

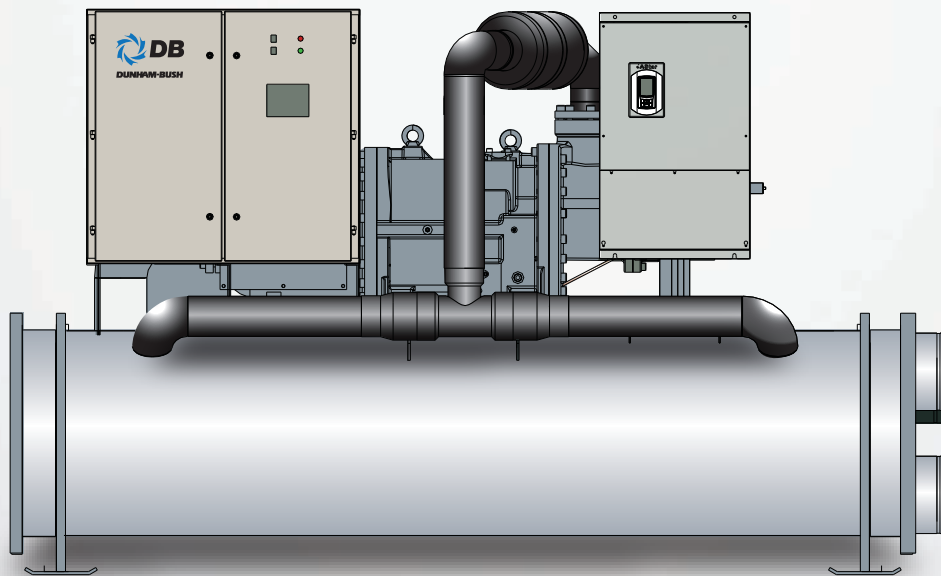


HYPERION

Water Cooled Screw Chillers

WCHX-AV 50/60Hz

Cooling Capacity: 268 to 448 TR (944 to 1575 kW)



DUNHAM-BUSH®

Chiller image is for illustration purpose only

Products that perform...By people who care

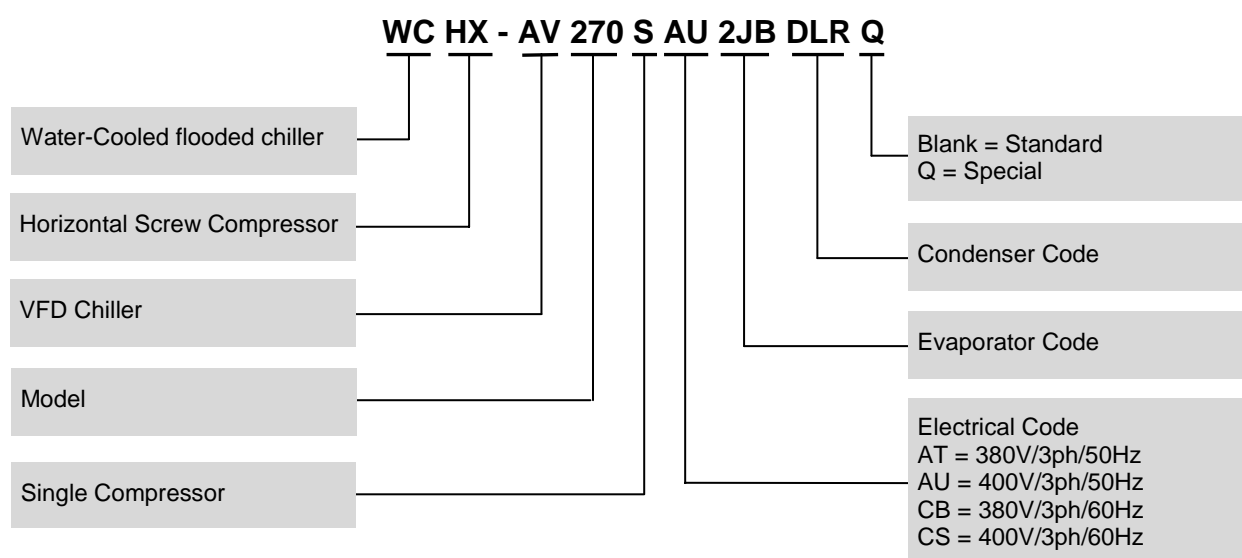
INTRODUCTION

The Dunham Bush HYPERION series WCHX-AV Variable Speed Water Cooled Screw Chillers are available from 268 to 448 TR [944 to 1575 kW]. These units are designed with a horizontal screw compressor that are backed by more than 50 years of experiences. The WCHX-AV series are an AHRI certified product that suitable for a commercial applications that designed to meet both quality and performance.

TABLE OF CONTENTS

	Page
Introduction.....	2
Nomenclature.....	2
Unit Features.....	3
Option And Accessories.....	5
Operating Benefits.....	6
Physical Specifications.....	7
Electrical Data.....	7
Sound Pressure Data.....	7
Dimensional Data.....	8
Floor Loading Diagram.....	9
Typical Wiring Schematic.....	10
Application Data.....	15
Guide Specifications.....	16

NOMENCLATURE



UNIT FEATURES

COMPRESSOR

- ✿ Semi-hermetic Rotary Twin Screw Compressor
- ✿ Suction gas-cooled compressor motor
- ✿ Rotary screw compressor design for better reliability and redundancy
- ✿ External oil pump not required
- ✿ Optimized oil management
- ✿ Infinite variable capacity control with sliding valve mechanism

VARIABLE SPEED DRIVE (VSD)

- ✿ Regulates motor speed to match the capacity demand
- ✿ Offers faster response on load changed, and precise capacity control
- ✿ Soft and linear start
- ✿ Maintain displacement power factor at minimum 0.95 at all operating conditions

REFRIGERANT LIQUID LEVEL CONTROL

By using Electronic Expansion Valve (EEV), the refrigerant flow into evaporator can be control precisely. In such, the refrigerant liquid amount in evaporator can be controlled at the optimum level to maximized heat transfer in the flooded type, shell-and-tube heat exchanger.



COMPACT FOOTPRINT

The revolutionary new WCHX-AV compact water cooled screw chiller innovative, space-conscious design elements focused on convenience and serviceability into the smallest footprint available and helps the chiller fit in buildings where space is limited, making it ideal for retrofit projects.

