Helios

Air Cooled Screw Chillers

ACHX-BH 50Hz

Cooling Capacity: 90 to 418 TR (315 to 1470 kW)

R134a

AHRI CERTIFIED

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-BH Air Cooled Screw Flooded Chillers, have a cooling capacity range from 90 to 418 TR [315 to 1470 kW] in 50/60Hz 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-BH series are certified to AHRI Standard 550/590 and the unit's performance easily exceeds ASHRAE Standard 90.1-2016.

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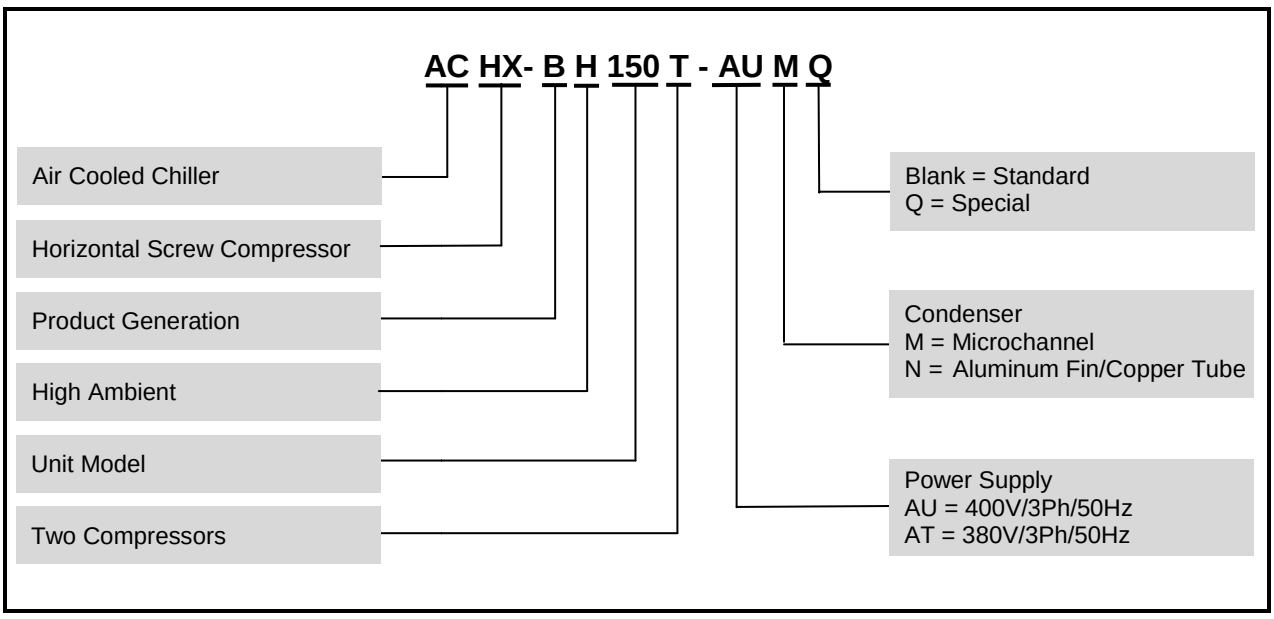
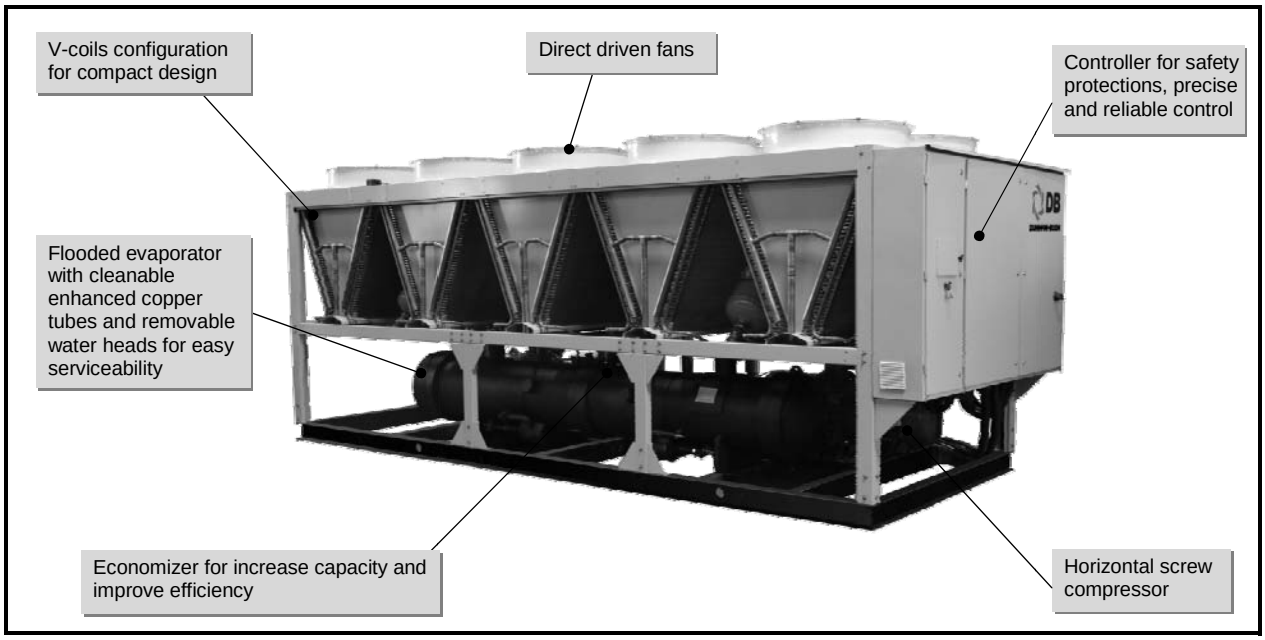
NOMENCLATURE



GENERAL CHARACTERISTICS



UNIT FEATURES

General

- 18 models from 90 to 418 TR [315 to 1470 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

- Microchannel condenser coil consists of 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

- **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.
- **Heat Recovery** – The hot gas desuperheater; a shell-and-tube heat exchanger that reclaims 'waste' heat from compressor to produce hot water up to 131°F [55°C]
- **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
- **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°F [-7.8°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°F [-7.8°C] for process cooling application
- **ASME Compliance** – Evaporator with ASME 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

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

Factory Supplied, Field Installed By The Customer

- **Evaporator Water Flow Switch**– Flow switch to be installed at evaporator outlet piping as safety interlock to evaporator water flow status. Three options are available: Weather tight flow switch with 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

