	188.2	188.2	188.2
	sq.m	8.74	13.11	17.49	13.11	17.49	17.49	17.49	17.49	17.49
No. of Fans		4	6	8	6	8	8	8	8	8
Fan Motor HP		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
General										
Unit Length	inches	125 5/8	170 7/8	197 1/4	170 7/8	197 1/4	197 1/4	197 1/4	197 1/4	197 1/4
	mm	3190	4340	5010	4340	5010	5010	5010	5010	5010
Unit Width	inches	89	89	89	89	89	89	89	89	89
	mm	2260	2260	2260	2260	2260	2260	2260	2260	2260
Unit Height	inches	96	96	96	96	96	96	96	96	96
	mm	2440	2440	2440	2440	2440	2440	2440	2440	2440
Shipping Weight	lbs	6303	7731	9387	8339	9695	9373	10103	9783	10570
	kg	2859	3507	4258	3782	4398	4252	4583	4437	4795
Operating Weight	lbs	6492	7957	9613	8565	9921	9645	10374	10054	10842
	kg	2945	3609	4360	3885	4500	4375	4706	4560	4918
Operating Charge R134a	lbs	243	309	309	353	353	397	419	463	463
	kg	110	140	140	160	160	180	190	210	210

Notes: 1. Nominal capacity is based on evaporator in/out fluid temperature at 54/44°F, ambient temperature 95°F, evaporator fouling factor 0.0001ft².h.°F/Btu.
2. To consult nearest Dunham-Bush sales office for computer selections other than above operating conditions

PHYSICAL SPECIFICATIONS

Aluminum Fin/Copper Tube Condenser (Option)

Model ACHX-C		220T	250T	280T	300T	330T	360T	390T	420T	440T
Cooling Capacity	TR	222.7	253.0	276.3	300.4	330.1	364.4	387.8	418.3	439.4
	kW	783	890	972	1057	1161	1282	1364	1471	1545
Power Input	kW	253.4	283.2	311.7	340.2	368.1	409.0	448.9	466.3	483.8
Energy efficiency	kW/TR	1.138	1.119	1.128	1.132	1.115	1.122	1.158	1.115	1.101
COP	kW_o/kWi	3.090	3.142	3.117	3.106	3.154	3.134	3.038	3.155	3.194
Compressor										
QTY.		2	2	2	2	2	2	2	2	2
RPM		3550	3550	3550	3550	3550	3550	3550	3550	3550
Oil Charge	Litres	34	38	42	46	52	54	56	56	56
Min. % Unit Capacity Reduction		12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
No. Of Refrigerant Circuit		2	2	2	2	2	2	2	2	2
Evaporator										
Model		EBR(T)	JCR(T)	JCR(T)	JCR(T)	Q1R(T)	S2R(T)	S3R(T)	S3R(T)	S3R(T)
Quantity		1	1	1	1	1	1	1	1	1
Water Connector	inches	6	8	8	8	8	8	8	8	8
	mm	152.4	203.2	203.2	203.2	203.2	203.2	203.2	203.2	203.2
Nominal Water Flow	Usgpm	534.4	607.3	663.1	721.0	792.2	874.7	930.6	1004.0	1054.5
	l/s	33.7	38.3	41.8	45.5	50.0	55.2	58.7	63.3	66.5
Nominal Water Pressure Drop	ft.wg	21.4	21.3	25.0	29.0	30.4	21.8	22.4	25.7	28.0
	kPa	64.1	63.7	74.6	86.8	90.9	65.2	66.9	76.7	83.8
Min. Water Flow	Usgpm	211	252	252	252	280	375	393	393	393
	l/s	13.3	15.9	15.9	15.9	17.6	23.7	24.8	24.8	24.8
Max. Water Flow	Usgpm	702	840	840	840	932	1250	1312	1312	1312
	l/s	44.3	53.0	53.0	53.0	58.8	78.9	82.8	82.8	82.8
Min. Water Pressure Drop	ft.wg	4.0	4.4	4.4	4.4	4.7	4.7	4.8	4.8	4.8
	kPa	12.0	13.1	13.1	13.1	14.0	14.2	14.2	14.2	14.2
Max. Water Pressure Drop	ft.wg	35.0	38.2	38.2	38.2	40.8	41.5	41.5	41.5	41.5
	kPa	104.7	114.3	114.3	114.3	121.9	124.0	124.1	124.1	124.1
Condenser										
Total Air Flow	CFM	128,468	154,161	154,161	154,161	205,548	205,548	205,548	231,242	256,935
	CMH	218,266	261,920	261,920	261,920	349,226	349,226	349,226	392,879	436,533
Total Face Area	sq.ft	235.3	282.3	282.3	282.3	376.4	376.4	376.4	423.5	470.6
	sq.m	21.86	26.23	26.23	26.23	34.97	34.97	34.97	39.34	43.72
No. of Fans		10	12	12	12	16	16	16	18	20
Fan Motor HP		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
General										
Unit Length	inches	287 13/16	287 13/16	287 13/16	287 13/16	378 3/8	378 3/8	378 3/8	423 5/8	468 7/8
	mm	7310	7310	7310	7310	9610	9610	9610	10760	11910
Unit Width	inches	89	89	89	89	89	89	89	89	89
	mm	2260	2260	2260	2260	2260	2260	2260	2260	2260
Unit Height	inches	96	96	96	96	96	96	96	96	96
	mm	2440	2440	2440	2440	2440	2440	2440	2440	2440
Shipping Weight	lbs	12561	14001	14608	15171	17667	18653	19182	20594	21795
	kg	5697	6351	6626	6882	8014	8461	8701	9341	9886
Operating Weight	lbs	12907	14416	15024	15587	18132	19259	19811	21223	22425
	kg	5855	6539	6815	7070	8224	8736	8986	9627	10172
Operating Charge R134a	lbs	507	573	639	683	750	816	882	948	992
	kg	230	260	290	310	340	370	400	430	450

Notes: 1. Nominal capacity is based on evaporator in/out fluid temperature at 54/44°F, ambient temperature 95°F, evaporator fouling factor 0.0001ft².h.°F/Btu.
2. To consult nearest Dunham-Bush sales office for computer selections other than above operating conditions

ELECTRICAL DATA

Model ACHX-C	Power Supply : 380Vac-3Ph-60Hz (Ambient Temp: 115F)											
	Compressor Data					Condenser Fan Motor Data			Unit Data			
	Starter Type	Qty	RLA	Starting Current	LRA	Qty	HP	FLA	RLA	MCA	MFS	Max Inrush
100S	Star-Delta	1	248	458	1375	4	3	4.9	268	330	500	458
130S	Star-Delta	1	292	552	1655	6	3	4.9	321	394	600	552
130T	Star-Delta	2	138	308	925	8	3	4.9	315	350	450	466
150S	Star-Delta	1	353	600	1800	6	3	4.9	382	471	800	600
150T	Star-Delta	2	165	348	1045	8	3	4.9	369	410	500	533
170S	Star-Delta	1	376	622	1865	8	3	4.9	415	509	800	622
180T	Star-Delta	2	193	378	1135	8	3	4.9	425	473	600	591
200S	Star-Delta	1	477	675	2025	8	3	4.9	516	635	1000	675
200T	Star-Delta	2	247	458	1375	8	3	4.9	533	595	800	725
220T	Star-Delta	2	262	498	1495	10	3	4.9	573	639	800	785
250T	Star-Delta	2	292	552	1655	12	3	4.9	643	716	1000	873
280T	Star-Delta	1	292	552	1655	6	3	4.9	613	686	800	921
	Star-Delta	1	352	600	1800	6	3	4.9	733	821	1000	
300T	Star-Delta	2	352	600	1800	12	3	4.9	763	851	1200	981
330T	Star-Delta	2	375	622	1865	16	3	4.9	828	922	1200	1036
360T	Star-Delta	1	377	622	1865	8	3	4.9	934	1054	1200	1091
	Star-Delta	1	479	675	2025	8	3	4.9				
390T	Star-Delta	2	479	675	2025	16	3	4.9	1036	1156	1600	1193
420T	Star-Delta	1	478	675	2025	8	3	4.9	1065	1190	1600	1287
	Star-Delta	1	499	770	2310	10	3	4.9				
440T	Star-Delta	2	498	770	2310	20	3	4.9	1094	1219	1600	1317

Note: RLA - Running Load Amps At 115 °F Ambient Temperature; MCA - Minimum Circuit Ampacity; MFS - Maximum Fuse Size; LRA - Lock Rotor Amp

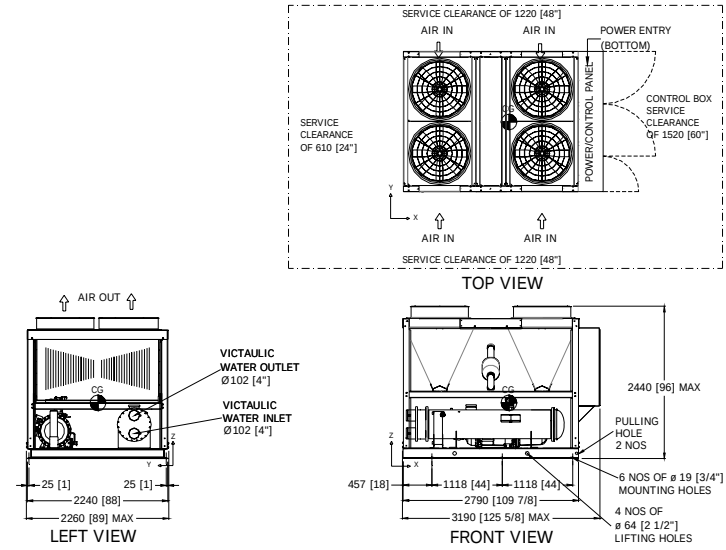
SOUND PRESSURE DATA

Model ACHX-C	Octave Band (Hz)								Total dB(A)
	63	125	250	500	1K	2K	4K	8K	
100S	54	51	58	62	62	54	46	36	67
130S	55	53	55	61	65	57	46	38	68
130T	57	54	55	65	62	59	56	54	68
150S	55	53	55	60	66	56	44	35	68
150T	57	54	55	67	60	58	50	45	69
170S	57	54	55	65	64	57	47	38	69
180T	57	54	55	67	63	60	49	44	69
200S	57	54	55	61	66	57	46	38	69
200T	57	54	61	65	65	57	49	39	70
220T	57	54	58	65	66	59	49	41	70
250T	58	55	58	64	68	59	49	40	70
280T	58	55	58	63	68	59	48	39	71
300T	58	55	57	63	69	58	47	38	71
330T	59	56	58	67	67	59	50	40	71
360T	59	56	58	66	68	60	49	40	71
390T	59	56	58	64	69	60	49	41	71
420T	49	56	60	64	70	60	48	41	72
440T	60	57	59	62	71	59	47	40	73

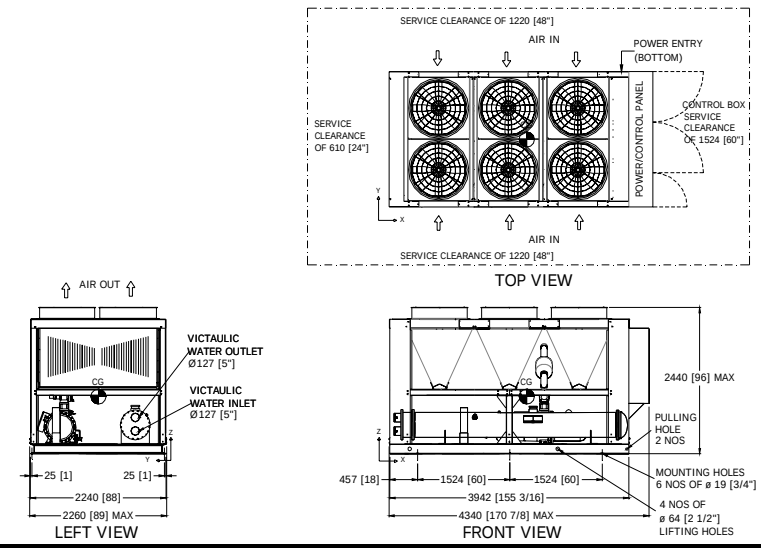
Note: Unit Sound Pressure Level (Lp) @ 33 ft [10m] (free field), ± 2 dB(A) tolerance.