Having one of the smallest footprints in its class allows the WCHX-AV Series to occupy less space in cramped mechanical rooms and it can pass through in single access door

CONTROL PANEL

- ✿ Electrical enclosure fabricated by heavy gauge sheet steel with powder coated baked finishing.
- ✿ Single point power connection for all models
- ✿ Main incoming isolator for compressor motor
- ✿ VFD for compressor motor
- ✿ Compressor overload protection by VFD
- ✿ Step down transformer for control circuit
- ✿ Main power supply monitoring module provide protection on under or over voltage, phase reversal, phase losses and imbalance

- ✿ Vision 2020i – the state-of-art Dunham-Bush proactive advanced controller that adapts to any abnormal operating conditions and for safety protections
- ✿ Emergency stop button

VISION 2020i CONTROLLER

Vision 2020i 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, compressor and 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 2020i 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 2020i controller is designed to work with a user friendly back-lit 132 by 64 pixels PGDE 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.

UNIT FEATURES

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
- ✿ 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
- ✿ Compressor and water status
- ✿ Oil Flow Status, Water Flow Switch Status, Remote Start/Stop Command Status

Capacity Control

Leaving chilled water temperature control is accomplished by entering the water temperature setpoint and placing the controller in automatic control. WCHX-AV visualized a precise capacity control thanks to the VFD controlled, Vision 2020i monitors all control functions and moves the compressor 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
- ✿ Compressor oil flow
- ✿ Compressor run error
- ✿ Power loss
- ✿ Chilled water flow loss
- ✿ Sensor error
- ✿ Compressor over current
- ✿ Compressor Anti-recycle
- ✿ High motor temperature
- ✿ VFD fault

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 2020i 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 2020i is able to communicate to BMS through the add-on communication card via various common protocols as:

- ✿ Modbus RTU RS485, ModBus TCP/IP
- ✿ BACnet over IP, MS/TP, or PTP

OPTIONS AND ACCESSORIES

- ✿ LONworks FTT10
- ✿ **Compressor Isolation Valve (Suction & Discharge)** – For the ease of servicing
- ✿ **Evaporator and Condenser Flanged Connection** – Flanged connection is available on request
- ✿ **250 psig Evaporator and Condenser** – Evaporator and condenser vessels with 250 psig working pressure at water side is available to suite site installation
- ✿ **Double Insulation** – Evaporator with double thick 2" [50mm] closed cell insulation, for extra resistance to condensation
- ✿ **Hotgas Bypass** – To maintain unit operation below minimum unloaded capacity
- ✿ **ASME / Compliance** – Evaporator and condenser with ASME approval are available on request
- ✿ **Extended Warranty Period for Compressor** – Extended compressor warranty is available on request

Electrical Options And Controls

- ✿ **Ground Fault Interrupt (GFI)** – Provides equipment with ground fault protection by VFD
- ✿ **Refrigerant Leak Detector** – A refrigerant detection sensor module is connected to vision 2020i controller to monitor refrigerant concentration around the unit. Alarm is triggered and unit is shut down when the refrigerant concentration has exceeded the preset safety limit
- ✿ **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 compressor by 4-20mA signal from BAS, other signal type can be configured
- ✿ **Chilled Water Pump Control** – Primary chilled water pump is controlled by chiller's vision 2020i controller for enhanced safety operation

- ✿ **Condenser Water Pump Control** – Condenser water pump is controlled by chiller for enhanced stable operation
- ✿ **Complete Temperature Monitoring** – Entering evaporator water temperature sensor, leaving and entering condenser water temperature sensors can be included for complete temperature monitoring of the unit
- ✿ **IP54 Control Panel** – IP54 rated control panel can be supplied for harsh working environment
- ✿ **BMS Communication** – Various add-on communication cards provide BMS communication via common protocols: Modbus RTU RS485 / TCP/IP, LONworks FTT10, BACnet over IP / MSTP / PTP

Factory Supplied - Field Installed by Customer

- ✿ **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

ECONOMICAL AND RELIABLE

- ✦ Optimization on the unit design to deliver a requirements needed without compromise on the quality and reliability
- ✦ Maximized performance through computer-matched components and compressor

Refrigerant Compatibility

- ✦ Designed to operate with environmentally sound and economically smart HFC-134a with proven efficiency and reliability

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 °F [0.5 °C] range for your comfort cooling, with best energy saving

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

The compressed gaseous refrigerant is now discharged into the internal oil separator, to separate lubrication oil from the gaseous refrigerant.

The fully compressed and superheated refrigerant is discharged into the condenser, where water in the condenser tubes cools and condenses the refrigerant.

The remaining liquid refrigerant shall passes through the Electronic Expansion Valve (EEV) which reduces refrigerant pressure to evaporator levels where it is then distributed evenly into the evaporator.

PART LOAD PERFORMANCE

Dunham-Bush WCHX-AV offer a performances meeting most of the commercial requirements 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 WCHX-AV combine the efficient operation of Variable Frequency Drive (VFD), rotary screw compressor and advanced controller to yield the best total energy efficiency and significant operating savings at part loads.

When specifying air conditioning equipment, it is important to consider the system load characteristics of the building.

In a typical city, the air conditioning load varies according to the changes in the ambient temperature. Weather data compiled over the years could predict the number of hours that equipment operate at various load percentages.