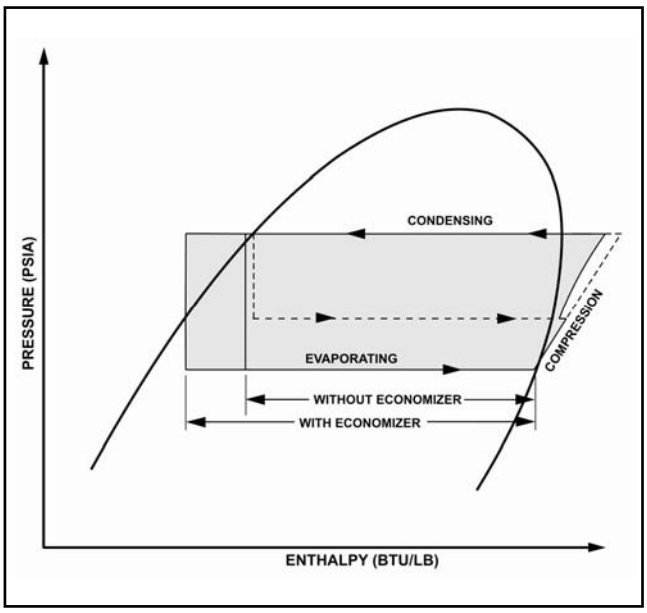
Control Flexibility

- 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) 50Hz

Model ACHX-BH		90T	100T	130T	150T	170T	185T	200T	215T	240T
Cooling Capacity	TR	89.7	98.1	126.7	145.3	172.9	184.0	196.8	215.1	240.4
	kW	315	345	445	511	608	647	692	757	845
Power Input	kW	99.2	111.0	138.6	159.4	192.0	205.4	221.7	251.1	271.4
Energy Efficiency	kW/TR	1.106	1.132	1.094	1.097	1.111	1.116	1.127	1.167	1.129
COP	kW_o/kWi	3.18	3.11	3.21	3.21	3.17	3.15	3.12	3.01	3.11
Compressor										
QTY.		2	2	2	2	2	2	2	2	2
RPM		2950	2950	2950	2950	2950	2950	2950	2950	2950
Oil Charge	Litres	28	32	32	32	33	34	36	42	46
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		C4R(TH)	1CR(TH)	1CR(TH)	1DR(TH)	2ER(TH)	2FR(TH)	2FR(TH)	EBR(TH)	EBR(TH)
(Qty)		1	1	1	1	1	1	1	1	1
Water Connector	inches	4	5	5	5	6	6	6	6	6
	mm	101.6	127	127	127	152.4	152.4	152.4	152.4	152.4
Nominal Water Flow	Usgpm	215.3	235.4	304.0	348.8	414.9	441.5	472.3	516.3	576.8
	l/s	13.6	14.9	19.2	22.0	26.2	27.9	29.8	32.6	36.4
Nominal Water Pressure Drop	ft.wg	7.7	16.8	26.2	24.8	25.3	22.0	24.8	23.6	28.7
	kPa	23.1	50.1	78.4	74.2	75.5	65.8	74.0	70.7	85.8
Min. Water Flow	Usgpm	141.4	116.8	116.8	138.3	162.9	187.5	187.5	210.6	210.6
	l/s	8.9	7.4	7.4	8.7	10.3	11.8	11.8	13.3	13.3
Max. Water Flow	Usgpm	471.4	389.4	389.4	461.1	543.1	625.1	625.1	701.9	701.9
	l/s	29.7	24.6	24.6	29.1	34.3	39.4	39.4	44.3	44.3
Min. Water Pressure Drop	ft.wg	3.6	4.8	4.7	4.7	4.7	4.7	4.7	4.7	4.7
	kPa	10.8	14.2	14.1	14.1	14.1	14.1	14.1	14.1	14.0
Max. Water Pressure Drop	ft.wg	31.7	41.5	41.1	41.1	41.1	41.1	41.1	41.1	41.1
	kPa	94.7	124.0	122.7	122.8	122.9	122.8	122.8	122.8	122.8
Condenser										
Total Air Flow	CFM	108,192	108,192	108,192	108,192	135,240	135,240	135,240	162,288	162,288
	CMH	183,818	183,818	183,818	183,818	229,773	229,773	229,773	275,727	275,727
Total Face Area	sq.ft	181.1	181.1	181.1	181.1	226.4	226.4	226.4	271.7	271.7
	sq.m	16.83	16.83	16.83	16.83	21.03	21.03	21.03	25.24	25.24
No. of Fans		8	8	8	8	10	10	10	12	12
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	197 1/4	197 1/4	197 1/4	197 1/4	242 1/2	242 1/2	242 1/2	287 13/16	287 13/16
	mm	5010	5010	5010	5010	6160	6160	6160	7310	7310
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	8220	8748	9056	9457	10530	10813	10930	12903	13458
	kg	3729	3968	4108	4290	4776	4905	4958	5853	6104
Operating Weight	lbs	8411	8948	9256	9684	10806	11116	11233	13251	13805
	kg	3815	4059	4198	4393	4902	5042	5095	6010	6262
Operating Charge R134a	lbs	139	154	201	231	262	285	309	332	370
	kg	63	70	91	105	119	130	140	151	168

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) 50Hz

Model ACHX-BH		260T	280T	300T	315T	340T	355T	380T	400T	420T
Cooling Capacity	**TR**	256.4	275.0	295.4	314.7	335.2	353.2	377.1	401.0	418.0
	kW	902	967	1039	1107	1179	1242	1326	1410	1470
Power Input	**kW**	289.7	305.2	323.0	344.9	375.7	401.6	425.4	447.8	470.7
Energy efficiency	**kW/TR**	1.130	1.110	1.094	1.096	1.121	1.137	1.128	1.117	1.126
COP	**kW_o/kWi**	3.11	3.17	3.22	3.21	3.14	3.09	3.12	3.15	3.12
Compressor										
QTY.		2	2	2	2	2	2	2	2	2
RPM		2950	2950	2950	2950	2950	2950	2950	2950	2950
Oil Charge	**Litres**	49	52	54	56	56	56	68	80	80
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		JCR(TH)	JCR(TH)	JAR(TH)	JAR(TH)	S1R(TH)	S2R(TH)	S2R(TH)	S2R(TH)	S2R(TH)
(Qty)		1	1	1	1	1	1	1	1	1
Water Connector	**inches**	8	8	8	8	8	8	8	8	8
	mm	203.2	203.2	203.2	203.2	203.2	203.2	203.2	203.2	203.2
Nominal Water Flow	**Usgpm**	615.3	660.0	708.9	755.4	804.6	847.7	905.1	962.5	1003.2
	l/s	38.8	41.6	44.7	47.7	50.8	53.5	57.1	60.7	63.3
Nominal Water Pressure Drop	**ft.wg**	23.5	26.5	27.1	30.3	24.6	21.5	24.1	26.8	28.8
	kPa	70.1	79.2	80.9	90.5	73.6	64.1	71.9	80.0	86.0
Min. Water Flow	**Usgpm**	252.1	252.1	267.5	267.5	328.9	375.0	375.0	375.0	375.0
	l/s	15.9	15.9	16.9	16.9	20.8	23.7	23.7	23.7	23.7
Max. Water Flow	**Usgpm**	840.3	840.3	891.5	891.5	1096.4	1250.2	1250.2	1250.2	1250.2
	l/s	53.0	53.0	56.2	56.2	69.2	78.9	78.9	78.9	78.9
Min. Water Pressure Drop	**ft.wg**	4.7	4.7	4.7	4.7	4.9	4.9	4.9	4.9	4.9
	kPa	14.1	14.0	14.0	14.0	14.7	14.8	14.8	14.8	14.6
Max. Water Pressure Drop	**ft.wg**	41.0	41.0	41.0	40.9	43.1	43.2	43.2	43.2	42.8
	kPa	122.6	122.6	122.6	122.2	128.8	129.2	129.2	129.2	127.9
Condenser										
Total Air Flow	**CFM**	189,336	189,336	216,384	216,384	216,384	216,384	243,432	270,480	270,480
	CMH	321,682	321,682	367,636	367,636	367,636	367,636	413,591	459,546	459,546
Total Face Area	**sq.ft**	317.0	317.0	362.2	362.2	362.2	362.2	407.5	452.8	452.8
	sq.m	29.45	29.45	33.65	33.65	33.65	33.65	37.86	42.07	42.07
No. of Fans		14	14	16	16	16	16	18	20	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**	333	333	378 3/8	378 3/8	378 3/8	378 3/8	423 5/8	468 7/8	468 7/8
	mm	8460	8460	9610	9610	9610	9610	10760	11910	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**	15134	15276	16505	16841	17609	17945	19716	21598	21687
	kg	6865	6929	7487	7639	7987	8140	8943	9797	9837
Operating Weight	**lbs**	15553	15694	16946	17281	18161	18555	20326	22208	22297
	kg	7055	7119	7687	7839	8238	8416	9220	10073	10114
Operating Charge R134a	**lbs**	401	432	463	486	525	548	586	617	648
	kg	182	196	210	221	238	249	266	280	294

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) 50Hz

Model ACHX-BH		90T	100T	130T	150T	170T	185T	200T	215T	240T
Cooling Capacity	TR	89.7	98.1	126.7	145.3	172.9	184.0	196.8	215.1	240.4
	kW	315	345	445	511	608	647	692	757	845
Power Input	kW	100.2	112.0	139.6	160.4	193.4	206.8	222.9	252.5	272.8
Energy efficiency	kW/TR	1.117	1.141	1.102	1.103	1.119	1.124	1.133	1.174	1.135
COP	kW_o/kWi	3.15	3.08	3.19	3.19	3.14	3.13	3.10	3.00	3.10
Compressor										
QTY.		2	2	2	2	2	2	2	2	2
RPM		2950	2950	2950	2950	2950	2950	2950	2950	2950
Oil Charge	Litres	28	32	32	32	33	34	36	42	46
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		C4R(TH)	1CR(TH)	1CR(TH)	1DR(TH)	2ER(TH)	2FR(TH)	2FR(TH)	EBR(TH)	EBR(TH)
(Qty)		1	1	1	1	1	1	1	1	1
Water Connector	inches	4	5	5	5	6	6	6	6	6
	mm	101.6	127	127	127	152.4	152.4	152.4	152.4	152.4
Nominal Water Flow	Usgpm	215.3	235.4	304.0	348.8	414.9	441.5	472.3	516.3	576.8
	l/s	13.6	14.9	19.2	22.0	26.2	27.9	29.8	32.6	36.4
Nominal Water Pressure Drop	ft.wg	7.7	16.8	26.2	24.8	25.3	22.0	24.8	23.6	28.7
	kPa	23.1	50.1	78.4	74.2	75.5	65.8	74.0	70.7	85.8
Min. Water Flow	Usgpm	141.4	116.8	116.8	138.3	162.9	187.5	187.5	210.6	210.6
	l/s	8.9	7.4	7.4	8.7	10.3	11.8	11.8	13.3	13.3
Max. Water Flow	Usgpm	471.4	389.4	389.4	461.1	543.1	625.1	625.1	701.9	701.9
	l/s	29.7	24.6	24.6	29.1	34.3	39.4	39.4	44.3	44.3
Min. Water Pressure Drop	ft.wg	3.6	4.8	4.7	4.7	4.7	4.7	4.7	4.7	4.7
	kPa	10.8	14.2	14.1	14.1	14.1	14.1	14.1	14.1	14.0
Max. Water Pressure Drop	ft.wg	31.7	41.5	41.1	41.1	41.1	41.1	41.1	41.1	41.1
	kPa	94.7	124.0	122.7	122.8	122.9	122.8	122.8	122.8	122.8
Condenser										
Total Air Flow	CFM	108,192	108,192	108,192	108,192	135,240	135,240	135,240	162,288	162,288
	CMH	183,818	183,818	183,818	183,818	229,773	229,773	229,773	275,727	275,727
Total Face Area	sq.ft	188.2	188.2	188.2	188.2	235.3	235.3	235.3	282.3	282.3
	sq.m	17.49	17.49	17.49	17.49	21.86	21.86	21.86	26.23	26.23
No. of Fans		8	8	8	8	10	10	10	12	12
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	197 1/4	197 1/4	197 1/4	197 1/4	242 1/2	242 1/2	242 1/2	287 13/16	287 13/16
	mm	5010	5010	5010	5010	6160	6160	6160	7310	7310
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	9007	9545	9866	10281	11553	11843	11970	14142	14706
	kg	4085	4329	4475	4663	5240	5372	5429	6415	6671
Operating Weight	lbs	9198	9745	10066	10508	11829	12146	12272	14489	15054
	kg	4172	4420	4566	4766	5365	5509	5567	6572	6828
Operating Charge R134a	lbs	198	220	287	331	375	408	441	474	529
	kg	90	100	130	150	170	185	200	215	240