DIMENSIONAL DATA

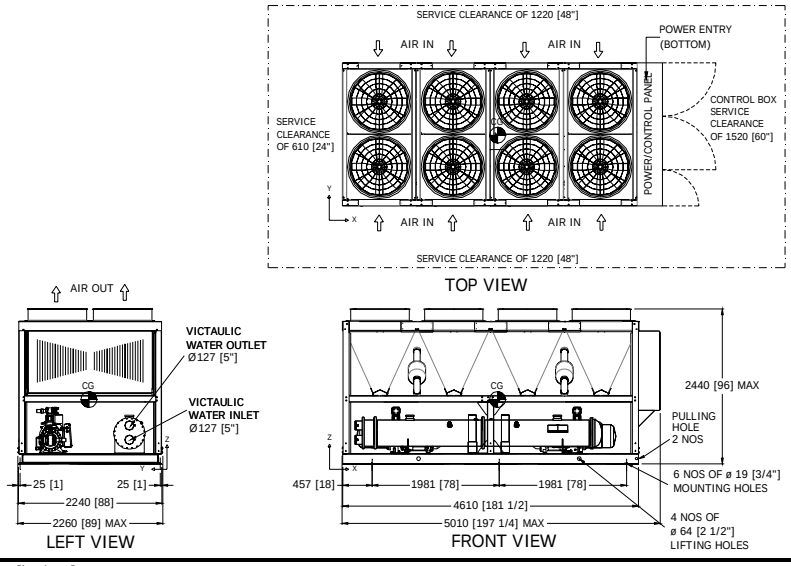
ACHX-C 100S



ACHX-C 130S



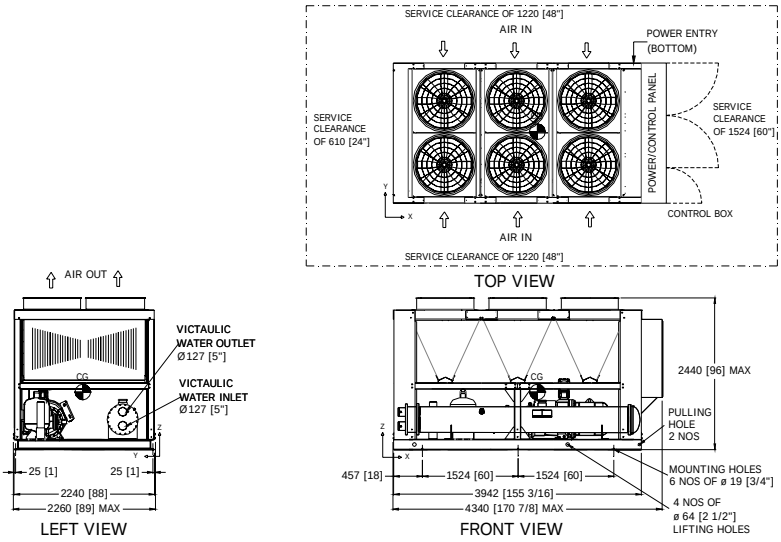
ACHX-C 130T



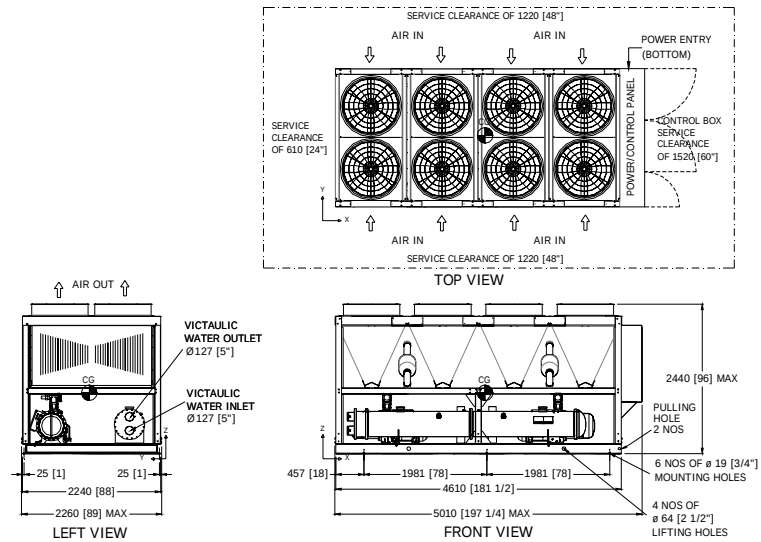
Note: All dimensions are in mm[inches].

DIMENSIONAL DATA

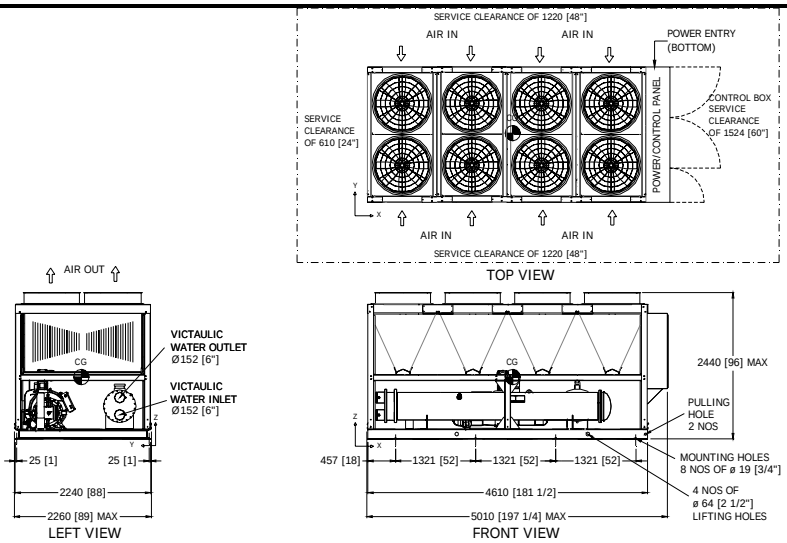
ACHX-C 150S



ACHX-C 150T



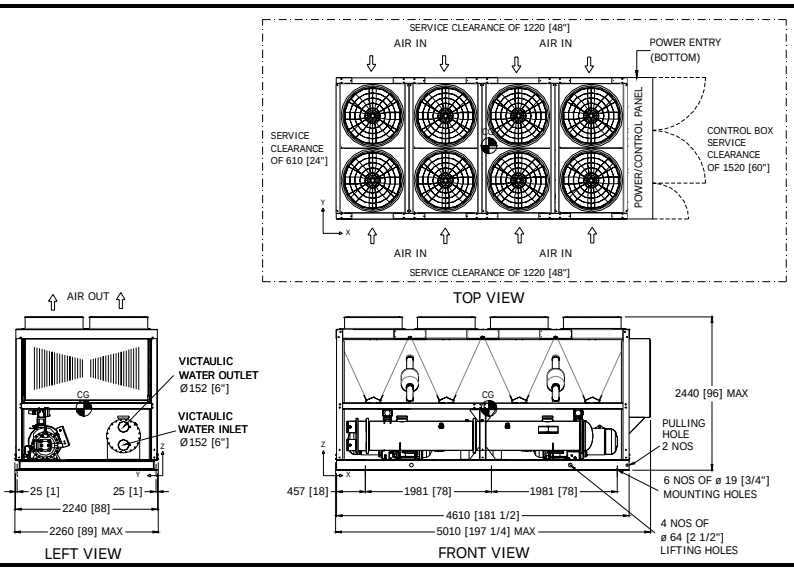
ACHX-C 170S



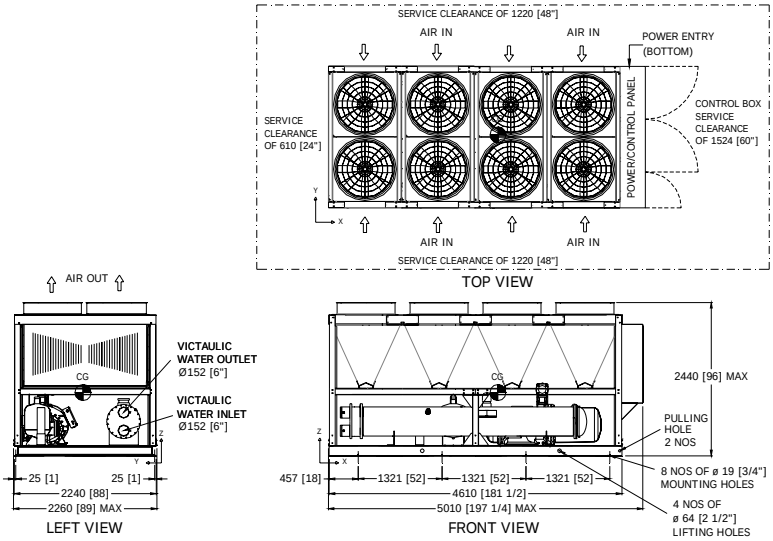
Note: All dimensions are in mm[inches].

DIMENSIONAL DATA

ACHX-C 180T



ACHX-C 200S



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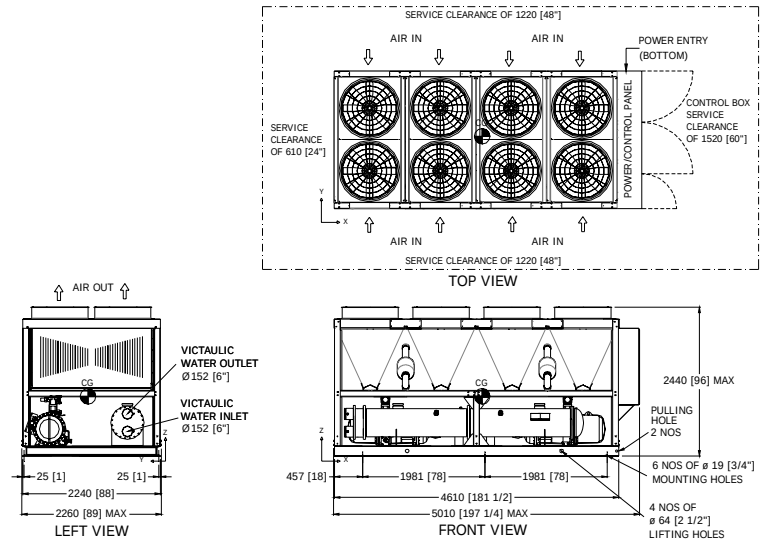
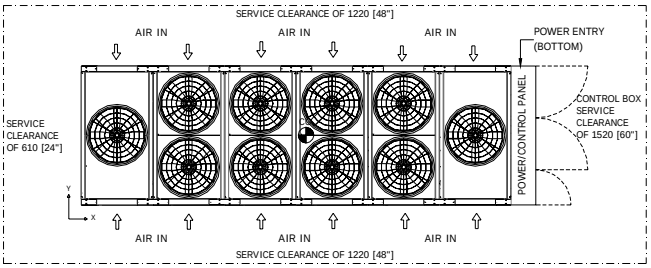


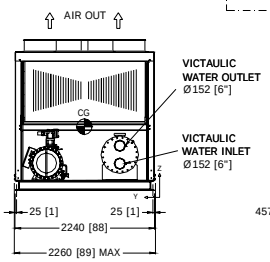
Note: All dimensions are in mm[inches].