The Air Conditioning and Refrigeration Institute (AHRI) has established a system, under 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 equipment for their efficiency on equal basis. The IPLV is a single number that estimate power consumption by chiller weighted over number of hours the unit might operate at each part-load point. IPLV's are based on AHRI 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

Model WCHX-AV		270S	390S	450S
Nominal Capacity	TR [kW]	268.3 [943.7]	390.9 [1374.8]	447.8 [1575.0]
Energy efficiency	kW/TR	0.544	0.558	0.556
	COP	6.46	6.31	6.32
Min % Unit Capacity	%	20	20	20
Voltage	V/PH/Hz	400/3/50		
Compressor				
Model (Qty)		2212 (1)	2512 (1)	2514 (1)
Nominal Power Input	kW	146.1	217.9	249.1
Oil Charge (Each)	Liter	50.0	70.0	85.0
Evaporator				
Model		ABB	6EB	EAB
Water Flow Rate	USgpm [m ³ /h]	644.0 [146.3]	938.1 [213.1]	1074.8 [244.1]
Pressure Drop	psig [kPa]	8.0 [54.9]	2.5 [17.4]	2.2 [14.8]
Water Connection Size	Inch [mm]	10 [254.0]	10 [254.0]	10 [254.0]
Condenser				
Model		QQR	CAR	CBR
Water Flow Rate	USgpm [m ³ /h]	799.6 [181.5]	1168.7 [265.3]	1338.5 [303.8]
Pressure Drop	psig [kPa]	1.8 [12.2]	2.3 [15.7]	2.8 [19.2]
Water Connection Size	Inch [mm]	10 [254.0]	12 [304.8]	12 [304.8]
General				
Unit Length	Inch [mm]	153 1/2 [3900]	154 1/4 [3920]	154 1/4 [3920]
Unit Width	Inch [mm]	75 [1910]	88 [2240]	88 [2240]
Unit Height *	Inch [mm]	98 [2490]	96 [2440]	96 [2440]
Unit Shipping Weight	lbs [kg]	13996 [6348]	18599 [8437]	21112 [9576]
Unit Operating Weight	lbs [kg]	15688 [7116]	20444 [9273]	23192 [10520]
R134a Charge (Approx)	lbs [kg]	710 [322]	1034 [470]	1185 [538]

* Please consult factory.

Notes: 1. The above data are for premium models with 2-pass evaporator and condenser which rated in accordance with AHRI Standard 550/590 (I-P)-2015 at standard conditions. The standard rating conditions are as below:

Chilled Water Inlet/Outlet Temperature 54/44°F [12.2/6.7°C]; Cooling Water Inlet Temperature 85°F [29.4°C]; Cooling Water Flow Rate 3USgpm/ton [0.054 l/s.kW]; Evaporator fouling factor 0.0001hr.ft².°F/Btu [0.000018 m².°C/W]; condenser fouling factor 0.00025hr.ft².°F/Btu [0.0000144 m².°C/W]; 2-pass evaporator and condenser.

2. To consult nearest Dunham-Bush sales office for computer selections other than above operating conditions.

ELECTRICAL DATA

Model WCHX-AV	Compressor Model	Unit			Compressor	
		RLA	MCA	MFS	RLA	LRA
Power Supply: 400V / 3PH / 50Hz						
270S	2212 (1)	266A	333A	500A	266A	1912A
390S	2512 (1)	371A	464A	800A	371A	2617A
450S	2514 (1)	488A	610A	1000A	488A	3192A

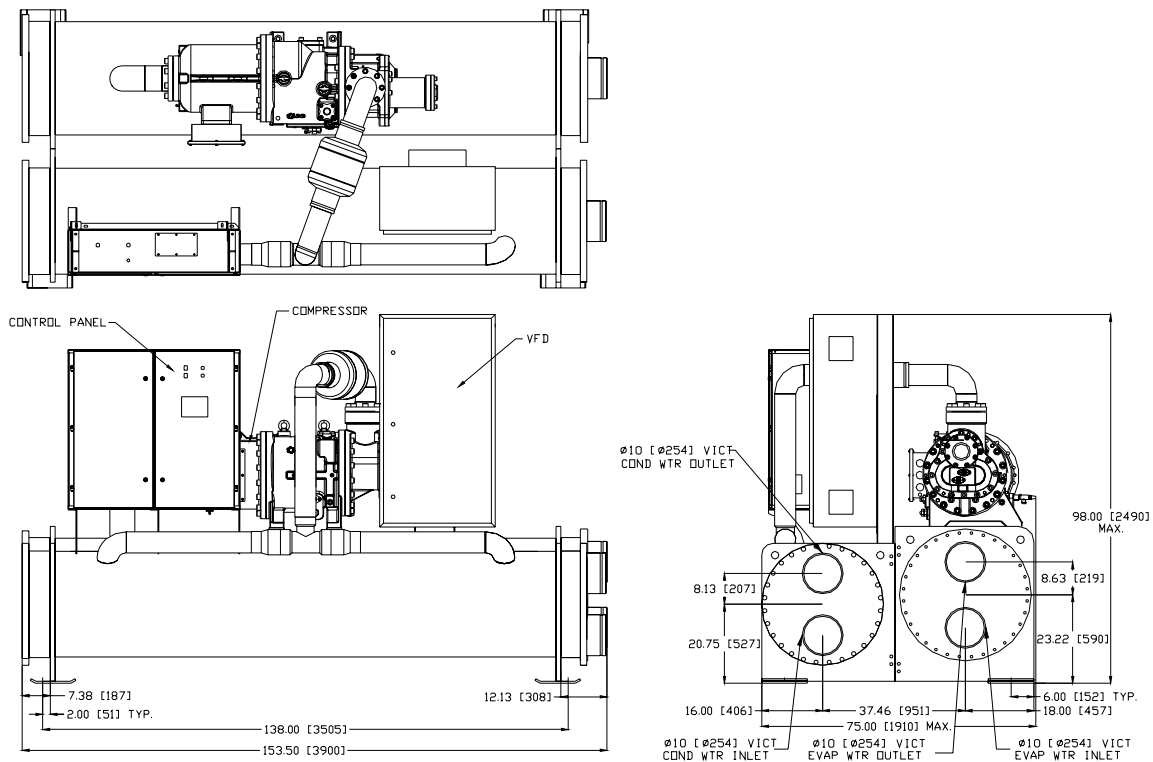
SOUND PRESSURE DATA

Model WCHX-AV	Octave Band (Hz)								Total dB (A)
	63	125	250	500	1K	2K	4K	8K	
270S	71.5	62.5	66.5	70.5	79.5	76.5	75.5	60.5	83.1
390S	73.2	64.2	68.2	72.2	81.2	78.2	77.2	62.2	84.8
450S	75.3	66.3	70.3	74.3	83.3	80.3	79.3	64.3	86.9