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) 50Hz

Model ACHX-BH		260T	280T	300T	315T	340T	355T	380T	400T	420T
Cooling Capacity	TR	256.4	275.0	295.4	314.7	335.2	353.2	377.1	401.0	418.0
	kW	902	967	1039	1107	1179	1242	1326	1410	1470
Power Input	kW	291.4	306.9	324.9	346.8	377.6	403.5	427.6	450.2	473.1
Energy efficiency	kW/TR	1.137	1.116	1.100	1.102	1.126	1.142	1.134	1.123	1.132
COP	kW_o/kWi	3.09	3.15	3.20	3.19	3.12	3.08	3.10	3.13	3.11
Compressor										
QTY.		2	2	2	2	2	2	2	2	2
RPM		2950	2950	2950	2950	2950	2950	2950	2950	2950
Oil Charge	Litres	49	52	54	56	56	56	68	80	80
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		JCR(TH)	JCR(TH)	JAR(TH)	JAR(TH)	S1R(TH)	S2R(TH)	S2R(TH)	S2R(TH)	S2R(TH)
(Qty)		1	1	1	1	1	1	1	1	1
Water Connector	inches	8	8	8	8	8	8	8	8	8
	mm	203.2	203.2	203.2	203.2	203.2	203.2	203.2	203.2	203.2
Nominal Water Flow	Usgpm	615.3	660.0	708.9	755.4	804.6	847.7	905.1	962.5	1003.2
	l/s	38.8	41.6	44.7	47.7	50.8	53.5	57.1	60.7	63.3
Nominal Water Pressure Drop	ft.wg	23.5	26.5	27.1	30.3	24.6	21.5	24.1	26.8	28.8
	kPa	70.1	79.2	80.9	90.5	73.6	64.1	71.9	80.0	86.0
Min. Water Flow	Usgpm	252.1	252.1	267.5	267.5	328.9	375.0	375.0	375.0	375.0
	l/s	15.9	15.9	16.9	16.9	20.8	23.7	23.7	23.7	23.7
Max. Water Flow	Usgpm	840.3	840.3	891.5	891.5	1096.4	1250.2	1250.2	1250.2	1250.2
	l/s	53.0	53.0	56.2	56.2	69.2	78.9	78.9	78.9	78.9
Min. Water Pressure Drop	ft.wg	4.7	4.7	4.7	4.7	4.9	4.9	4.9	4.9	4.9
	kPa	14.1	14.0	14.0	14.0	14.7	14.8	14.8	14.8	14.6
Max. Water Pressure Drop	ft.wg	41.0	41.0	41.0	40.9	43.1	43.2	43.2	43.2	42.8
	kPa	122.6	122.6	122.6	122.2	128.8	129.2	129.2	129.2	127.9
Condenser										
Total Air Flow	CFM	189,336	189,336	216,384	216,384	216,384	216,384	243,432	270,480	270,480
	CMH	321,682	321,682	367,636	367,636	367,636	367,636	413,591	459,546	459,546
Total Face Area	sq.ft	329.4	329.4	376.4	376.4	376.4	376.4	423.5	470.6	470.6
	sq.m	30.60	30.60	34.97	34.97	34.97	34.97	39.34	43.72	43.72
No. of Fans		14	14	16	16	16	16	18	20	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	333	333	378 3/8	378 3/8	378 3/8	378 3/8	423 5/8	468 7/8	468 7/8
	mm	8460	8460	9610	9610	9610	9610	10760	11910	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	16575	16727	18152	18501	19282	19632	21599	23677	23779
	kg	7518	7587	8234	8392	8746	8905	9797	10740	10786
Operating Weight	lbs	16994	17145	18593	18942	19835	20242	22209	24287	24389
	kg	7708	7777	8434	8592	8997	9182	10074	11016	11063
Operating Charge R134a	lbs	573	617	661	694	750	783	838	882	926
	kg	260	280	300	315	340	355	380	400	420

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-BH	Power Supply : 400Vac-3Ph-50Hz (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
90T	Star-Delta	2	82	182	545	8	3	5.3	206	227	300	285
100T	Star-Delta	2	93	218	655	8	3	5.3	228	251	300	332
130T	Star-Delta	1	114	268	805	4	3	5.3	287	320	400	453
	Star-Delta	1	130	317	950	4	3	5.3				
150T	Star-Delta	1	130	317	950	4	3	5.3	324	362	500	489
	Star-Delta	1	151	337	1010	4	3	5.3				
170T	Star-Delta	1	164	393	1180	5	3	5.3	396	441	600	610
	Star-Delta	1	179	420	1260	5	3	5.3				
185T	Star-Delta	2	179	420	1260	10	3	5.3	411	456	600	626
200T	Star-Delta	1	179	420	1260	5	3	5.3	446	500	700	676
	Star-Delta	1	214	470	1410	5	3	5.3				
215T	Star-Delta	1	210	470	1410	6	3	5.3	522	584	800	750
	Star-Delta	1	248	508	1525	6	3	5.3				
240T	Star-Delta	2	248	508	1525	12	3	5.3	560	622	800	788
260T	Star-Delta	1	248	508	1525	6	3	5.3	592	660	800	858
	Star-Delta	1	270	578	1735	8	3	5.3				
280T	Star-Delta	2	275	578	1735	14	3	5.3	624	693	800	890
300T	Star-Delta	1	271	578	1735	8	3	5.3	676	757	1000	901
	Star-Delta	1	321	588	1765	8	3	5.3				
315T	Star-Delta	2	321	588	1765	16	3	5.3	727	807	1000	951
340T	Star-Delta	1	321	588	1765	8	3	5.3	779	872	1200	1062
	Star-Delta	1	373	698	2095	8	3	5.3				
355T	Star-Delta	2	373	698	2095	16	3	5.3	830	923	1200	1113
380T	Star-Delta	1	373	698	2095	8	3	5.3	848	942	1200	1152
	Star-Delta	1	379	737	2210	10	3	5.3				
400T	Star-Delta	2	379	737	2210	20	3	5.3	865	960	1200	1169
420T	Star-Delta	1	379	737	2210	10	3	5.3	908	1014	1200	1215
	Star-Delta	1	424	783	2350	10	3	5.3				

RLA - Running Load Amps At 115°F Ambient Temperature; MCA - Minimum Circuit Ampacity; MFS - Maximum Fuse Size; LRA - Lock Rotor Amp
Note: Standard Star-Delta starter is open transition type.

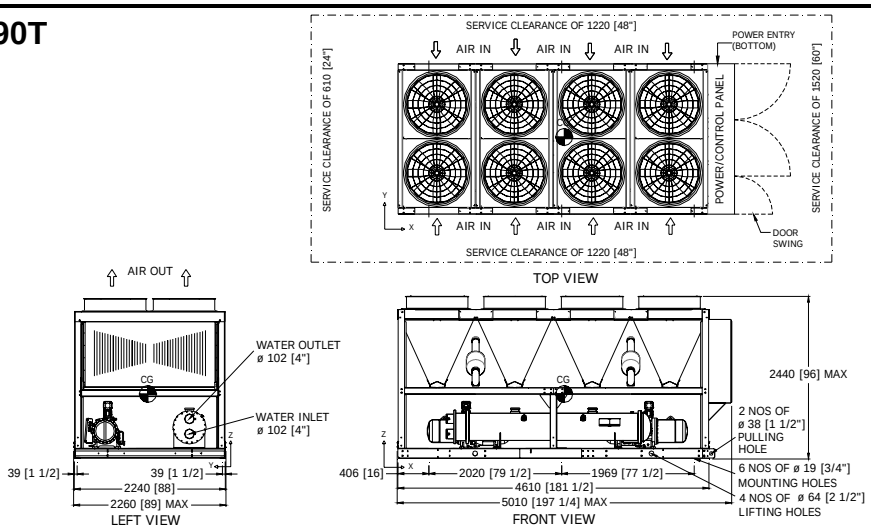
SOUND PRESSURE DATA

Model ACHX-BH	Octave Band (Hz)								Total dB(A)
	63	125	250	500	1K	2K	4K	8K	
90T	46	53	57	59	62	56	44	37	65
100T	46	53	62	63	62	56	47	38	68
130T	46	53	58	64	65	59	53	51	69
150T	46	53	58	65	65	59	48	42	69
170T	46	54	60	65	65	58	49	40	69
185T	46	54	59	66	66	58	49	41	70
200T	46	54	59	65	66	59	48	40	70
215T	47	55	59	64	68	58	48	39	70
240T	47	55	59	64	68	58	47	38	70
260T	48	55	59	66	68	59	49	40	71
280T	48	55	59	67	67	59	50	40	71
300T	48	56	60	66	68	59	49	41	71
315T	48	56	60	64	69	60	48	41	71
340T	48	56	60	64	70	59	48	40	71
355T	48	56	60	63	70	58	46	39	72
380T	49	56	60	67	69	59	50	42	72
400T	49	57	61	69	66	60	52	43	72
420T	49	57	61	68	68	60	54	44	72