DIMENSIONAL DATA

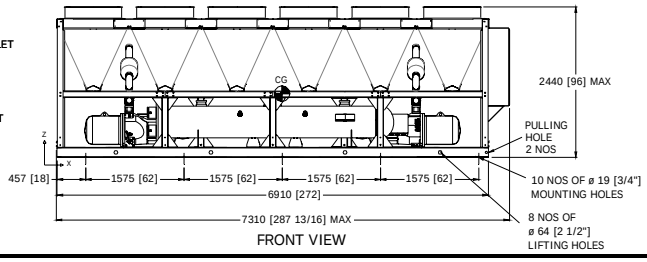
ACHX-C 220T



TOP VIEW

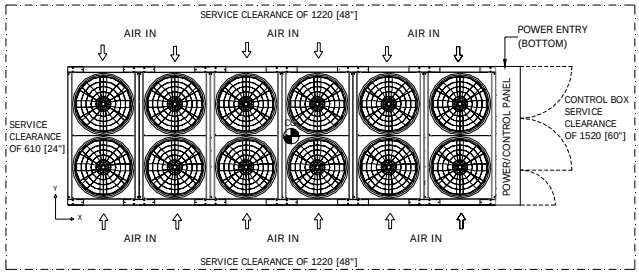


LEFT VIEW

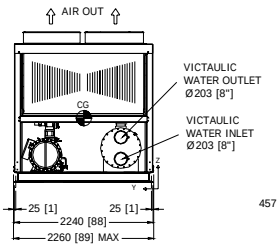


FRONT VIEW

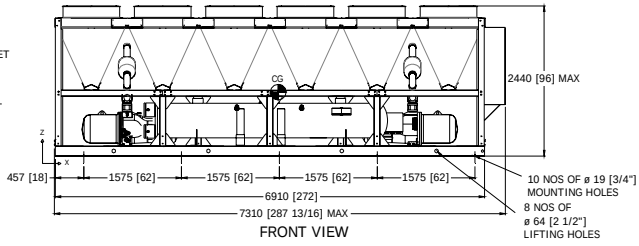
ACHX-C 250T



TOP VIEW

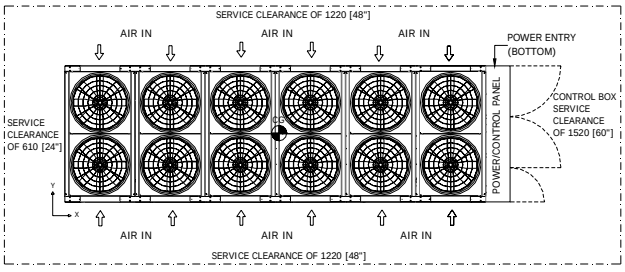


LEFT VIEW

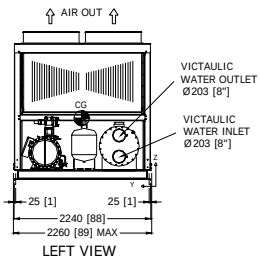


FRONT VIEW

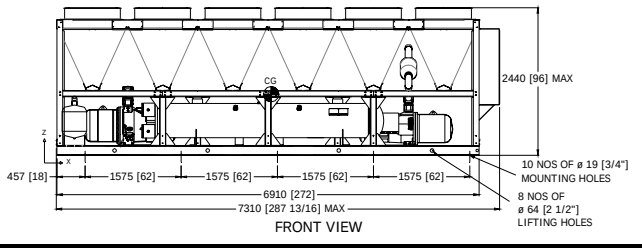
ACHX-C 280T



TOP VIEW



LEFT VIEW

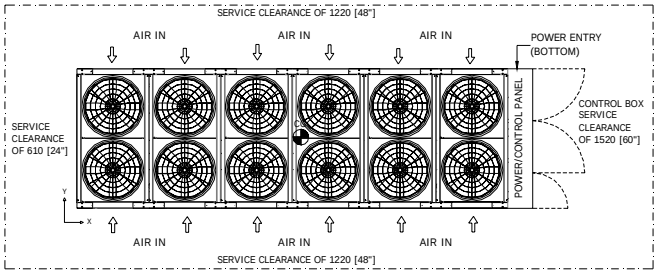


FRONT VIEW

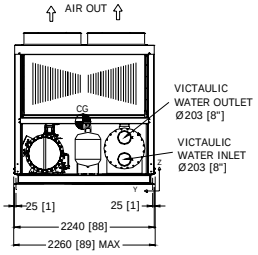
Note: All dimensions are in mm[inches].

DIMENSIONAL DATA

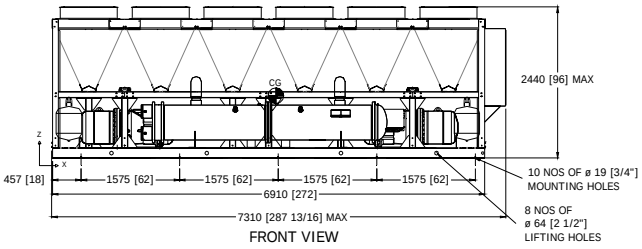
ACHX-C 300T



TOP VIEW

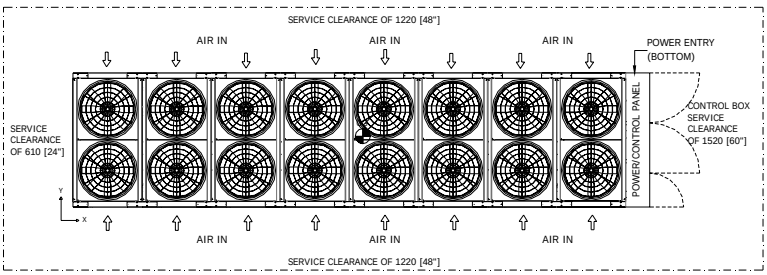


LEFT VIEW

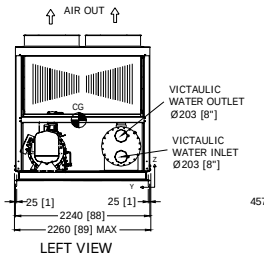


FRONT VIEW

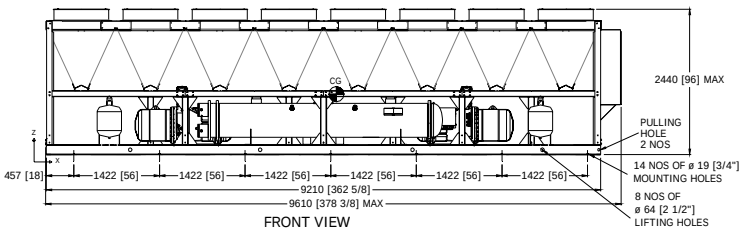
ACHX-C 330T



TOP VIEW

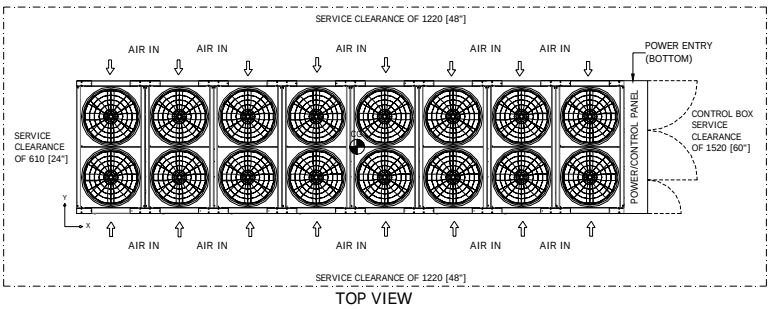


LEFT VIEW

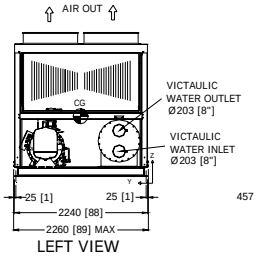


FRONT VIEW

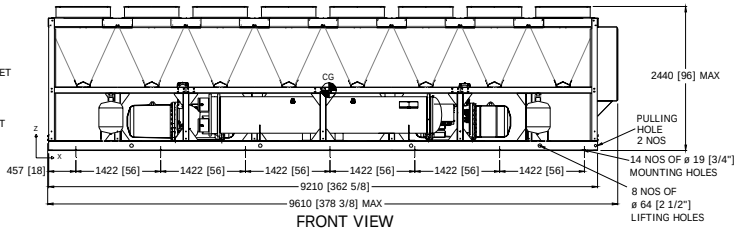
ACHX-C 360T
ACHX-C 390T



TOP VIEW



LEFT VIEW

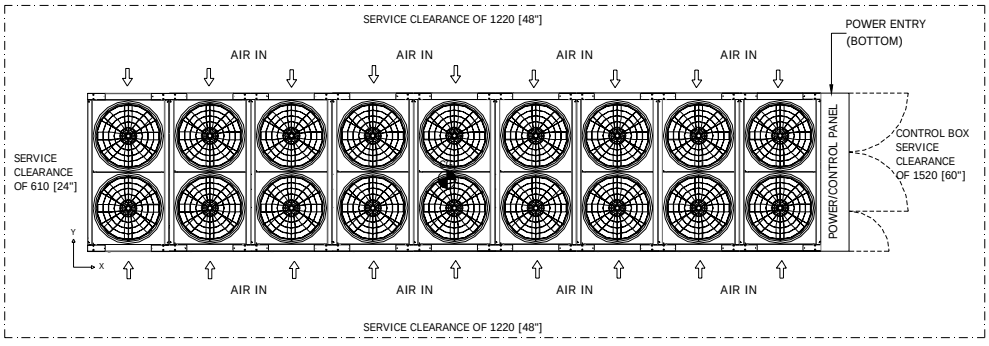


FRONT VIEW

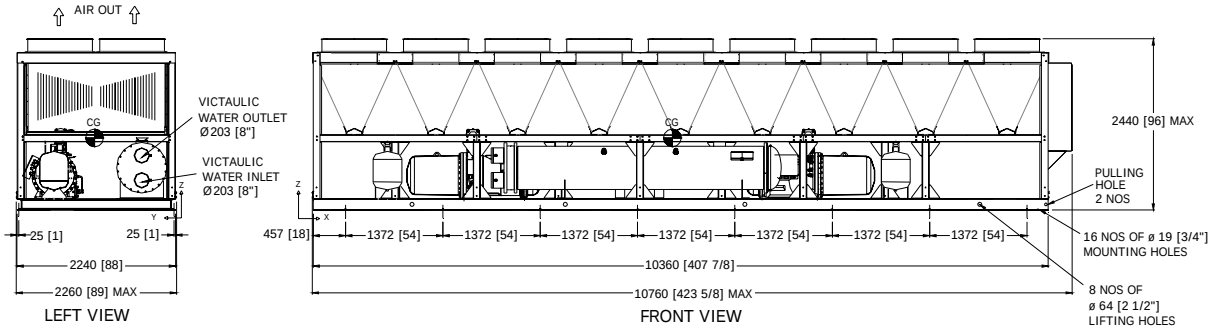
Note: All dimensions are in mm[inches].