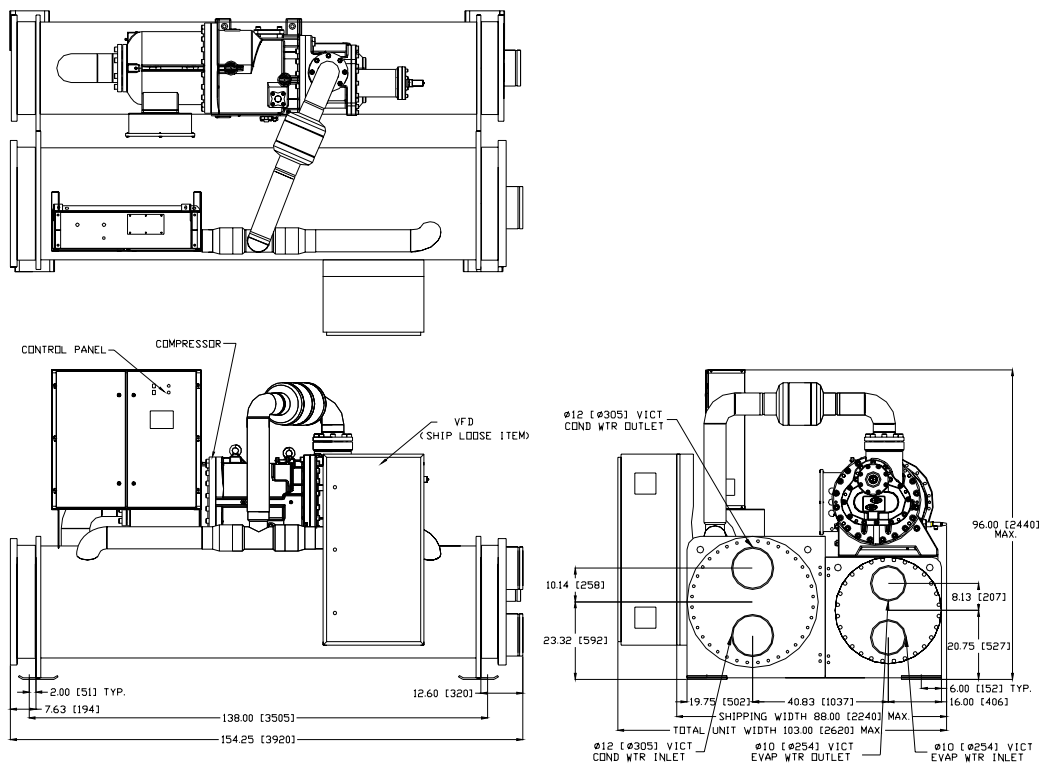
Note: Sound Pressure Level dB(A) @ 3.3ft [1m] (free field) ± 2dBA.

DIMENSIONAL DATA

WCHX-AV 270S



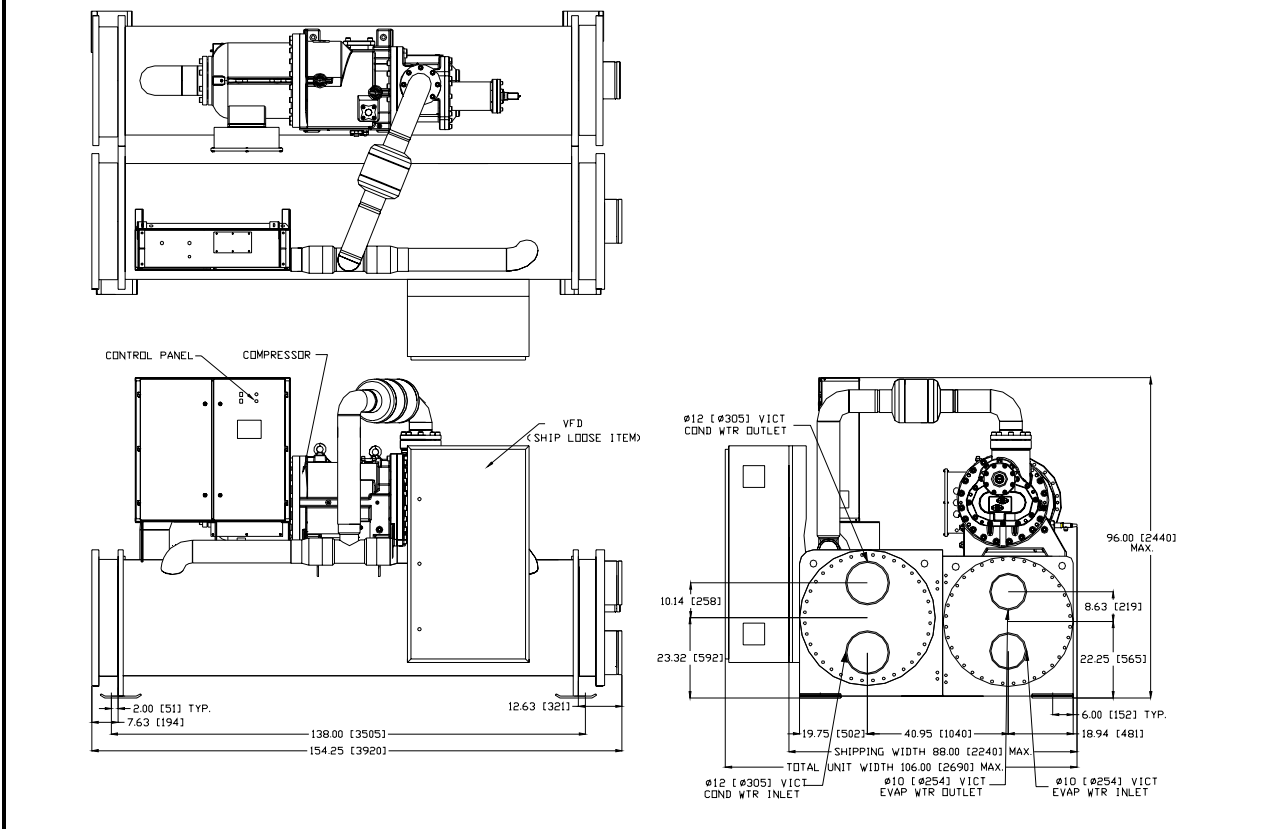
WCHX-AV 390S



Note: All dimensions are in inches [mm].