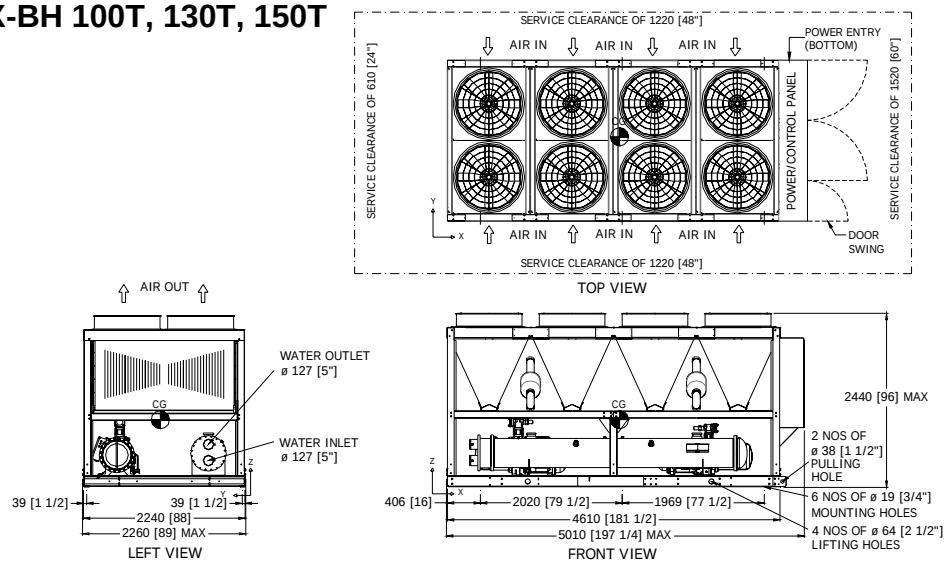
Note: Unit Sound Pressure Level (Lp) @ 33 ft [10m] (free field), ± 2 dB(A) tolerance.

DIMENSIONAL DATA

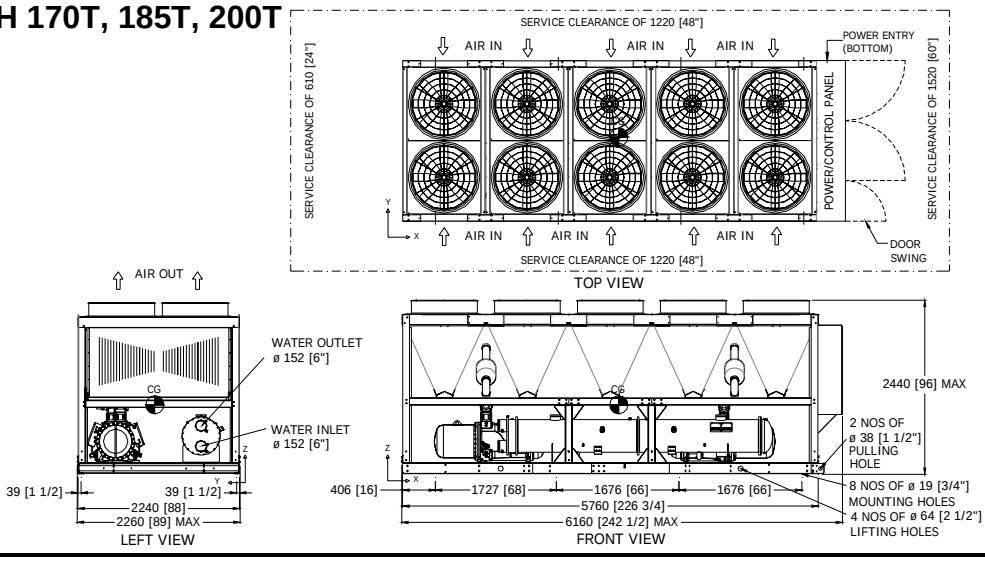
ACHX-BH 90T



ACHX-BH 100T, 130T, 150T



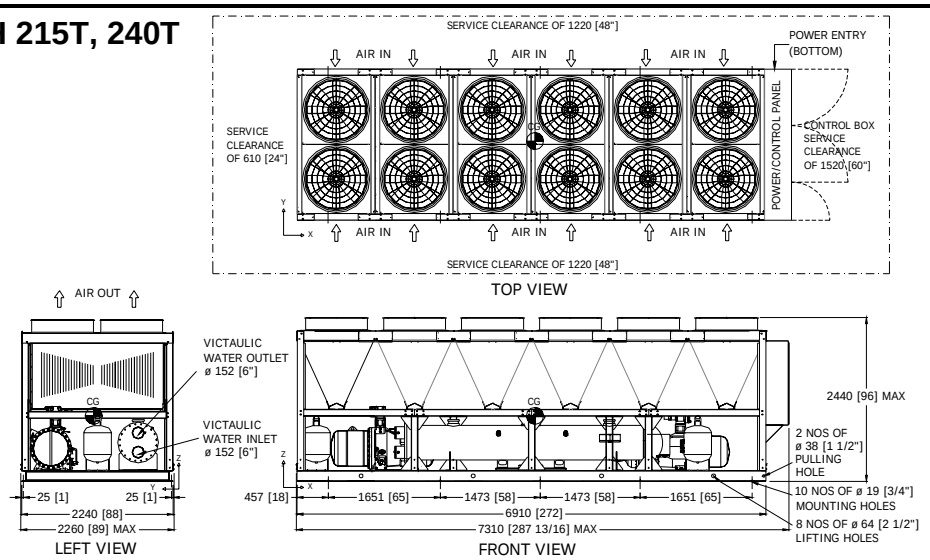
ACHX-BH 170T, 185T, 200T



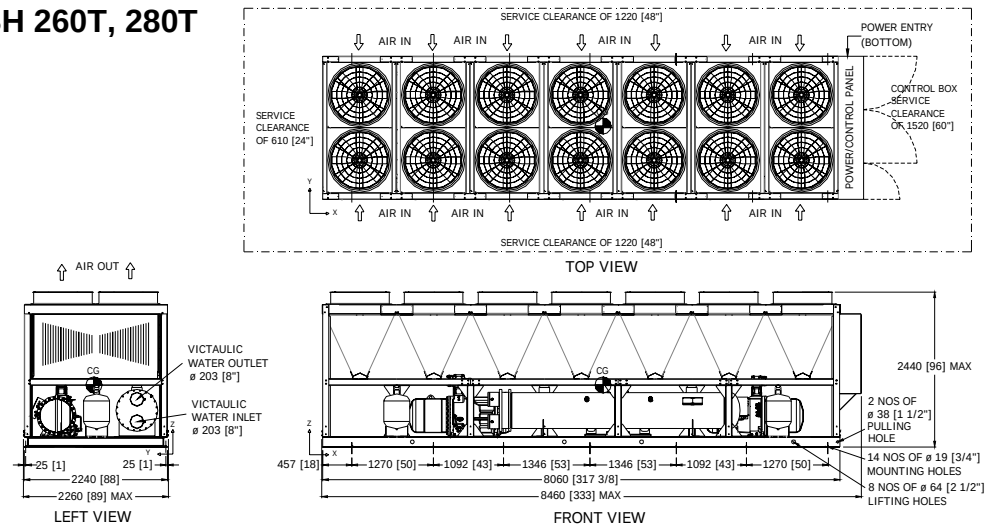
Note: All dimensions are in mm[inches].