DIMENSIONAL DATA

ACHX-C 420T



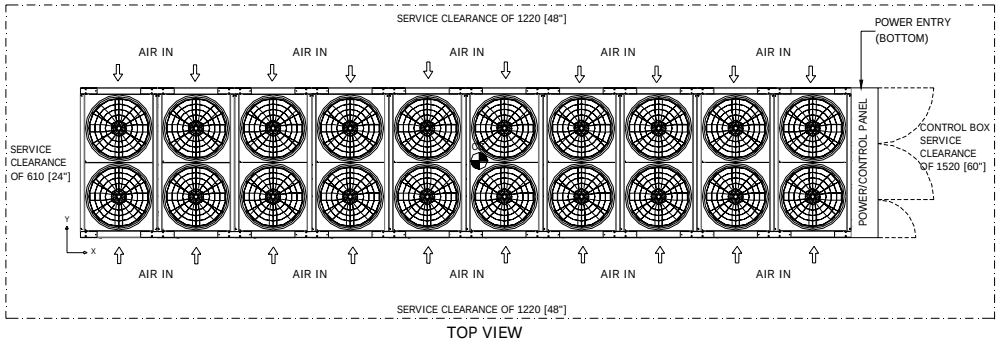
TOP VIEW



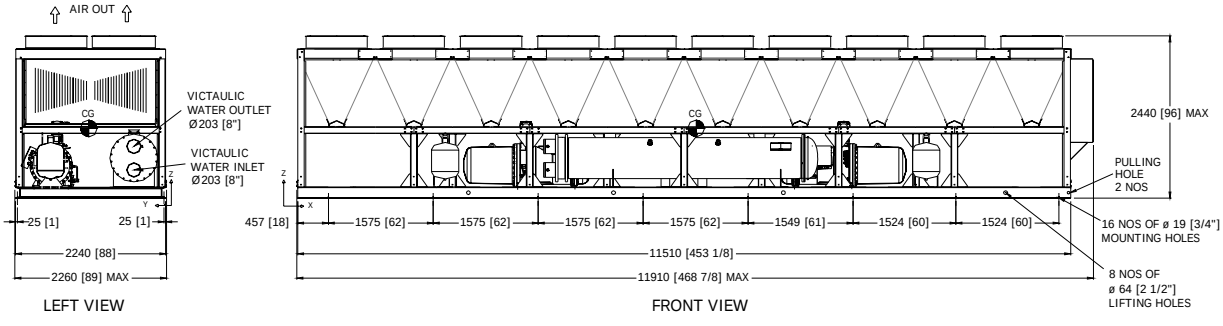
LEFT VIEW

FRONT VIEW

ACHX-C 440T



TOP VIEW

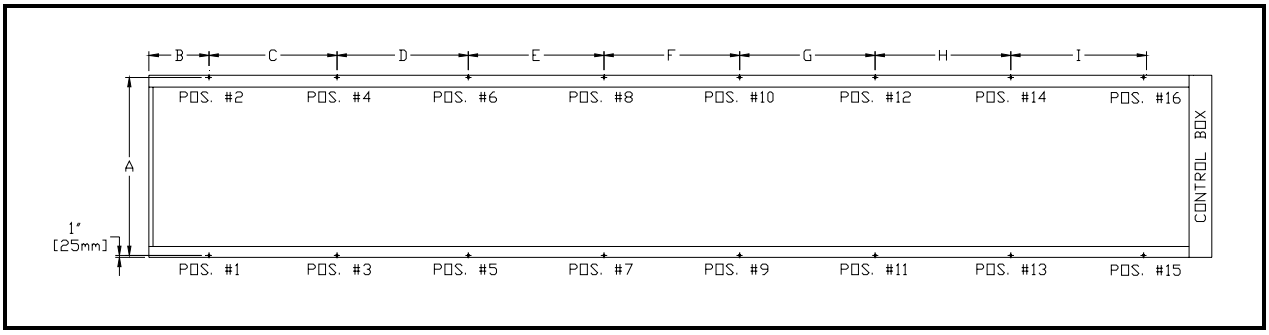


LEFT VIEW

FRONT VIEW

Note: All dimensions are in mm[inches].

FLOOR LOADING DIAGRAM



a.) Point Load Location – inches [mm]

Model ACHX-C		A	B	C	D	E	F
100S	inches	86	18	44	44	-	-
	mm	2184	457	1118	1118	-	-
130S	inches	86	18	60	60	-	-
	mm	2184	457	1524	1524	-	-
130T	inches	86	18	78	78	-	-
	mm	2184	457	1981	1981	-	-
150S	inches	86	18	60	60	-	-
	mm	2184	457	1524	1524	-	-
150T	inches	86	18	78	78	-	-
	mm	2184	457	1981	1981	-	-
170S	inches	86	18	52	52	52	-
	mm	2184	457	1321	1321	1321	-
180T	inches	86	18	78	78	-	-
	mm	2184	457	1981	1981	-	-
200S	inches	86	18	52	52	52	-
	mm	2184	457	1321	1321	1321	-
200T	inches	86	18	78	78		-
	mm	2184	457	1981	1981		-

Model ACHX-C		A	B	C	D	E	F	G	H	I
220T	inches	86	18	62	62	62	62	-	-	-
	mm	2184	457	1575	1575	1575	1575	-	-	-
250T	inches	86	18	62	62	62	62	-	-	-
	mm	2184	457	1575	1575	1575	1575	-	-	-
280T	inches	86	18	62	62	62	62	-	-	-
	mm	2184	457	1575	1575	1575	1575	-	-	-
300T	inches	86	18	62	62	62	62	-	-	-
	mm	2184	457	1575	1575	1575	1575	-	-	-
330T	inches	86	18	56	56	56	56	56	56	-
	mm	2184	457	1422	1422	1422	1422	1422	1422	-
360T	inches	86	18	56	56	56	56	56	56	-
	mm	2184	457	1422	1422	1422	1422	1422	1422	-
390T	inches	86	18	56	56	56	56	56	56	-
	mm	2184	457	1422	1422	1422	1422	1422	1422	-
420T	inches	86	18	54	54	54	54	54	54	54
	mm	2184	457	1372	1372	1372	1372	1372	1372	1372
440T	inches	86	18	62	62	62	62	61	60	60
	mm	2184	457	1575	1575	1575	1575	1549	1524	1524

b.) Point Load Data – Microchannel Condenser (Standard)

Model ACHX-C		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	Total Operating Weight
100S	lbs	1008	762	1128	1423	974	803	-	-	-	-	-	-	-	-	-	-	6100
	kg	457	346	512	646	442	364	-	-	-	-	-	-	-	-	-	-	2767
130S	lbs	1078	862	1223	1525	1453	1245	-	-	-	-	-	-	-	-	-	-	7386
	kg	489	391	555	692	659	565	-	-	-	-	-	-	-	-	-	-	3350
130T	lbs	1563	1580	1462	1468	1350	1415	-	-	-	-	-	-	-	-	-	-	8837
	kg	709	717	663	666	612	642	-	-	-	-	-	-	-	-	-	-	4009
150S	lbs	1148	950	1257	1577	1542	1506	-	-	-	-	-	-	-	-	-	-	7980
	kg	521	431	570	715	699	683	-	-	-	-	-	-	-	-	-	-	3620
150T	lbs	1600	1678	1490	1541	22	1490	-	-	-	-	-	-	-	-	-	-	9177
	kg	726	761	676	699	625	676	-	-	-	-	-	-	-	-	-	-	4163
170S	lbs	1068	899	1205	1568	1283	1213	834	816	-	-	-	-	-	-	-	-	8887
	kg	484	408	547	711	582	550	378	370	-	-	-	-	-	-	-	-	4031
180T	lbs	1680	1764	1557	1623	1429	1557	-	-	-	-	-	-	-	-	-	-	9610
	kg	762	800	706	736	648	706	-	-	-	-	-	-	-	-	-	-	4359
200S	lbs	1037	785	1064	1020	1534	1999	903	934	-	-	-	-	-	-	-	-	9276
	kg	470	356	483	463	696	907	409	424	-	-	-	-	-	-	-	-	4208
200T	lbs	1753	1974	1568	1571	1483	1715	-	-	-	-	-	-	-	-	-	-	10064
	kg	795	896	711	712	673	778	-	-	-	-	-	-	-	-	-	-	4565
220T	lbs	870	1103	1667	1332	1052	1019	1560	1515	861	978	-	-	-	-	-	-	11956
	kg	395	500	756	604	477	462	708	687	390	444	-	-	-	-	-	-	5423
250T	lbs	990	1242	1909	1461	1156	1089	1752	1652	957	1078	-	-	-	-	-	-	13286
	kg	449	563	866	663	525	494	795	749	434	489	-	-	-	-	-	-	6026
280T	lbs	1065	1431	1940	1579	1178	1139	1780	1689	970	1102	-	-	-	-	-	-	13874
	kg	483	649	880	716	534	517	808	766	440	500	-	-	-	-	-	-	6293
300T	lbs	1104	1432	1981	1612	1233	1194	1756	1831	1065	1218	-	-	-	-	-	-	14424
	kg	501	649	898	731	559	542	796	830	483	553	-	-	-	-	-	-	6542
330T	lbs	705	830	995	1575	2121	1351	878	960	1773	1414	1022	1397	751	858	-	-	16629
	kg	320	376	451	715	962	613	398	435	804	641	464	634	341	389	-	-	7543
360T	lbs	847	891	1249	1749	1711	1285	1554	1154	1546	1369	1176	1447	862	896	-	-	17737
	kg	384	404	566	794	776	583	705	523	701	621	533	657	391	406	-	-	8045
390T	lbs	859	907	1266	1769	1754	1319	1596	1216	1585	1442	1213	1539	878	927	-	-	18269
	kg	390	411	574	802	796	598	724	552	719	654	550	698	398	420	-	-	8287
420T	lbs	764	889	1140	1695	1788	1363	1063	1036	2102	1372	1166	1728	878	991	738	791	19502
	kg	347	403	517	769	811	618	482	470	953	622	529	784	398	449	335	359	8846
440T	lbs	790	775	935	988	1545	2175	1792	1301	1690	1167	1553	2230	1016	1016	792	767	20530
	kg	358	351	424	448	701	986	813	590	767	529	704	1011	461	461	359	348	9312