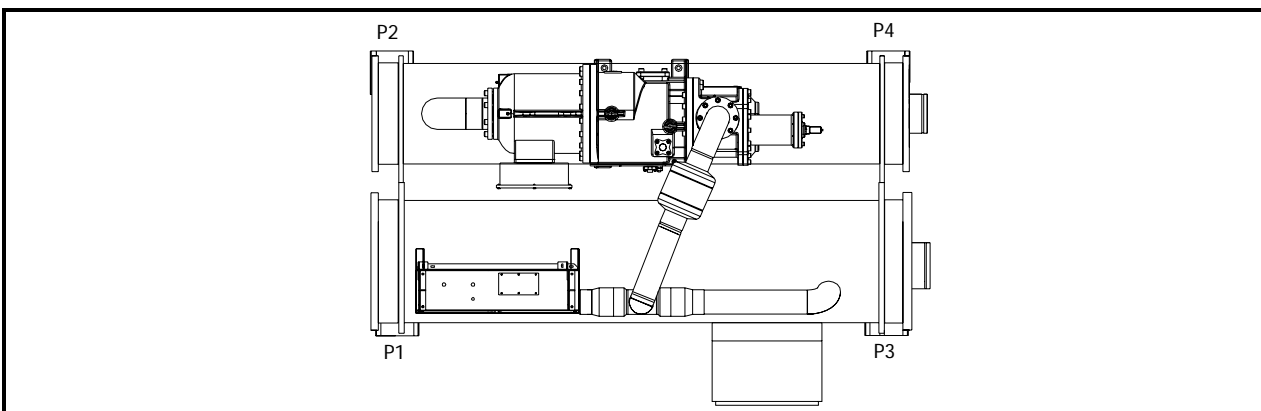
DIMENSIONAL DATA

WCHX-AV 450S



Note: All dimensions are in inches [mm].