DIMENSIONAL DATA

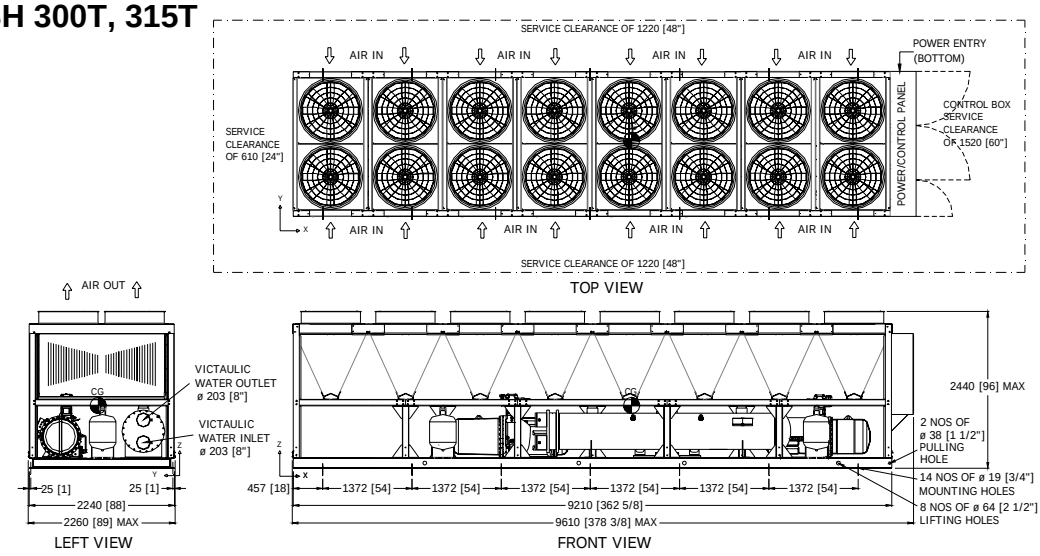
ACHX-BH 215T, 240T



ACHX-BH 260T, 280T



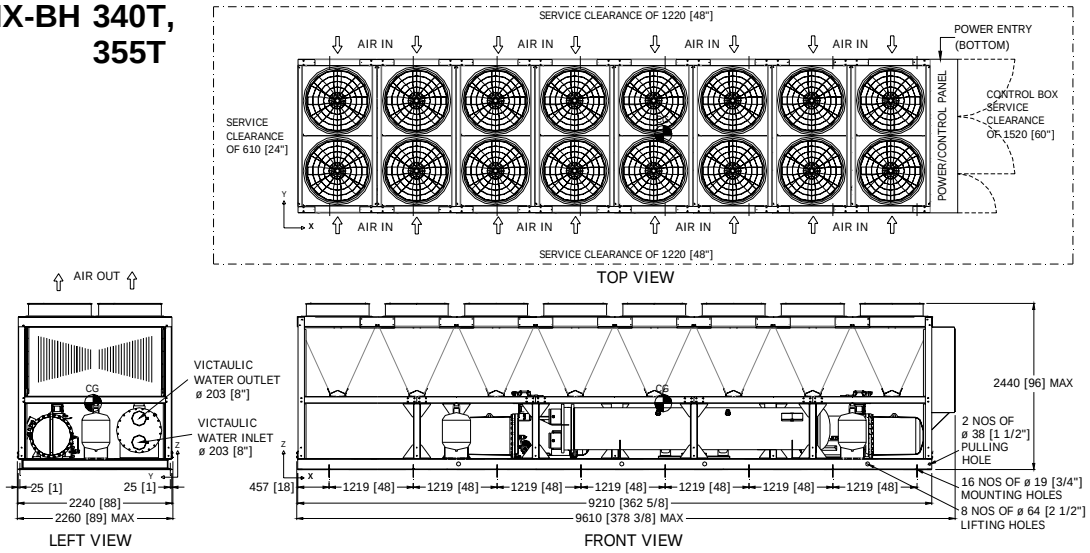
ACHX-BH 300T, 315T



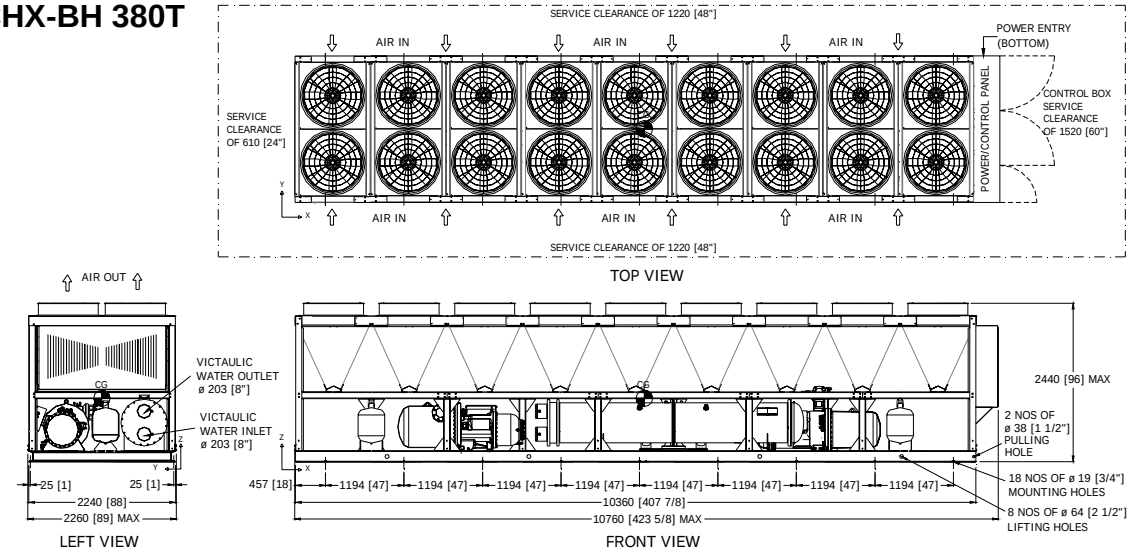
Note: All dimensions are in mm[inches].

DIMENSIONAL DATA

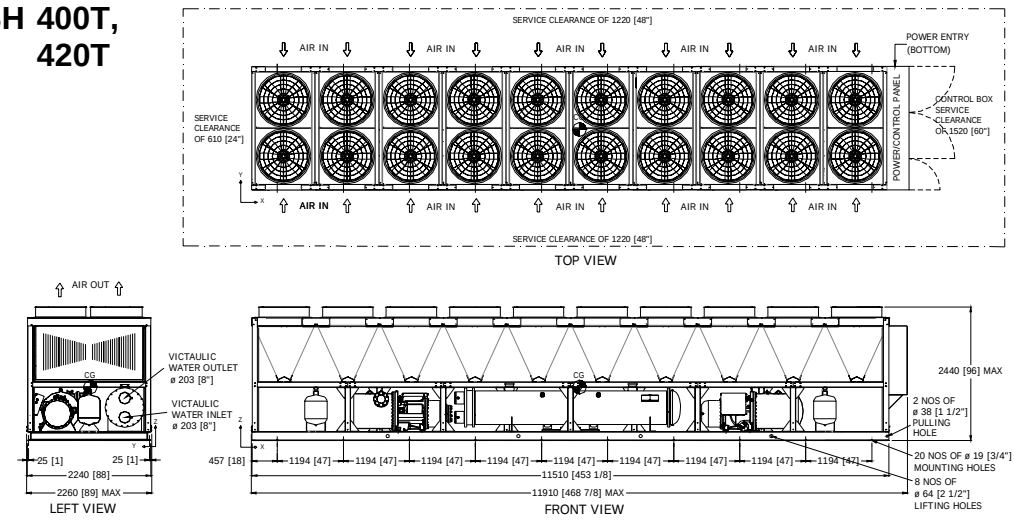
ACHX-BH 340T, 355T



ACHX-BH 380T



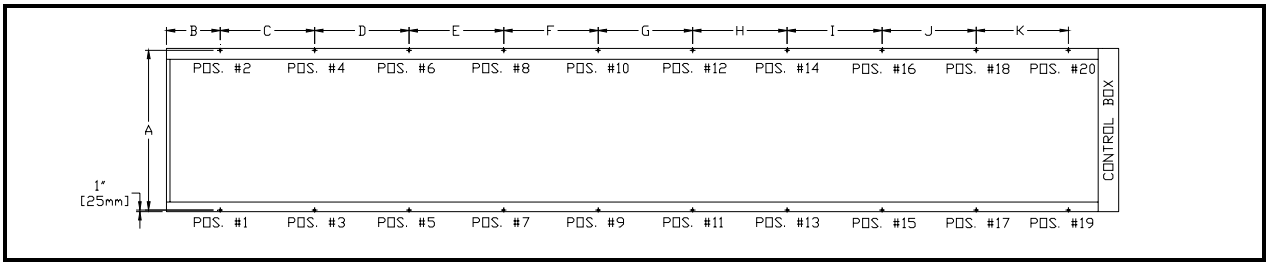
ACHX-BH 400T, 420T



Note: All dimensions are in mm[inches].

FLOOR LOADING DIAGRAM

Microchannel Condenser (Standard) 50Hz



a.) Point Load Location

Model ACHX-BH		A	B	C	D	E	F
90T	inches	85	16	79 1/2	77 1/2	-	-
	mm	2159	406	2020	1969	-	-
100T	inches	85	16	79 1/2	77 1/2	-	-
	mm	2159	406	2020	1969	-	-
130T	inches	85	16	79 1/2	77 1/2	-	-
	mm	2159	406	2020	1969	-	-
150T	inches	85	16	79 1/2	77 1/2	-	-
	mm	2159	406	2020	1969	-	-
170T	inches	85	16	68	66	66	-
	mm	2159	406	1727	1676	1676	-
185T	inches	85	16	68	66	66	-
	mm	2159	406	1727	1676	1676	-
200T	inches	85	16	68	66	66	-
	mm	2159	406	1727	1676	1676	-
215T	inches	86	18	65	58	58	65
	mm	2184	457	1651	1473	1473	1651
240T	inches	86	18	65	58	58	65
	mm	2184	457	1651	1473	1473	1651