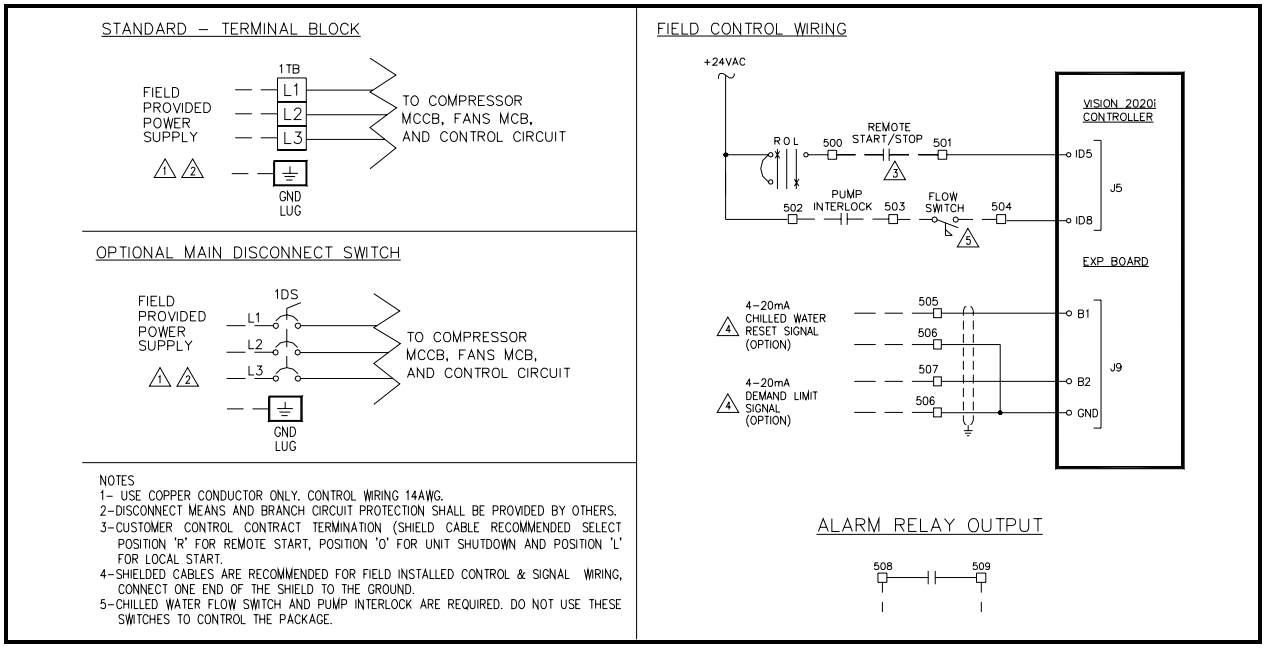
FLOOR LOADING DIAGRAM

c.) Point Load Data – Aluminum Fin/Copper Tube Condenser (Option)

Model ACHX-C		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	Total Operating Weight
100S	lbs	1101	845	1179	1465	1047	855	-	-	-	-	-	-	-	-	-	-	6492
	kg	499	383	535	665	475	388	-	-	-	-	-	-	-	-	-	-	2945
130S	lbs	1168	933	1347	1641	1551	1318	-	-	-	-	-	-	-	-	-	-	7957
	kg	530	423	611	744	703	598	-	-	-	-	-	-	-	-	-	-	3609
130T	lbs	1721	1706	1613	1595	1467	1511	-	-	-	-	-	-	-	-	-	-	9613
	kg	780	774	732	723	665	685	-	-	-	-	-	-	-	-	-	-	4360
150S	lbs	1241	1023	1383	1694	1644	1580	-	-	-	-	-	-	-	-	-	-	8565
	kg	563	464	627	768	746	717	-	-	-	-	-	-	-	-	-	-	3885
150T	lbs	1748	1801	1634	1666	22	1585	-	-	-	-	-	-	-	-	-	-	9921
	kg	793	817	741	756	675	719	-	-	-	-	-	-	-	-	-	-	4500
170S	lbs	1176	988	1323	1673	1398	1304	905	878	-	-	-	-	-	-	-	-	9645
	kg	533	448	600	759	634	591	411	398	-	-	-	-	-	-	-	-	4375
180T	lbs	1833	1890	1705	1750	1544	1653	-	-	-	-	-	-	-	-	-	-	10374
	kg	831	857	773	794	700	750	-	-	-	-	-	-	-	-	-	-	4706
200S	lbs	1149	875	1187	1125	1652	2091	977	997	-	-	-	-	-	-	-	-	10054
	kg	521	397	538	510	749	949	443	452	-	-	-	-	-	-	-	-	4560
200T	lbs	1910	2101	1719	1699	1600	1812	-	-	-	-	-	-	-	-	-	-	10842
	kg	867	953	780	770	726	822	-	-	-	-	-	-	-	-	-	-	4918
220T	lbs	941	1168	1808	1438	1158	1112	1710	1641	910	1022	-	-	-	-	-	-	12907
	kg	427	530	820	652	525	504	776	744	413	463	-	-	-	-	-	-	5855
250T	lbs	1098	1343	2061	1574	1270	1188	1916	1789	1032	1145	-	-	-	-	-	-	14416
	kg	498	609	935	714	576	539	869	811	468	520	-	-	-	-	-	-	6539
280T	lbs	1174	1532	2095	1694	1295	1238	1951	1827	1046	1170	-	-	-	-	-	-	15024
	kg	533	695	950	768	587	562	885	829	474	531	-	-	-	-	-	-	6815
300T	lbs	1213	1533	2144	1728	1353	1295	1924	1968	1141	1287	-	-	-	-	-	-	15587
	kg	550	696	973	784	613	587	873	893	518	584	-	-	-	-	-	-	7070
330T	lbs	800	923	1100	1677	2294	1460	977	1050	1931	1529	1138	1506	821	925	-	-	18132
	kg	363	419	499	761	1041	662	443	476	876	693	516	683	373	420	-	-	8224
360T	lbs	949	986	1365	1854	1850	1386	1690	1253	1688	1479	1299	1559	938	964	-	-	19259
	kg	431	447	619	841	839	629	766	569	766	671	589	707	425	437	-	-	8736
390T	lbs	963	1002	1384	1874	1900	1421	1734	1317	1728	1553	1337	1651	954	995	-	-	19811
	kg	437	454	628	850	862	645	787	597	784	704	606	749	433	451	-	-	8986
420T	lbs	860	979	1255	1800	1937	1466	1170	1125	2277	1480	1277	1828	994	1101	813	862	21223
	kg	390	444	569	817	879	665	530	510	1033	671	579	829	451	499	369	391	9627
440T	lbs	899	877	1047	1089	1671	2277	1986	1450	1847	1276	1679	2333	1151	1140	867	835	22425
	kg	408	398	475	494	758	1033	901	658	838	579	762	1058	522	517	393	379	10172

FIELD POWER & CONTROL WIRING SCHEMATIC

TYPICAL FIELD WIRING DIAGRAM



APPLICATION DATA

UNIT DESIGNED OPERATING RANGE

Unit Operating Range – Ambient Temperature

The units are designed to operate at ambient temperature, 45~131°F [7~55°C]. If the unit requires to be operated at lower ambient temperature, the optional ***Low Ambient Operation (LA 1),*** or ***Extra Low Ambient Operation (LA 2)*** shall be incorporated for stable operation.

Operating Limits – Ambient Temperature

Operating Ambient Temperature	Minimum	Maximum
Standard	45°F [7°C]	131°F [55°C]
With LA 1	14°F [-10°C]	131°F [55°C]
With LA 2	-20°F [-29°C]	131°F [55°C]

If wind velocity in the area is over 5 mph [8 kmph], wind barrier is recommended.

Unit Operating Range – Evaporator Temperature

The unit is designed to deliver chilled fluid temperature within 40~50°F [4.5~10°C]. The unit can start and pull down with up to 80°F [27°C] entering-fluid temperature. For sustained operation, it is recommended that the entering fluid temperature not exceed 70°F [21°C].

For unit installation with minimum ambient temperature at 32°F [0°C] or below, ***Evaporator Anti-Freeze Protection*** option is recommended to prevent freezing of water in evaporator when the chiller is not in operation.

Operating Limits – Leaving Fluid Temperature

Leaving Fluid Temperature	Minimum	Maximum
Standard	40 °F [4.5 °C]	50 °F [10 °C]
Dual Mode / Low Temp. (with PG 30%)	22.5 °F [-5.3 °C]	50 °F [10 °C]
Dual Mode / Low Temp. (with EG 30%)	20.1°F [-6.6°C]	50 °F [10 °C]

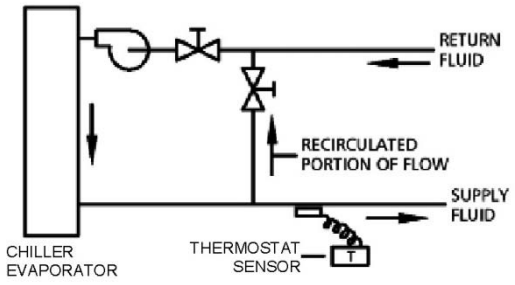
EVAPORATOR FLUID CIRCUIT

Wide Range ΔT - Low Flow Applications

Multiple smaller chillers may be applied in series, each providing a portion of the design temperature range typical 10°F [5.5°C] each.

Chilled fluid may be recirculated through the evaporator as shown below to allow the chiller to operate with acceptable flow rates and temperature ranges (Figure 1A).

Figure 1A



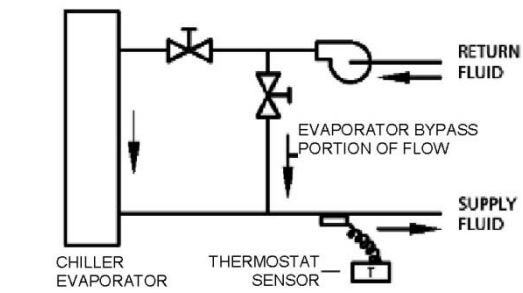
The mixed fluid temperature range through the evaporator for units with standard evaporators, should not be less than 7.5°F [4.2°C].

Narrow Range ΔT - High Flow Applications

For Narrow Range ΔT applications, a partial evaporator bypass piping and valve configuration can be used as shown below.

This permits a higher ΔT and lower ΔP (pressure drop) through the evaporator (Figure 1B).

Figure 1B



The fluid mixes after the evaporator.

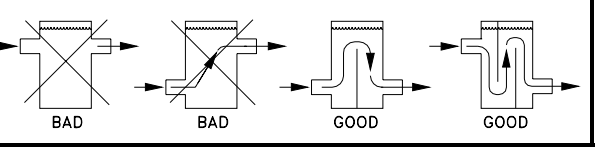
Minimum Chilled Fluid Loop Volume

The evaporator fluid circuit requires a minimum system fluid volume of 3 US gallons per Ton [3.3 liters/ cooling kW] for stable operation. The minimum system fluid volume may increasing up to 10 US gallons per Ton [11 liters/ cooling kW] for process cooling, low load applications with small temperature range and/or vastly fluctuating load conditions.

Tanks for System Volume Enhancement

It may be necessary to install a tank in the system to provide sufficient system fluid volume, as shown below. The tank should be baffled and piped for proper fluid mixing to prevent stratification.

Figure 2A



APPLICATION DATA

Figure 2B Single Loop System with Storage Tank to Increase Loop Volume

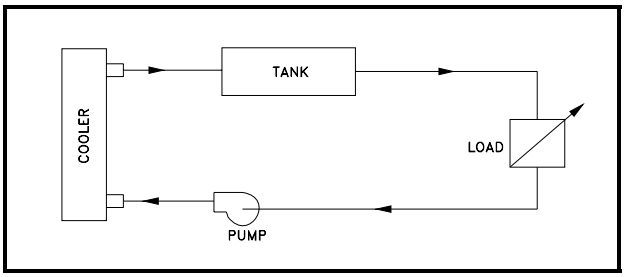
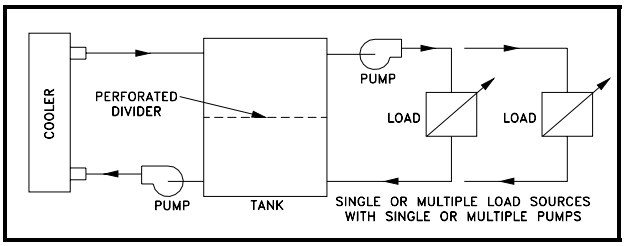


Figure 2C Primary and Secondary Loop Systems are normally used where the secondary system has variable flow and/or multiple loads. See example below.