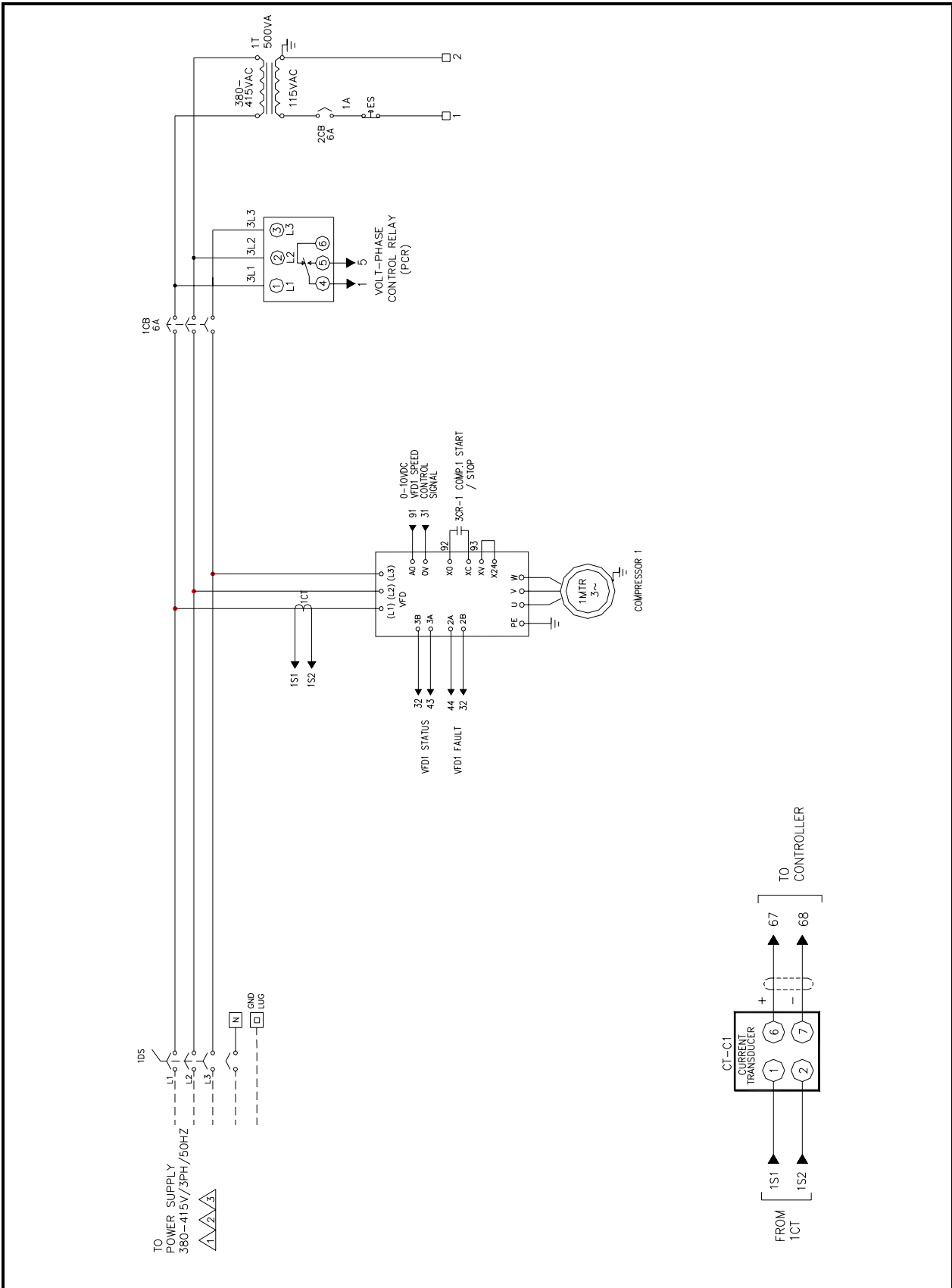
FLOOR LOADING DIAGRAM



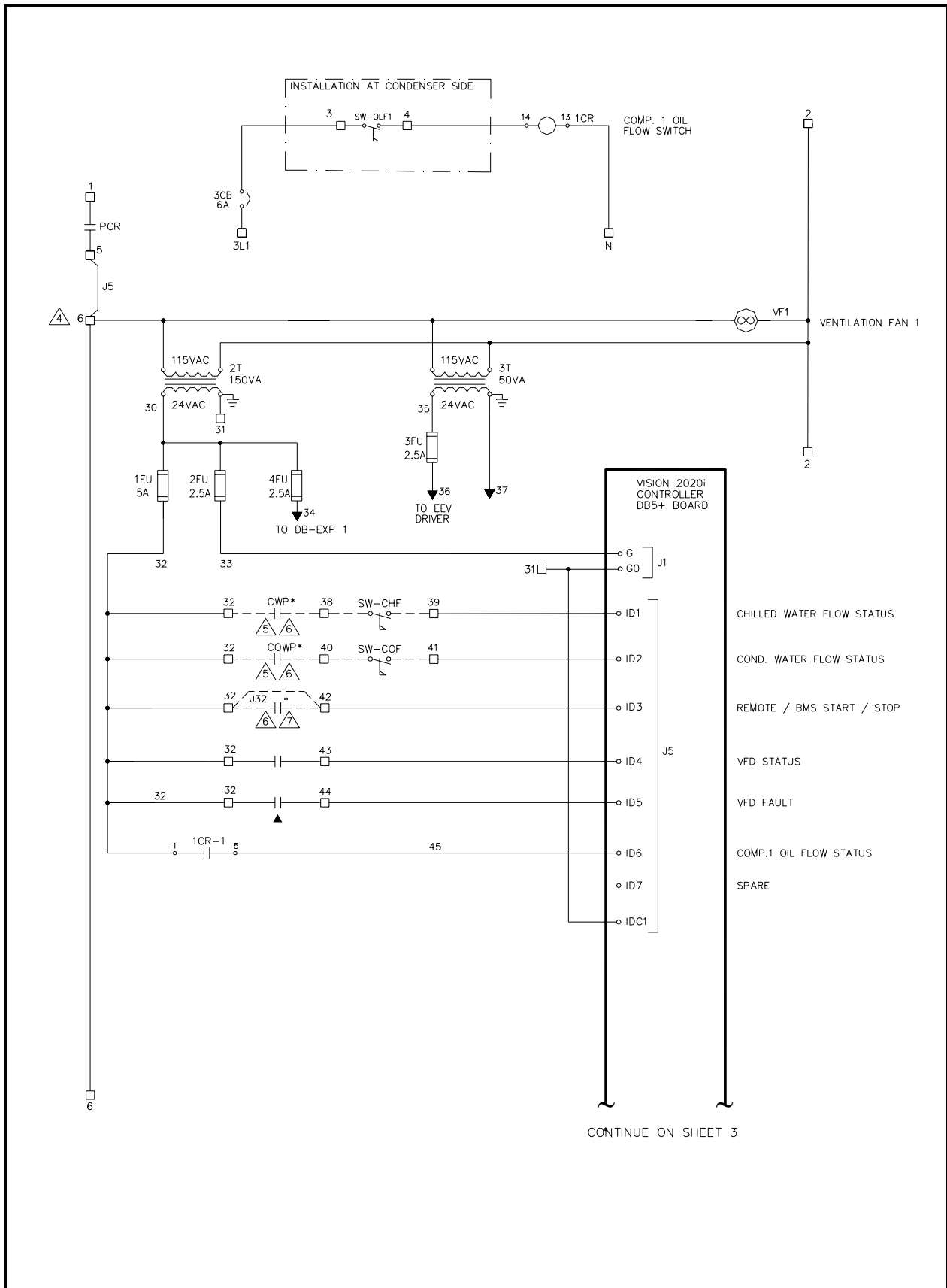
POINT LOAD DATA

Model	P1	P2	P3	P4	Operating Weight
	Lbs [kg]	Lbs [kg]	Lbs [kg]	Lbs [kg]	Lbs [kg]
WCHX-AV 270S	3559 [1614]	4200 [1905]	3643 [1652]	4287 [1945]	15688 [7116]
WCHX-AV 390S	4223 [1915]	5899 [2676]	4442 [2015]	5880 [2667]	20444 [9273]
WCHX-AV 450S	5242 [2378]	6226 [2824]	5530 [2508]	6194 [2810]	23192 [10520]