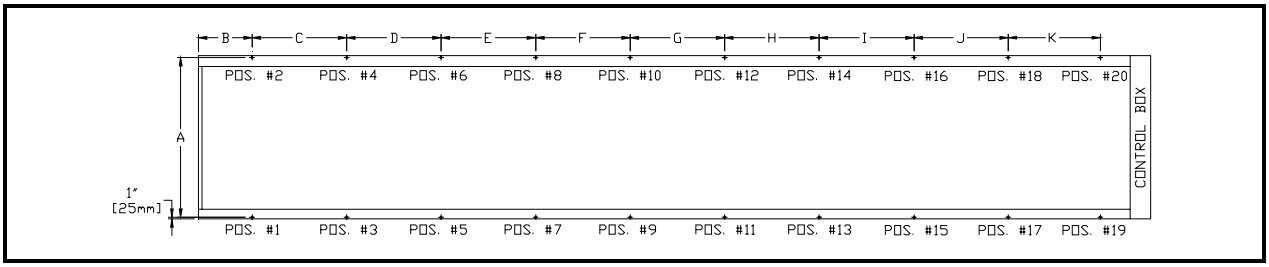
Model ACHX-BH		A	B	C	D	E	F	G	H	I	J	K
260T	inches	86	18	50	43	53	53	43	50	-	-	-
	mm	2184	457	1270	1092	1346	1346	1092	1270	-	-	-
280T	inches	86	18	50	43	53	53	43	50	-	-	-
	mm	2184	457	1270	1092	1346	1346	1092	1270	-	-	-
300T	inches	86	18	54	54	54	54	54	54	-	-	-
	mm	2184	457	1372	1372	1372	1372	1372	1372	-	-	-
315T	inches	86	18	54	54	54	54	54	54	-	-	-
	mm	2184	457	1372	1372	1372	1372	1372	1372	-	-	-
340T	inches	86	18	48	48	48	48	48	48	48	-	-
	mm	2184	457	1219	1219	1219	1219	1219	1219	1219	-	-
355T	inches	86	18	48	48	48	48	48	48	48	-	-
	mm	2184	457	1219	1219	1219	1219	1219	1219	1219	-	-
380T	inches	86	18	47	47	47	47	47	47	47	47	-
	mm	2184	457	1194	1194	1194	1194	1194	1194	1194	1194	-
400T	inches	86	18	47	47	47	47	47	47	47	47	47
	mm	2184	457	1194	1194	1194	1194	1194	1194	1194	1194	1194
420T	inches	86	18	47	47	47	47	47	47	47	47	47
	mm	2184	457	1194	1194	1194	1194	1194	1194	1194	1194	1194

b.) Point Load Data

Model ACHX-BH		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	Total Operating Weight
90T	lbs	1244	1399	1583	1465	1287	1434	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8411
	kg	564	635	718	664	584	650	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3815
100T	lbs	1440	1534	1490	1571	1432	1482	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8948
	kg	653	696	676	713	649	672	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4059
130T	lbs	1492	1702	1509	1600	1444	1510	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9256
	kg	677	772	685	726	655	685	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4198
150T	lbs	1520	1725	1570	1711	1503	1656	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9684
	kg	689	782	712	776	682	751	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4393
170T	lbs	908	1289	1707	1540	1364	1627	1139	1232	-	-	-	-	-	-	-	-	-	-	-	-	10806
	kg	412	585	774	698	619	738	517	559	-	-	-	-	-	-	-	-	-	-	-	-	4902
185T	lbs	1109	1529	1471	1323	1601	1452	1134	1496	-	-	-	-	-	-	-	-	-	-	-	-	11116
	kg	503	693	667	600	726	659	514	679	-	-	-	-	-	-	-	-	-	-	-	-	5042
200T	lbs	1104	1497	1500	1422	1638	1586	1109	1377	-	-	-	-	-	-	-	-	-	-	-	-	11233
	kg	501	679	680	645	743	719	503	625	-	-	-	-	-	-	-	-	-	-	-	-	5095
215T	lbs	940	1364	1797	1642	1026	1137	1636	1708	893	1108	-	-	-	-	-	-	-	-	-	-	13251
	kg	426	619	815	745	466	516	742	775	405	503	-	-	-	-	-	-	-	-	-	-	6010
240T	lbs	948	1383	1816	1673	1047	1190	1708	1982	907	1152	-	-	-	-	-	-	-	-	-	-	13805
	kg	430	627	824	759	475	540	775	899	411	522	-	-	-	-	-	-	-	-	-	-	6262
260T	lbs	692	699	975	1176	1349	1411	1124	909	1408	909	1318	2133	752	699	-	-	-	-	-	-	15553
	kg	314	317	442	533	612	640	510	412	639	412	598	967	341	317	-	-	-	-	-	-	7055
280T	lbs	693	715	961	1155	1337	1497	1171	973	1392	1002	1288	1817	820	874	-	-	-	-	-	-	15694
	kg	314	324	436	524	606	679	531	441	631	455	584	824	372	396	-	-	-	-	-	-	7119
300T	lbs	646	682	777	861	1087	2019	2062	1257	992	984	1628	1543	1041	1366	-	-	-	-	-	-	16946
	kg	293	310	352	390	493	916	935	570	450	446	739	700	472	619	-	-	-	-	-	-	7687
315T	lbs	648	688	779	867	1090	2027	2077	1270	999	998	1619	1486	1111	1623	-	-	-	-	-	-	17281
	kg	294	312	353	393	495	919	942	576	453	452	735	674	504	736	-	-	-	-	-	-	7839
340T	lbs	799	814	1926	2176	1044	1059	1131	1018	1516	1464	1006	1226	797	795	694	698	-	-	-	-	18161
	kg	362	369	874	987	474	480	513	462	687	664	456	556	362	360	315	317	-	-	-	-	8238
355T	lbs	809	820	1967	2191	1061	1067	1146	1005	1575	1550	1038	1282	816	814	703	710	-	-	-	-	18555
	kg	367	372	892	994	481	484	520	456	714	703	471	582	370	369	319	322	-	-	-	-	8416
380T	lbs	700	708	931	1047	1342	1778	1330	1039	1413	1009	1482	1026	1416	1763	894	932	767	746	-	-	20326
	kg	318	321	422	475	609	807	603	471	641	458	672	465	642	800	405	423	348	338	-	-	9220
400T	lbs	696	666	905	935	1454	1848	1318	980	1335	939	1174	870	1530	983	1524	1777	905	898	755	714	22208
	kg	316	302	410	424	660	838	598	445	606	426	533	395	694	446	691	806	410	407	343	324	10073
420T	lbs	682	651	869	895	1482	2042	1306	972	1331	938	1168	863	1526	974	1556	1827	889	874	748	704	22297
	kg	309	295	394	406	672	926	592	441	604	425	530	391	692	442	706	829	403	397	339	319	10114

FLOOR LOADING DIAGRAM

Aluminum Fin/Copper Tube Condenser (Option) - 50Hz



a.) Point Load Location

Model ACHX-BH		A	B	C	D	E	F
90T	inches	85	16	79 1/2	77 1/2	-	-
	mm	2159	406	2020	1969	-	-
100T	inches	85	16	79 1/2	77 1/2	-	-
	mm	2159	406	2020	1969	-	-
130T	inches	85	16	79 1/2	77 1/2	-	-
	mm	2159	406	2020	1969	-	-
150T	inches	85	16	79 1/2	77 1/2	-	-
	mm	2159	406	2020	1969	-	-
170T	inches	85	16	68	66	66	-
	mm	2159	406	1727	1676	1676	-
185T	inches	85	16	68	66	66	-
	mm	2159	406	1727	1676	1676	-
200T	inches	85	16	68	66	66	-
	mm	2159	406	1727	1676	1676	-
215T	inches	86	18	65	58	58	65
	mm	2184	457	1651	1473	1473	1651
240T	inches	86	18	65	58	58	65
	mm	2184	457	1651	1473	1473	1651