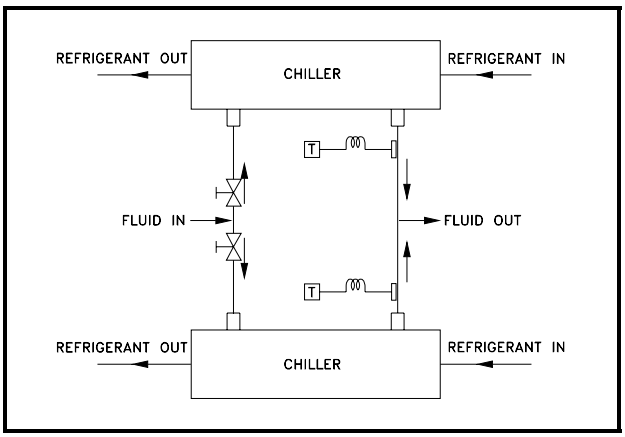
Multiple Chillers In A Chilled Water System

Where the load is greater than available from one Helios ACHX-C, where standby capacity is required or the load profile dictates, multiple chillers may be piped in parallel. Units of equal size help to ensure fluid flow balance, but balancing valves ensure balanced flows even with dissimilar sized chillers.

Temperature controller sensors may or may not need to be moved to the common fluid piping depending on the specific application.

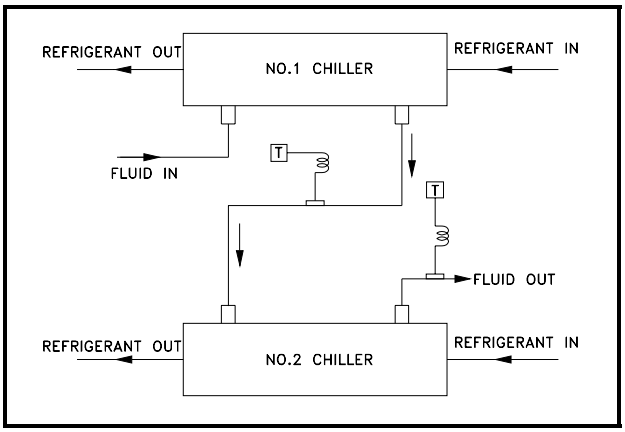
Parallel Chiller Applications – Both units operate simultaneously modulating with load variations. Each unit operates independently sensing its own leaving fluid temperature. The set point of each thermostat is set to maintain the desired loading scheme. (Figure 3A)

Figure 3A



Series Chiller Applications – Where a large temperature range is required (over 25 °F [13.9 °C]), the chiller may be piped in series. In this case the units are controlled independently. The load is progressive by temperature so the chiller selections are critical. (Figure 3B)

Figure 3B



Variable Evaporator Flow

Dunham-Bush chillers are capable for variable evaporator flow system. The chiller may operate to maintain constant leaving fluid temperature with evaporator flow rate changes, with below conditions fulfilled.

- Evaporator fluid flow rate is within minimum and maximum flow rate of the unit at all time during the operation
- Rate of flow changed shall not exceeded 10% per minute

Failure to comply with the above conditions will cause problem to the chiller operation and may cause the chiller to shutdown.

Glycol Freeze Protection

If the chiller or fluid piping may be exposed to temperatures below freezing, glycol protection is recommended if the water is not drained. The recommended protection is 10°F [5.6°C] below the minimum ambient temperature in the equipment room and around piping. Use only glycol solutions approved for heat exchanger duty. DO NOT use automotive anti-freezing.

If the equipment is being used to supply chilled fluid 38°F [3.3°C] or below, glycol should be used to prevent freeze damage. The freeze protection level should be 15°F [8.3°C] lower than the leaving brine temperature.
The use of glycol causes a performance derate as shown below which needs to be included in the unit selection procedure.

APPLICATION DATA

Table 1 : Ethylene Glycol

% E. G. By Weight	Freeze Point		C1 Capacity Factor	K1 kW Rate	G1 Flow Factor	P1 P.D. Factor
	°F	°C				
10	26.2	-3.2	0.995	0.998	1.019	1.050
15	22.4	-5.3	0.991	0.997	1.030	1.083
20	17.8	-7.9	0.988	0.996	1.044	1.121
25	12.6	-10.8	0.984	0.995	1.060	1.170
30	6.7	-14.1	0.981	0.994	1.077	1.219
35	0.0	-17.8	0.977	0.992	1.097	1.275
40	-10.0	-23.3	0.973	0.991	1.116	1.331
45	-17.5	-27.5	0.968	0.990	1.138	1.398
50	-28.9	-33.8	0.964	0.989	1.161	1.466

Table 2 : Propylene Glycol

% P. G. By Weight	Freeze Point		C2 Capacity Factor	K2 kW Rate	G2 Flow Factor	P2 P.D. Factor
	°F	°C				
10	26.1	-3.3	0.988	0.994	1.005	1.019
15	22.8	-5.1	0.984	0.992	1.008	1.031
20	19.1	-7.2	0.978	0.990	1.010	1.051
25	14.5	-9.7	0.970	0.988	1.015	1.081
30	8.9	-12.8	0.962	0.986	1.021	1.120

Table 3 : Correction Factor - Elevation

Elevation above Sea Level		Capacity Correction Factor	kW Correction Factor
Feet [m]	Meters Factor		
0	0	1.00	1.00
2000	600	0.99	1.01
4000	1200	0.98	1.02
6000	1800	0.97	1.03

Table 4 : Correction Factor - FF

Fouling Factor		Capacity Correction Factor	kW Correction Factor
Hr.ft².°F/BTU	m².°C/kW		
0.0001	0.018	1.000	1.000
0.00025	0.044	0.993	0.997
0.00050	0.088	0.978	0.990
0.00100	0.176	0.951	0.978

Note: P.D. – Pressure drop across evaporator

ICE THERMAL STORAGE SYSTEM (*ITES*)

The globe is progressively marching towards a serious electric energy crisis. The HVAC/R industry is shifting to operate with more efficient machines, as well as alternate system designs and solutions. Dunham-Bush, as a leader of HVAC/R solutions provider, we provide packaged solution for ***ITES***, which include, equipments selections, chillers, Ice Cels and ***CPM*** for ***ITES*** system controls.

Dunham-Bush Chillers, with positive displacement rotary screw compressor can easily cool low temperature glycol down to 20°F [-6.7 ^{o}C] to charge the ice storage tanks. The same chiller can also produce warmer supply fluid temperature, 40 to 45 ^{o}F [4.4 to 7.2 ^{o}C], for those building systems designed for only peak shaving.

Dunham-Bush is the only HVAC/R manufacturer who can provide complete ***ITES*** packaged solution, with own products for chillers, ice storage tanks and plant room control system, with following benefits.

Demand Charge: ***ITES*** allows some of the peak demand to be shifted to low-demand nighttime periods, thus reducing demand charges for the entire year.

Energy Cost: ***ITES***, by operating chillers at night, will fully utilize incentive on electricity night tariff, which is much lower compare to day tariff

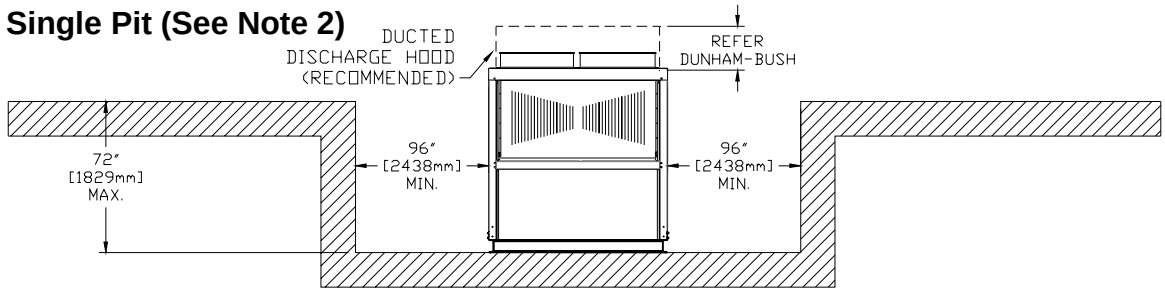
Rebates: ***ITES*** usually qualifies for rebates offered by electric utilities or governments for equipment that shift peak loads to off-peak hours

Colder Air Temperature: ***ITES*** can produce chilled liquid at supply temperature of 38°F [3.3°C] or even lower without scarifying system's efficiencies. This realizes energy saving on chilled water pumping system, AHUs and FCUs. Colder supply air distribution lowers room humidity, and thus, comfort cooling can be achieved with higher room temperature. This reduce air conditioning load required, and therefore, reduces the installation cost and system operating cost.

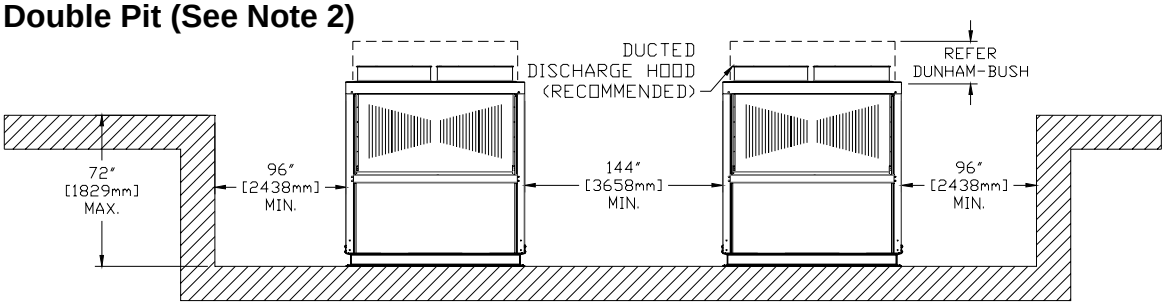
Standby Cooling Capacity: Energy stored in ***ITES*** can be utilized to cater peak or unexpected loads which exceeded total cooling capacity available from the installed chillers. This is savior to the regions which having difficulties on power generation plants expansion, where with ***ITES***, will significantly reduced total demand of the buildings.