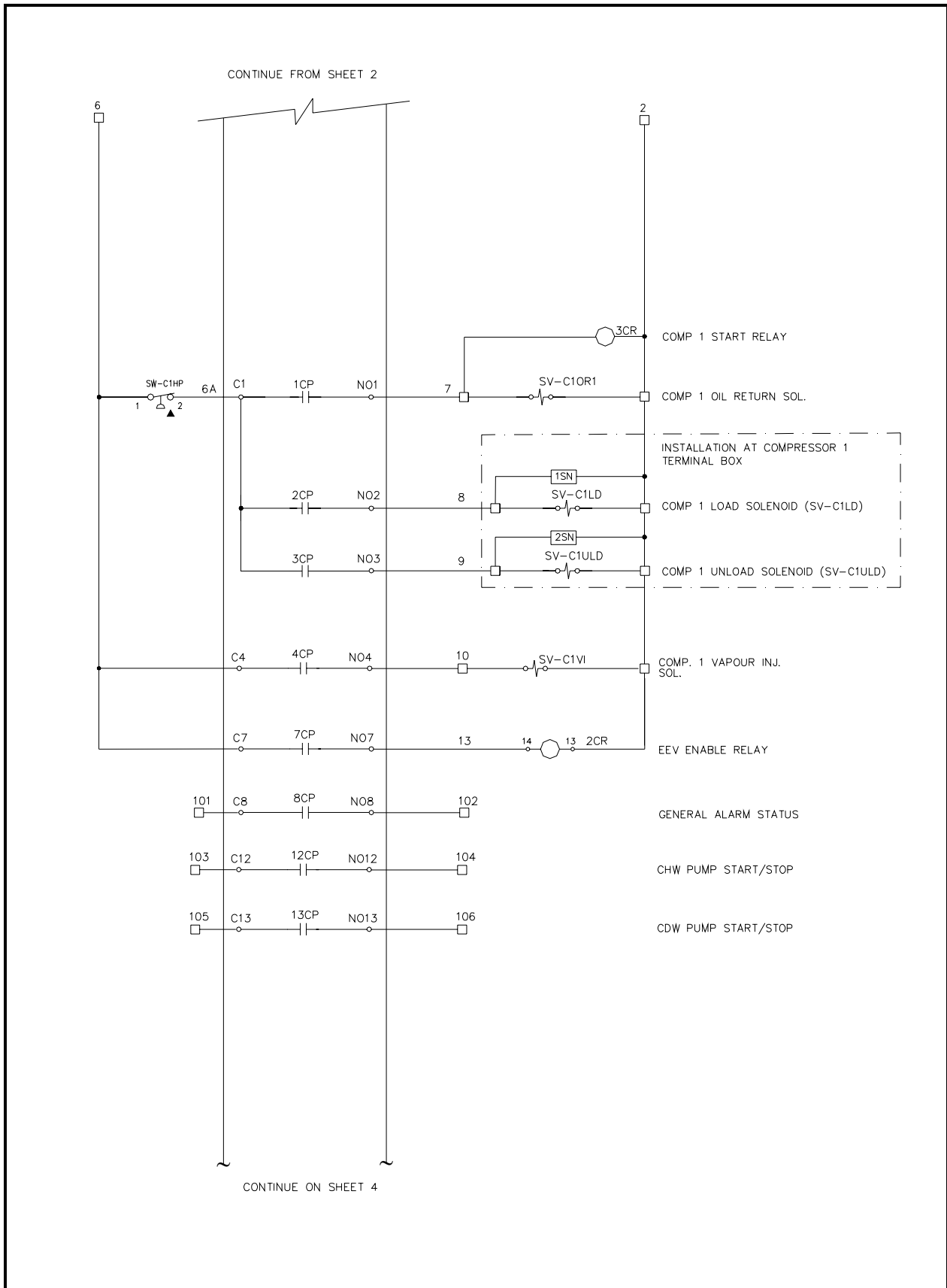
TYPICAL WIRING SCHEMATIC



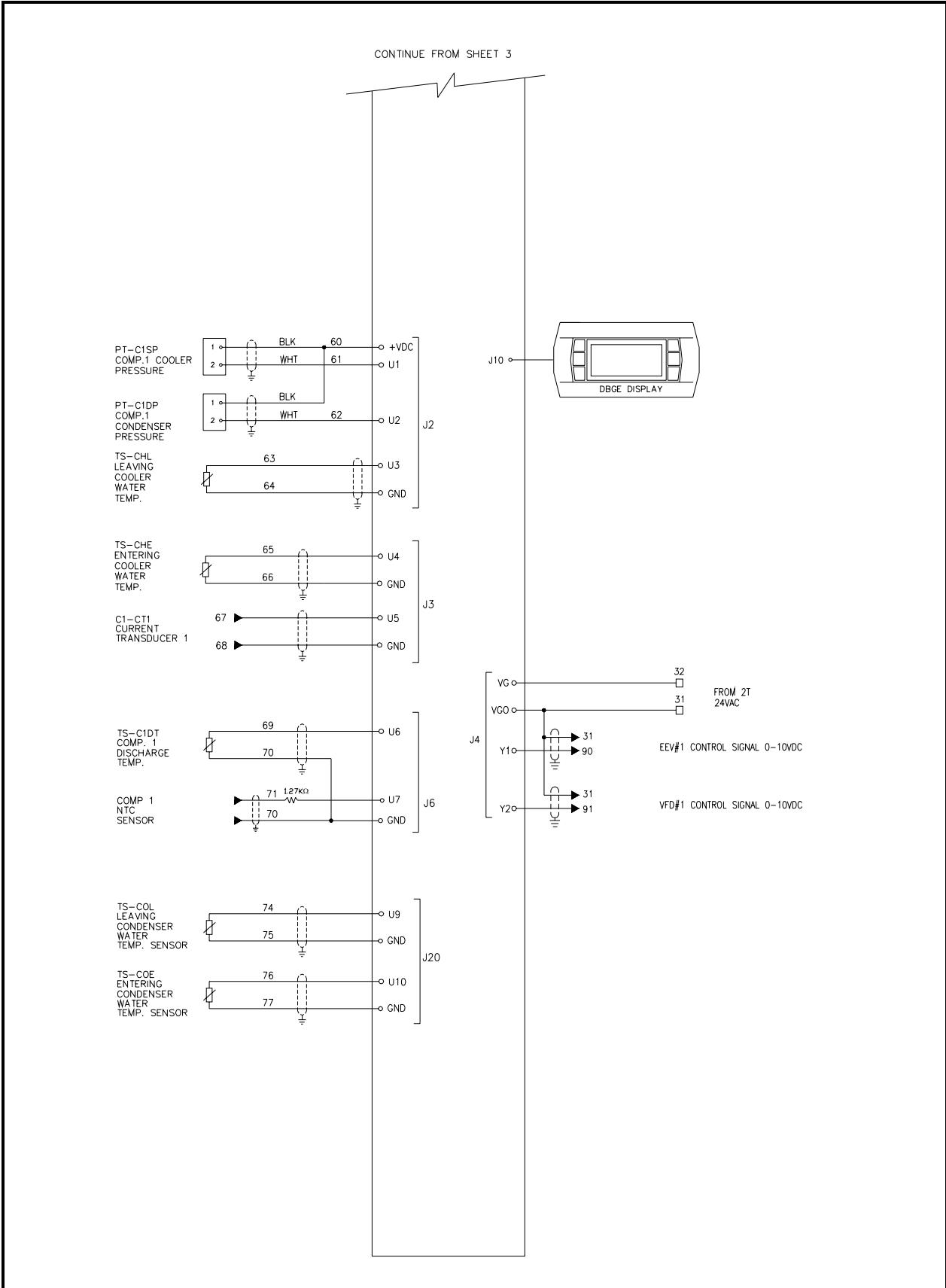
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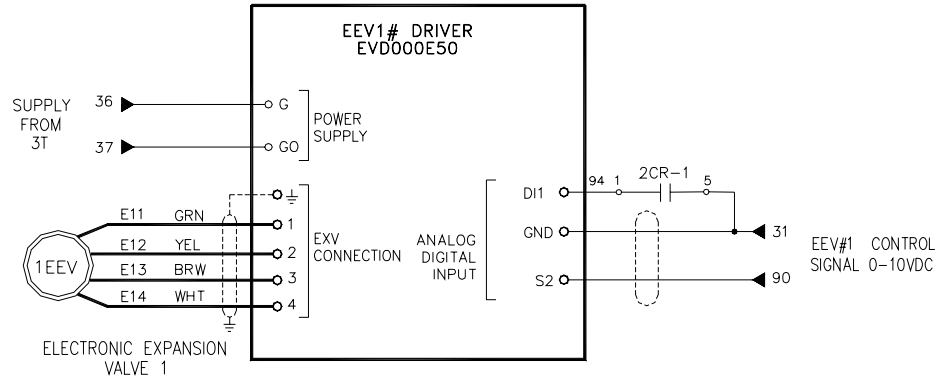
TYPICAL WIRING SCHEMATIC