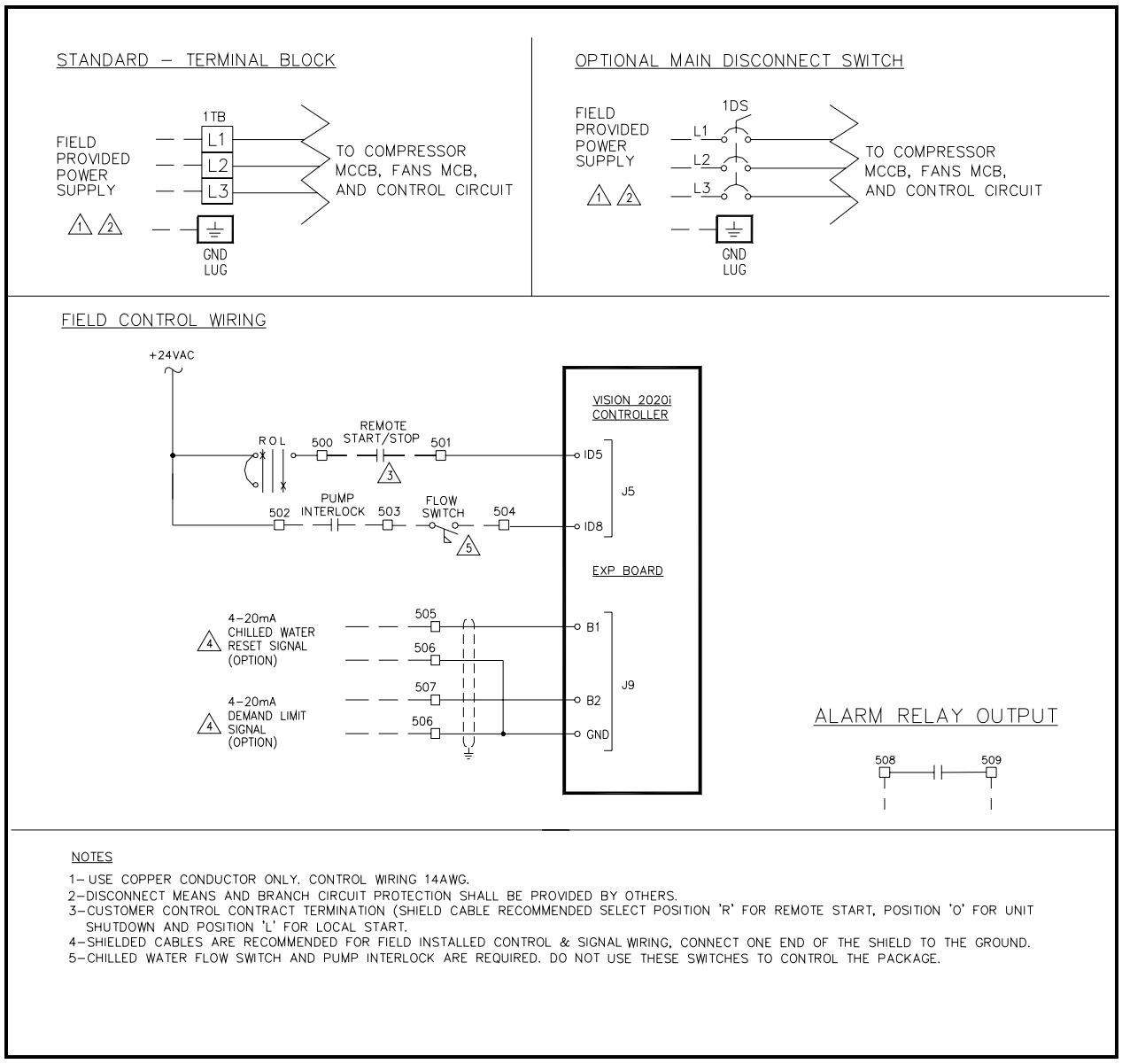
Model ACHX-BH		A	B	C	D	E	F	G	H	I	J	K
260T	inches	86	18	50	43	53	53	43	50	-	-	-
	mm	2184	457	1270	1092	1346	1346	1092	1270	-	-	-
280T	inches	86	18	50	43	53	53	43	50	-	-	-
	mm	2184	457	1270	1092	1346	1346	1092	1270	-	-	-
300T	inches	86	18	54	54	54	54	54	54	-	-	-
	mm	2184	457	1372	1372	1372	1372	1372	1372	-	-	-
315T	inches	86	18	54	54	54	54	54	54	-	-	-
	mm	2184	457	1372	1372	1372	1372	1372	1372	-	-	-
340T	inches	86	18	48	48	48	48	48	48	48	-	-
	mm	2184	457	1219	1219	1219	1219	1219	1219	1219	-	-
355T	inches	86	18	48	48	48	48	48	48	48	-	-
	mm	2184	457	1219	1219	1219	1219	1219	1219	1219	-	-
380T	inches	86	18	47	47	47	47	47	47	47	47	-
	mm	2184	457	1194	1194	1194	1194	1194	1194	1194	1194	-
400T	inches	86	18	47	47	47	47	47	47	47	47	47
	mm	2184	457	1194	1194	1194	1194	1194	1194	1194	1194	1194
420T	inches	86	18	47	47	47	47	47	47	47	47	47
	mm	2184	457	1194	1194	1194	1194	1194	1194	1194	1194	1194

b.) Point Load Data

Model ACHX-BH		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	Total Operating Weight
90T	lbs	1381	1529	1739	1609	1400	1540	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9198
	kg	627	694	789	730	635	698	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4172
100T	lbs	1584	1666	1643	1714	1549	1590	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9745
	kg	718	756	745	777	703	721	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4420
130T	lbs	1639	1835	1666	1744	1565	1619	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10066
	kg	743	832	755	791	710	734	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4566
150T	lbs	1670	1859	1730	1856	1627	1766	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10508
	kg	757	843	785	842	738	801	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4766
170T	lbs	1028	1405	1869	1670	1516	1764	1248	1330	-	-	-	-	-	-	-	-	-	-	-	-	11829
	kg	466	637	848	757	688	800	566	603	-	-	-	-	-	-	-	-	-	-	-	-	5365
185T	lbs	1236	1646	1621	1450	1768	1594	1238	1592	-	-	-	-	-	-	-	-	-	-	-	-	12146
	kg	561	747	735	658	802	723	562	722	-	-	-	-	-	-	-	-	-	-	-	-	5509
200T	lbs	1232	1614	1652	1550	1807	1728	1215	1474	-	-	-	-	-	-	-	-	-	-	-	-	12272
	kg	559	732	749	703	820	784	551	668	-	-	-	-	-	-	-	-	-	-	-	-	5567
215T	lbs	1061	1481	1956	1766	1148	1249	1806	1853	979	1190	-	-	-	-	-	-	-	-	-	-	14489
	kg	481	672	887	801	521	566	819	841	444	540	-	-	-	-	-	-	-	-	-	-	6572
240T	lbs	1070	1500	1979	1798	1169	1302	1882	2128	993	1233	-	-	-	-	-	-	-	-	-	-	15054
	kg	485	680	898	815	530	591	853	965	451	559	-	-	-	-	-	-	-	-	-	-	6828
260T	lbs	786	788	1097	1290	1486	1528	1245	1012	1529	1001	1422	2224	822	763	-	-	-	-	-	-	16994
	kg	356	357	498	585	674	693	565	459	694	454	645	1009	373	346	-	-	-	-	-	-	7708
280T	lbs	787	804	1083	1269	1475	1614	1293	1076	1516	1096	1393	1909	891	939	-	-	-	-	-	-	17145
	kg	357	365	491	576	669	732	586	488	688	497	632	866	404	426	-	-	-	-	-	-	7777
300T	lbs	750	785	897	978	1192	2119	2231	1372	1106	1087	1783	1668	1154	1472	-	-	-	-	-	-	18593
	kg	340	356	407	444	541	961	1012	622	502	493	809	757	523	668	-	-	-	-	-	-	8434
315T	lbs	753	791	899	985	1195	2127	2251	1386	1114	1100	1777	1611	1224	1729	-	-	-	-	-	-	18942
	kg	341	359	408	447	542	965	1021	628	505	499	806	731	555	784	-	-	-	-	-	-	8592
340T	lbs	896	903	2087	2295	1174	1175	1251	1122	1648	1566	1106	1317	888	880	762	763	-	-	-	-	19835
	kg	407	410	947	1041	532	533	567	509	747	710	502	598	403	399	346	346	-	-	-	-	8997
355T	lbs	907	910	2132	2312	1192	1184	1268	1110	1710	1653	1138	1374	907	900	772	775	-	-	-	-	20242
	kg	412	413	967	1049	540	537	575	503	775	750	516	623	411	408	350	351	-	-	-	-	9182
380T	lbs	790	794	1035	1145	1462	1888	1468	1153	1548	1115	1617	1129	1533	1859	990	1019	846	818	-	-	22209
	kg	358	360	469	519	663	856	666	523	702	506	734	512	695	843	449	462	384	371	-	-	10074
400T	lbs	787	752	1009	1033	1575	1959	1458	1096	1469	1046	1295	971	1667	1085	1625	1868	996	983	829	783	24287
	kg	357	341	458	468	714	889	662	497	666	475	587	440	756	492	737	847	452	446	376	355	11016
420T	lbs	773	737	974	993	1603	2153	1448	1088	1467	1045	1291	963	1666	1077	1657	1918	981	959	822	773	24389
	kg	351	334	442	450	727	977	657	494	665	474	586	437	756	488	752	870	445	435	373	351	11063

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] shall be incorporated for operation.

Operating Limits – Ambient Temperature

Operating Ambient Temperature	Minimum	Maximum
Standard	45°F [7°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. Operation	18 °F [-7.8 °C]	50 °F [10°C]

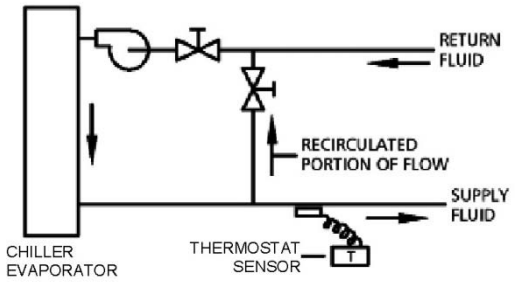
EVAPORATOR FLUID CIRCUIT

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



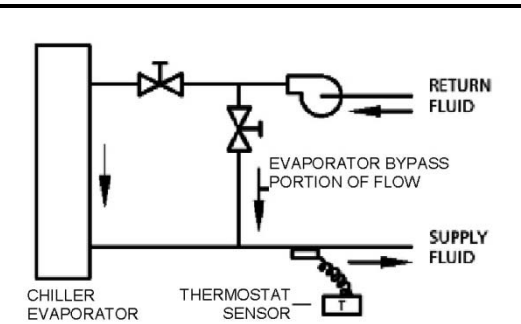
The mixed fluid temperature range through the evaporator for units with standard evaporators, should not be less than 7.5°F [4.2°C].

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.