MINIMUM CLEARANCE REQUIREMENTS

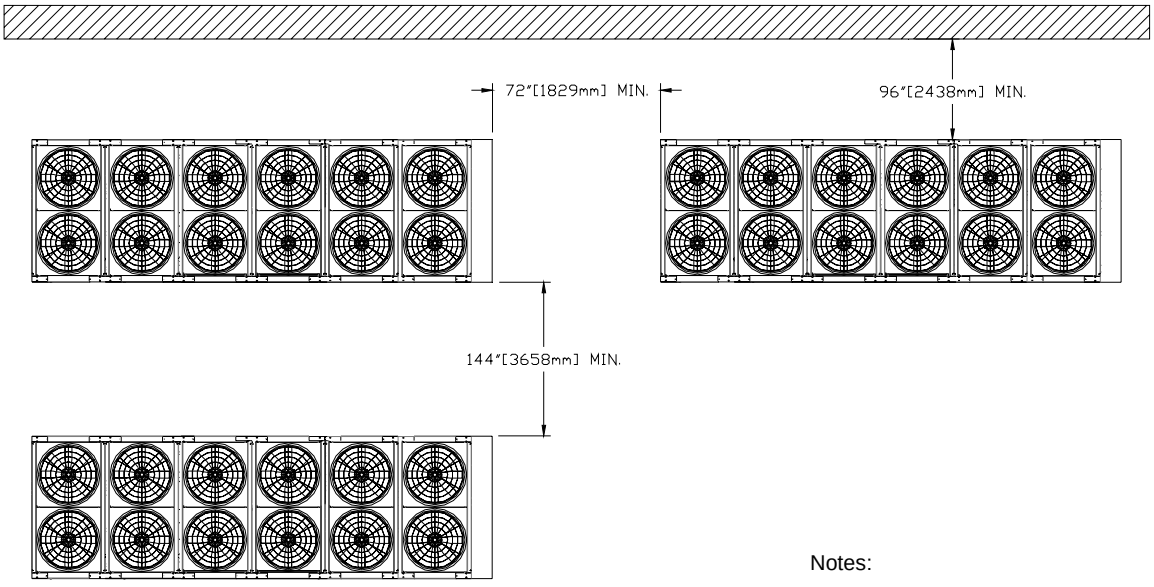
Single Pit (See Note 2)



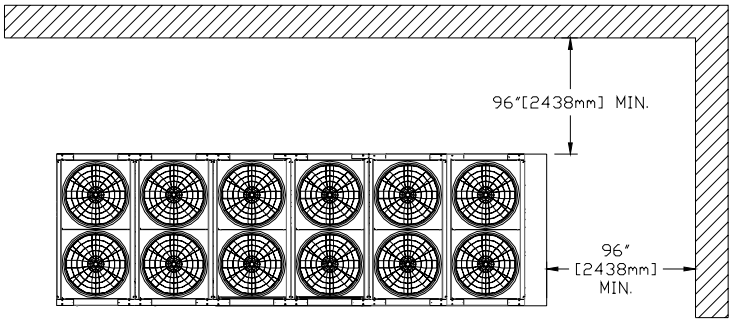
Double Pit (See Note 2)



Multi Pit



Corner Wall



Notes:

1.) All dimensions are minimal, unless otherwise noted.

2.) Pit installations are not re-commended. Re-circulation of hot condenser air in combination with surface air turbulence cannot be predicted. Hot air re-circulation will severely affect unit efficiency (EER) and can cause high pressure or fan motor temperature trips. Dunham-Bush will not be responsible for ducting fans to a higher level to alleviate the above mentioned conditions.

GUIDE SPECIFICATIONS

1.0 GENERAL

1.1 SUMMARY

Supply and commissioning of complete factory assembled air cooled screw chiller suitable for outdoor installation. The air cooled chiller shall contain rotary screw compressor(s), evaporator, air cooled condenser with coil and fan, interconnecting refrigerant piping, electronic expansion valve, control panel, chilled liquid connections. The control panel shall be fully wired by the manufacturer to connect and interlock controller, starter, protection devices with electrical power and control connections. Packaged chiller shall be factory assembled, charged and run tested with a full operating refrigerant and oil charge. The refrigerant type shall be R134a and shall not have phasing out schedule.

Contractor shall furnish and install chiller as shown and scheduled on the drawings. Unit shall be installed in accordance with this specification.

1.2 QUALITY ASSURANCE

- Chiller performance shall be rated in accordance to AHRI 550/590 standard latest edition.
- ASME standard B31.5 for Refrigerant piping
- Vessels shall be fabricated and pressure tested in accordance with ASME Boiler and Pressure vessel code, Section VIII, Division 1 “Unfired Pressure Vessels”
- Manufacturer shall have experience of minimum 15 years in manufacturing Air Cooled Screw Chillers in their facility
- Unit shall be manufactured in ISO9001 registered manufacturing facility.
- [OPTIONAL] ASHRAE Standard 15 safety code for mechanical refrigeration
- [OPTIONAL] PED certification required in Europe market place
- Factory run test: Chiller shall be pressure tested, evacuated and fully charged with refrigerant and oil. The chiller shall be run tested with water flowing through the vessels.
- Manufacturer shall have a service organization with trained service personal.

1.3 DESIGN BASE

The construction drawings indicate a system based on a selected manufacturer of equipment and the design data available to the Engineer during construction document preparation. Electrical services, size, configuration and space allocations are consistent with that manufacturer’s recommendations and requirements.

Other listed or approved manufacturers are encouraged to provide equipment on this project; however, it will be the Contractor and/or Supplier’s responsibility to assure the equipment is consistent with the design base. No compensation will be approved for revisions required by the design base or other manufacturers for any different services, space, clearances, etc.

1.4 DELIVERY, STORAGE AND HANDLING

Unit shall be delivered to job site fully assembled with all interconnecting refrigerant piping and internal wiring ready for field installation and charged with refrigerant and oil by manufacturer. When delivered, machine shall be stored indoors, away from construction dirt, dust, moisture or any other hazardous material that would harm the chillers. Inspect under shipping tarps, bags, or crates to be sure there is no water collected during transit. Protective shipping covers shall be kept with the unit until machine is ready for installation.

1.5 WARRANTY

Chiller manufacturer’s warranty shall cover for 12 months from the date of start-up or 18 months from the date of shipment whichever is first. The start-up shall be carried out by an authorized service personnel and the warranty is limited to part replacement excluding labor and consumables such as refrigerant, oil & filter driers etc.

1.6 MAINTENANCE

Maintenance of the chillers will be the responsibility of the owner and performed in accordance with the manufacturer’s instructions

2.0 PRODUCTS

2.1 OPERATING REQUIREMENTS

The units will be furnished as shown on capacity schedules and drawings. Unit performance will be in accordance with AHRI Standard 550/590.

The unit shall be capable of starting up with entering fluid temperature to the cooler at 95°F [35^{o}C].

The unit shall be capable to produce chilled fluid temperature between 40^{o}F to 50^{o}F [4.5^{o}C to 10^{o}C] at standard operating mode.

[OPTIONAL]:

A. Dual Mode operation – The unit shall capable for ice thermal storage applications with supply brine temperature down to 18^{o}F [-7.8^{o}C].

The unit shall be design to operate at ambient temperature 45^{o}F to 131^{o}F [7^{o}C to 55^{o}C].

[OPTIONAL]:

A. Low Ambient Operation (LA1) – The unit shall capable to operate with ambient temperature down to 14^{o}F [-10^{o}C].

B. Extra Low Ambient Operation (LA2) – The unit shall capable to operate with ambient temperature down to -20^{o}F [-29^{o}C].

Unit shall be able to operate with 3-phase power supply with voltage within +/- 10% of unit rated voltage. Control Voltage shall be 115V/1Ph.

2.2 CONSTRUCTION

The unit panels, control boxes shall be constructed by heavy gauge, galvanized steel with powder coating baked finishing to pass 1000-hours salt spray test in accordance with ATSM B117 standard.

2.3 COMPRESSOR

The packaged chiller shall be furnished with Semi-hermetic rotary twin-screw compressor(s) as required, driven by a 3550 RPM (60Hz) 2 pole motor. Each compressor shall include oil sump. The oil differential pressure shall be controlled during operation to maintain proper oil lubrication throughout the lubrication system. An electric oil heater shall be provided in each compressor to maintain required oil temperature during shutdown period. The heater shall be energized when the chiller is switched off. Each compressor shall have a sight glass, suction filter, a discharge check valve and a discharge service valve. Compressor capacity control shall be obtained by an electrically initiated, hydraulically actuated slide valve within each compressor. The bearing shall be heavy duty, anti-friction, type, shall be able to carry both radial and thrust loads.

The compressor motor shall be semi-hermetic refrigerant gas cooled, 2 pole, squirrel cage induction type with class F insulation. Motor winding shall have thermistors embedded in the motor windings to protect motor from overheating. The thermistors shall be wired to the solid state motor protection module.

[OPTIONAL]:

Compressor Suction Service Valve – To further isolate compressor from evaporator.

2.4 EVAPORATOR

Evaporator vessel shall be cleanable shell and tube, flooded type. Shell shall be fabricated from rolled carbon steel sheet with fusion welded seams or carbon steel standard pipes. End plates shall be of carbon steel with precision drilling, reamed in order to accommodate tubes. Intermediate tube support shall be in place to provide required tube support between tube sheets. Tubes shall be of copper, seamless, high efficient, internally enhanced and externally finned, mechanically expanded into fixed steel tube sheets. Tube diameter shall be ¾ inch and thickness shall be 0.025 inch. The flooded evaporator shall have a built in distributor for feeding refrigerant evenly under the tube bundle to produce a uniform boiling action and baffle plates shall be provided to ensure vapor separation.

Water box shall be removable type for tube cleaning. Water connections shall be with Victaulic grooves in compliance to ANSI / AWWAC-606. Vent and drain plugs are to be provided in water box. The shell side of the evaporator shall have pressure relief valve with provision for refrigerant venting.

Evaporator refrigerant side shall be designed and constructed in accordance with the ASME Code for Unfired Pressure Vessels. Evaporator shell side shall be designed for working pressure up to 200PSIG [13.8BAR] and undergo pneumatic pressure test at 220PSIG [15.2BAR]. Tube side shall be designed for 150PSIG [10.3BAR] working pressure and undergo hydrostatic pressure test at 195PSIG [13.4BAR].

The flooded evaporator shall have an efficient and reliable oil recovery system. The oil recovery system shall insure the evaporator is operating at peak efficiency at all times and provide optimal energy efficiency during extended periods of part load. Units without such oil recovery systems shall not be acceptable.

All low temperature surfaces shall be factory insulated with 1 inch [25mm] thick Polyethylene resin having K factor of 0.26 btu-in / hr.ft².°F.

[OPTIONAL]:

A. Evaporator Flanged Water Connection – Flanged water connection shall be provided in lieu of Victaulic connection.

B. Double Thick Insulation – Evaporator shall be provided with 2 inch [50mm] thick closed cell insulation for extra resistance to condensation.

C. 250PSIG [1.7MPa] Working Pressure Vessel – Evaporator with 250PSIG working pressure on shell side shall be provided.

D. PED Compliance – Evaporator with PED approval shall be provided for installation in European countries.

2.5 CONDENSER AND FANS

Condenser Coil shall be constructed with Microchannel type aluminium alloy tube brazed together with aluminium alloy fin. The whole coil shall be made of a single type material to prevent galvanic corrosion from different metals. Microchannel coil shall come anti-corrosion coating and is able to withstand more than 1400hours Sea Water Acetic Acid Test (SWAAT) in accordance with ASTM G85-A3 standard.

The coil construction shall be of V configuration in order to increase heat transfer area and condenser divider baffles shall fully separate each condenser fan section to control the air flow by fan cycling and fan staging to maintain optimum head pressure. Coil plate shall be make of galvanized steel and divider baffles shall be made of galvanized steel with powder coating.

The fan shall be direct drive propeller type, made of heavy duty alloy blades, in order to have higher resistance for dust and sand abrasion. Fan shall be protected with powder coated steel wire fan guard.