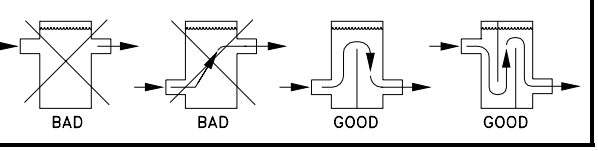
Minimum Chilled Fluid Loop Volume

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

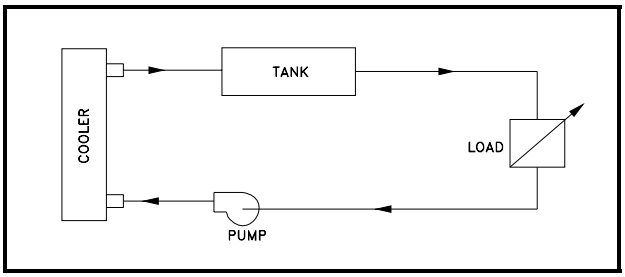
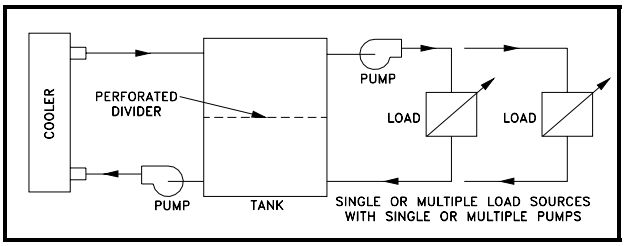


Figure 2C Primary and Secondary Loop Systems are normally used where the secondary system has variable flow and/or multiple loads. See example below.



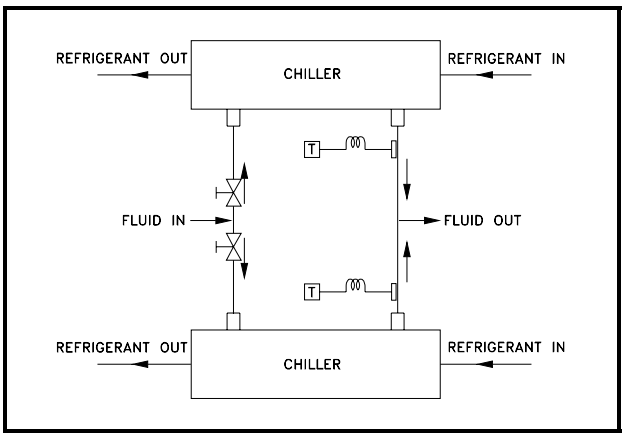
Multiple Chillers In A Chilled Water System

Where the load is greater than available from one Helios ACHX-BH, 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.

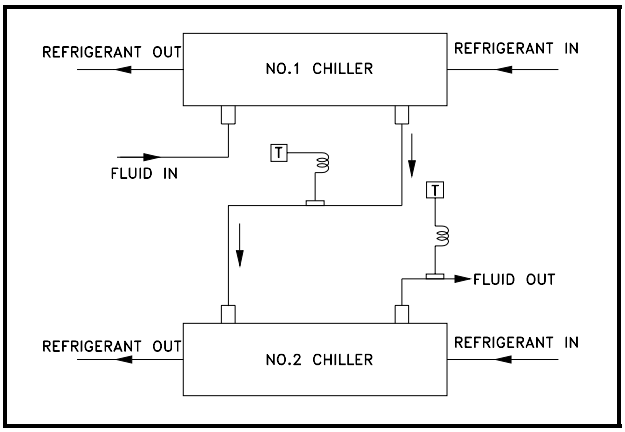
Parallel Chiller Applications – Both units operate simultaneously modulating with load variations. Each unit operates independently sensing its own leaving fluid temperature. The set point of each thermostat is set to maintain the desired loading scheme. (Figure 3A)

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

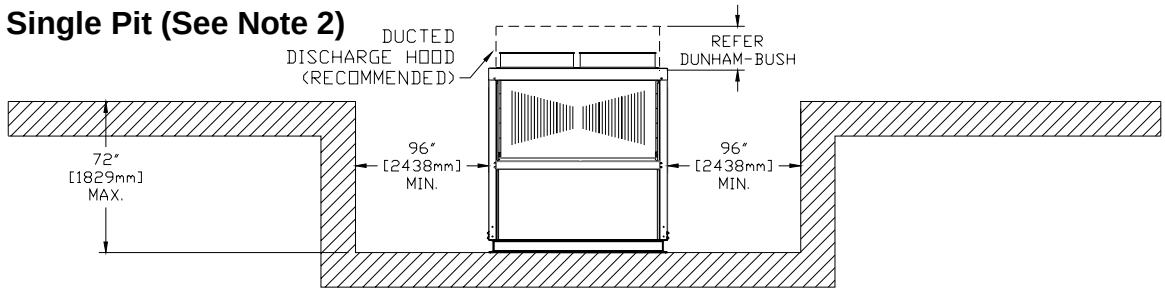
Rebates: ***ITES*** usually qualifies for rebates offered by electric utilities or governments for equipment that shift peak loads to off-peak hours

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.

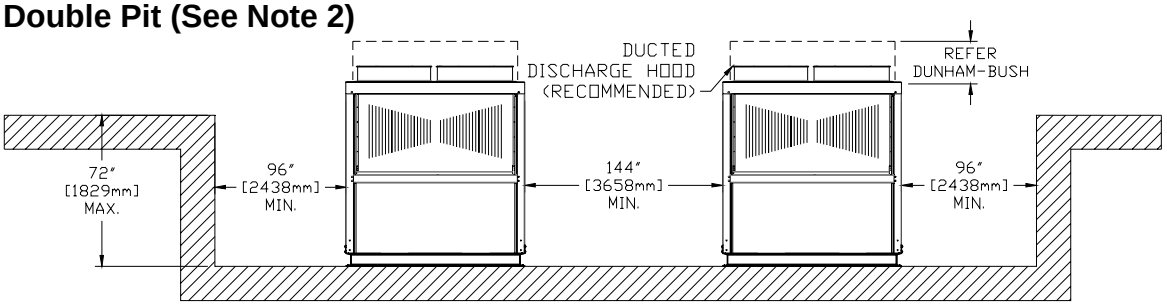
Standby Cooling Capacity: Energy stored in ***ITES*** can be utilized to cater peak or unexpected loads which exceeded total cooling capacity available from the installed chillers. This is savior to the regions which having difficulties on power generation plants expansion, where with ***ITES***, will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

MINIMUM CLEARANCE REQUIREMENTS

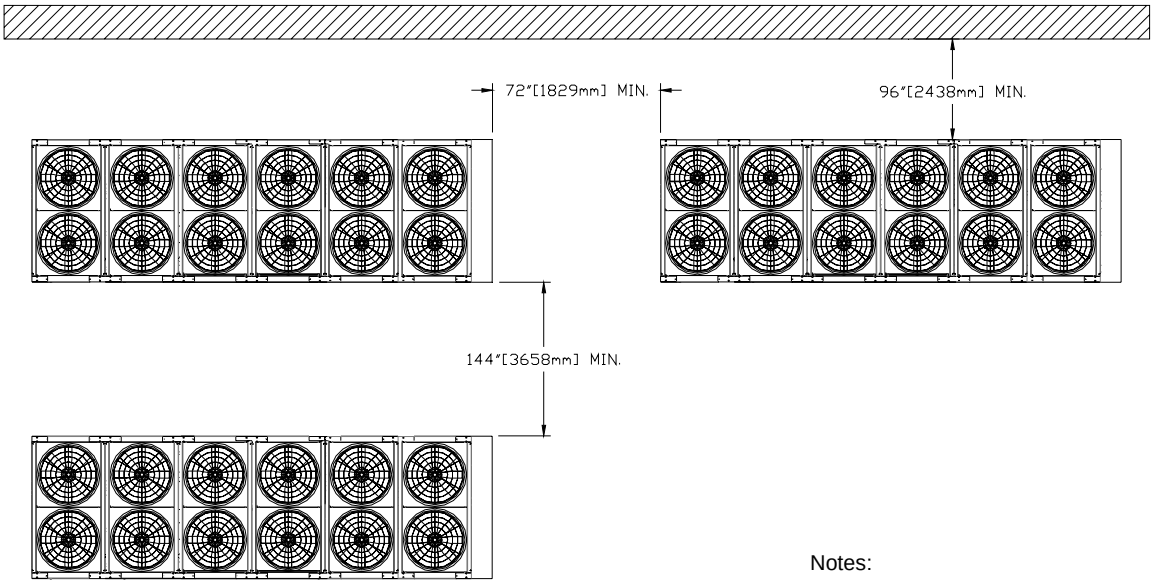
Single Pit (See Note 2)



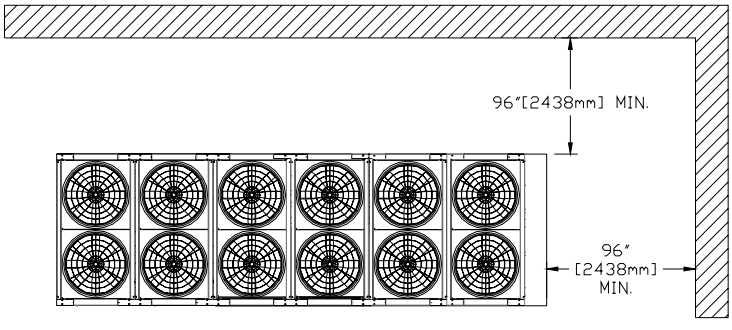
Double Pit (See Note 2)



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
- 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 55^{o}F [4.5^{o}C to 12.8^{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].

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/50Hz.

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 2950 RPM (50Hz) / 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.

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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