The motor shall be 3-phase, TEFC, squirrel cage induction type with IP55 enclosure and class F insulation. The motor bearing shall be permanently lubricated. Motor shall have internal thermal protection

The fan and the motor assembly shall be rigidly secured to the casing with a heavy gauge steel powder coated fan brackets with air discharge upward.

Full pump down capacity in condenser (Al-Cu option only).

[OPTIONAL]:

A. Microchannel Condenser Coil [E-Coating] - Condenser Coil shall be constructed with Microchannel type aluminium alloy tube brazed together with aluminium alloy fin. The whole coil shall be made of a single type material to prevent galvanic corrosion from different metals. Microchannel coil shall be electro-coated with protective coating to withstand at least 3000hours Sea Water Acetic Acid Test (SWAAT) in accordance with ASTM G85-A3 standard.

B. Aluminum Fin/ Copper Tube – The coil shall be constructed of seamless inner-grooved copper tube and die formed aluminum fins having self spacing collars in staggered configuration. Copper tubes shall be mechanically expanded into the fins.

C. Pre-Coated Aluminum Fin/Copper Tube Coil – Copper/Pre-coated Aluminum fin construction shall be made of seamless inner grooved copper tubes mechanically expanded into pre-coated (hydrophilic coated) aluminum fins. The tube sheet shall be of galvanized steel and the divider baffles shall be of galvanized steel with powder coating.

D. Copper Tube/ Copper Fin Coil – Copper/Copper coil construction shall be made of seamless inner grooved copper tubes mechanically expanded into copper fins. The tube sheet shall be of galvanized steel or stainless steel and the divider baffles shall be of galvanized steel with powder coating.

E. Post-Coated Aluminum Fin Coil – Copper tube/per-coated Aluminum fin coil construction shall be made of seamless inner grooved copper tubes mechanically expanded into Aluminum fins. The tube sheet shall be of galvanized steel. The entire fin shall be coated with anti corrosive coating after the coil fabrication. The divider baffles shall be made of galvanized steel with powder coating.

F. Protective Grille for Condenser Coil – Protective grille shall be provided to condenser coil section to prevent unauthorized access.

2.6 REFRIGERANT CIRCUIT

The refrigerant circuit shall include discharge service valves, liquid line shut off valve, oil filter, replaceable filter drier, and sight glass at liquid line. Liquid line angle valve shall be provided for refrigerant charging. Pressure relief valves shall be provided at evaporator.

The packaged chiller shall be furnished with electronic expansion valve for precise modulation of refrigerant flow control and improve efficiency by optimizing the suction and discharge superheat. In addition, the refrigerant control system shall optimized refrigerant liquid level in the flooded evaporator to protect the compressor from slugging liquid refrigerant. Fixed orifice control systems shall not be acceptable.

[OPTIONAL]:

A. Heat Recovery – Factory supplied shell-and-tube heat exchanger to reclaim waste heat from the system to produce hot water up to 131^{o}F [55^{o}C].

B. Hotgas Bypass – Shall be factory for operation down to approximately 10% of full load.

2.7 OIL MANAGEMENT

The chiller package shall ensure proper lubrication during the operation in order to have prolonged compressor life as well as maintaining system efficiency. An efficient pressure differential lubrication system shall be provided with oil filter, sight glass, oil sump and oil sump heater. The oil heater shall be energized during the chiller switched off to prevent oil from dilution. Oil pump shall not be acceptable.

2.8 ELECTRICAL AND CONTROL PANEL

The electrical switch gears, controller, sensor transmitters and relays shall be housed in IP54 panel. The panel casing shall be of galvanized steel with powder coating baked finishing for corrosion resistance. The panel shall be divided into two separate compartments or shall have two separate panels to house power and control devices separately.

The chiller manufacturer shall provide suitable reduced inrush starter for the compressor motor in order to minimize the starting current. The starter shall be factory mounted, wired to the motor and controller. The starter shall be able to provide adequate starting torque and the required acceleration for the compressor during starting.

The electrical panel compartment shall include:

A. Main incoming power terminal block suitable to receive single entry of three phase 3-wire power supply with specified voltage.

B. Circuit breaker for each compressor.

C. Solid state / thermal compressor motor with over current protection module for each phase.

D. Solid state compressor motor overheat protection module.

E. Under/over voltage phase reversal and imbalance relay.

The compressor starter contactors and circuit breakers shall be wired securely to the main incoming terminal block. Solid state/ thermal external compressor over load protector, over heating protection modules, over/under voltage phase relay shall be interlocked with the compressor starter contactors to provide adequate protection to the compressor motor.

[OPTIONAL]:

A. IP55 control panel – Option shall be offered to upgrade the standard IP54 control panel to IP55 rated.

B. Unit Mounted Main Disconnect Switch – Non-fused disconnect switch with external lockable handle shall be provided to isolate unit main incoming power supply for servicing.

C. Ground Fault Interrupt (GFI) – GFI shall be provided for ground fault protection of the unit.

D. Softstarter for compressors motor – Solid state starter comes with bypass contactor shall be offered in lieu of standard starter for better compressor starting characteristic.

E. Ammeter/ Voltmeter – Analog ammeter and voltmeter with 3-phase selector switch shall be provided for quick system voltage and current indication.

2.9 CONTROLS

2.9.1 GENERAL

The packaged chiller shall be equipped with stand along proactive advance controller which adapts to abnormal operation conditions. The unit algorithm program and operating parameters shall be stored in flash-memory that does not require a battery back-up. Controller requires back-up battery is not acceptable.

115V power supply to the control circuit shall be provided by a factory mounted control transformer installed in the panel. External power source to the control circuit is not acceptable.

The controller shall be equipped with a user friendly back-lit 132 x 64 pixels semi-graphic display and dedicated keys that provide easy access to the unit operating parameters, control set points and alarm history. There shall be dedicated physical buttons to enable user to access information, based on security level of password. There shall be min three level of password for operator, service personnel and for the critical manufacturer settings in order to protect the chiller controller from unauthorized access.

The controller shall be provided with a set of terminals that connected to various devices such as temperature sensors, pressure transducers, current transducers, solenoid valves, compressor contactors, electronic expansion valve, control relays. The controller should be able to be configured and connected multiple units that allow sequencing control without additional hardware. The controller shall be able to carry out all program operations. It shall be able to display unit operating parameters, compressor information, alarm history and shall able to modify the parameters.

The controller shall be able to carry out self-diagnostic test on the controller and the connected devices and alarm messages shall be displayed automatically on faulty devices.
All messages shall be displayed in English language. Readings and settings displayed shall be selectable between Imperial or SI units.

Leaving chilled water temperature control shall be accomplished by entering the water temperature set point with accuracy to 0.8°F and placing the controller automatic control mode. The controller shall monitor all control functions and move the compressor slide valve to the calibrated position. The compressor loading cycle shall be programmable and shall be adjusted to the building load requirement. The loading adjustable range shall be from 0.1% to 0.4% per increment to prevent excessive demand hike at start up.

The controller shall continuously monitor evaporator leaving water temperature, rate of change of chilled water leaving temperature, evaporator and condenser pressure; compressor amp draw; and discharge refrigerant temperature.
The controller shall be capable to accept low level remote control signal. Remote Start/Stop shall be provided as standard for unit start/stop by external on/off signal.

[OPTIONAL]:

Chilled Water Temperature Reset – The controller shall be capable to accept a 0 to 5VDC chilled water temperature reset signal to reset the chilled water supply temperature setpoint, based on external demand.

Demand Limit / Current Limit – The controller shall be capable to accept a 0 to 5VDC demand limit signal to limit the compressors operating current during the unit operation.

The electrical control panel shall be wired to permit fully automatic operation during - initial start-up, normal operation, and shutdown conditions. The control system shall contain the following control, displays and safety devices:

2.9.2 AUTOMATIC CONTROLS

- Compressor motor increment contactors
- Start delay timer
- Anti-recycle timer
- Oil sump heater interlock relays

2.9.3 MANUAL CONTROLS

- Auto/Local/Remote switch
- Control circuit stop and start switches
- Compressor enable switch
- Compressor over current
- Programmable with Seven day operation cycle

[OPTIONAL]:

Dual mode changeover switch – Digital input to changeover unit operation from chiller mode to freezing mode.

2.9.4 INDICATOR LIGHTS

- Control power
- Compressor run
- Compressor motor overload
- System common alarm

The control system shall be provided with an anti-recycle device. The control shall limit compressor starting to a minimum of 15 minutes between starts.

2.9.5 REFRIGERANT CONTROLS

- Refrigerant flow control shall be carried out electronically by a precision electronic expansion valve
- Compressor loading and unloading solenoid valves

2.9.6 SYSTEM INFORMATION

The chiller display shall provide following operating information.

- Leaving chilled water temperature
- Entering Chilled water temperature
- Compressor discharge temperature
- Leaving chilled water temperature derivative
- Evaporator pressure
- Condenser pressure
- Ambient Temperature
- Compressor amps draw for each compressor
- Compressor elapsed run time of each compressor
- Compressor start status
- Oil level sensor status
- Water flow switch status
- External start/stop command status
- Percentage of compressor capacity
- Electronic expansion valve percentage of opening

[OPTIONAL]:

- Operating supply Voltage
- Chilled water temperature reset value
- Demand limiting value

2.9.7 SAFETY PROTECTION

- Short circuit protection
- Compressor motor over load protection (3 phase)
- Compressor over current
- Compressor motor overheat protection
- Compressor Anti-recycle
- High discharge temperature protection
- Under voltage phase failure relay
- Low oil level protection
- High condenser pressure
- Low evaporator pressure
- Freeze protection (low chilled liquid leaving temperature)
- Chilled water flow loss
- Low differential pressure
- Power loss
- Sensor error
- Refrigerant loss (by low pressure)
- Reverse rotation

Controller shall be able to retain up to 99 alarm conditions complete with time of failure and all critical sensor readings. This aids service technicians in their trouble shooting task enabling downtime and nuisance trip-outs to be minimized.

2.9.8 REMOTE MONITORING (BMS INTERFACING)

The controller shall be designed to make easy on BMS interfacing by just an optional add-on communication card.

Various communication protocols as below shall be offered for user's selection.

- Modbus RTU RS485 / TCPIP
- BACnet TCPIP / MsTP / PTP
- LONworks

2.9.9 OPTIONAL ACCESSORIES

Factory shall supply below accessories for customer's field installation.

- Evaporator Water Flow Switch – Weather tight flow switch with three options for customer's selection; Flow switch with CE mark; NEMA 1 and NEMA 4 rated flow switch
- Rubber-In-Shear Isolators
- Spring Isolators

3.0 EXECUTION

3.1 INSTALLATION

Chiller shall be installed strictly according to manufacturer's recommendations as stipulated in the installation manual, drawings and tender documents. Care should be taken to provide necessary service clearance as required in the manufacturer's drawing. Install the strainers at the inlet to the evaporator to prevent debris or other particles entering to the evaporator during piping work and initial flushing the system. Required coordination to be done with the electrical contractor and the control contractors to ensure electrical supply and required communications links are established.

3.2 START-UP/COMMISSIONING

Chiller shall be commissioned by a service representative from manufacturer or by their local representative. The service personnel shall be trained and authorized by the manufacturer for start up of the supplied units. The start-up shall include briefing operators on chiller operations and maintenance as well.

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