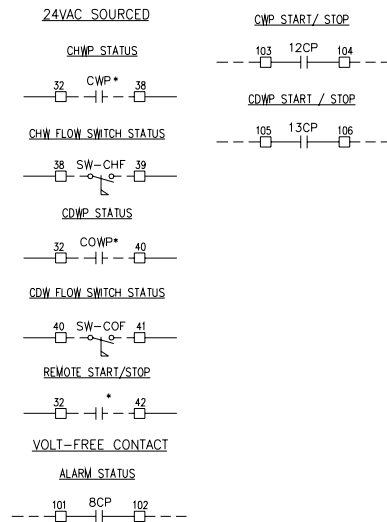
TYPICAL WIRING SCHEMATIC



TYPICAL WIRING SCHEMATIC



FIELD WIRING



NOTES

- 1- ALL FIELD WIRING SHALL COMPLY WITH LOCAL, STATE AND NATIONAL CODES.
- 2- USE COPPER CONDUCTORS ONLY.
- 3- DISCONNECT MEANS AND BRANCH CIRCUIT PROTECTION SHALL BE PROVIDED BY INSTALLER
- 4- REMOVE J5 IF GFR IS FURNISHED
- 5- CHILLED AND CONDENSER WATER FLOW SWITCH AND PUMP INTERLOCK ARE REQUIRED. DO NOT USE THESE SWITCHES TO CONTROL THE PACKAGE.
- 6- THE SHIELDED CABLES ARE RECOMMENDED FOR FIELD INSTALLED CONTROL & SIGNAL WIRING, CONNECT ONE END OF THE SHIELD TO GROUND.
- 7- FOR REMOTE START/STOP CONTROL, JUMPER J32 SHALL BE REMOVED. CUSTOMER CONTROL CONTACT SHALL BE WIRED BETWEEN TERMINAL 32 & 42.

CONTROL SETTINGS

QNT	PRESSURE (PSIG)	CLOSE
SW-CHP	165	▲

LEGEND

AI	ANALOG INPUT
AM	AMMETER
AS	AMMETER SWITCH
CB	CIRCUIT BREAKER
COMP	COMPRESSOR
CP	CONTROL POINT
CPR	CAPACITOR
CR	CONTROL RELAY
CT	CURRENT TRANSFORMER
CTR	CONTACTOR
CWP	CHILLED WATER PUMP
CWR	CHILLED WATER RESET
DI	DIGITAL INPUT
DPM	DIGITAL POWER METER
DS	DISCONNECT SWITCH
FS	FLOAT SWITCH
FU	FUSE
GND	GROUND
GFR	GROUND FAULT RELAY
H-O-T	HIGH OIL TEMP
HMT	HIGH MOTOR TEMP
HTR	HEATER
I/O	INPUT/OUTPUT
LD	LEAK DETECTOR
LS	LEVEL SENSOR
LT	LIGHT
M	CONTACTOR
MCS	MOLDED CASE SWITCH
MOV	METAL OXIDE VARISTOR
MTR	MOTOR
NC	NORMALLY CLOSED
NO	NORMALLY OPEN
OL	OVERLOAD
PB	PUSH BUTTON
PT	PRESSURE TRANSDUCER
RES	RESISTOR
R-O-L	REMOTE-OFF-LOCAL
RLY	RELAY
S5	PUMP DOWN SWITCH
SC	STARTS COUNTER
SH	SHIELD
SN	SNUBBER
SOL	SOLENOID
SW-CHF	CHILLED WATER FLOW SWITCH
TAS	THERMOSTAT
TB	TERMINAL BLOCK
TLW	TEMP LEAVING WATER
TR	TIMER
TS	TEMP. SENSOR
UVR	UNDERVOLTAGE RELAY
VF	VENTILATION FAN
VM	VOLTMETER
VS	VOLTMETER SWITCH
ZD	ZENOR DIODE
▲	MANUAL RESET
□	FACTORY TERMINAL
---	FACTORY WIRING
---	FIELD WIRING
*	FIELD SUPPLIED
▲	NOTE "n"
⊙	OPTION "n"

APPLICATION DATA

EVAPORATOR FLUID CIRCUIT

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 increase 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.

Variable Evaporator Flow

Dunham-Bush chillers are capable of 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 exceed 10% per minute

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

Operating Limits - Leaving Evaporator Fluid Temperature

Leaving Fluid Temperature	Minimum	Maximum
Standard	39.2 °F [4 °C]	50 °F [10 °C]
With Dual Mode Operation	18 °F [-7.8 °C]	50 °F [10 °C]

Performance Correction- Evaporator Fouling Factor

Fouling Factor		Capacity Correction Factor	kW-input Correction Factor
hr.ft ² .°F/BTU	m ² .°C/kW		
0.00010	0.018	1.000	1.000
0.00025	0.044	0.995	0.998
0.00050	0.088	0.985	0.995
0.00075	0.132	0.975	0.991
0.00100	0.176	0.964	0.987

CONDENSER FLUID CIRCUIT

The unit shall work with constant condenser flow, variable condenser flow is not recommended. Variable condenser flow will keep condenser pressure high at the chiller, and thus, decreases chiller's efficiency and increase power consumption of the system. In addition, variable condenser flow increases rate of fouling of condenser, which will de-rate chiller performance and increase unit maintenance cost.

The unit can be operated with condenser inlet water temperature above 55°F up to 105°F. If the unit is required to operate with condenser inlet water temperature lower than 55°F, a bypass control at condenser water loop is recommended to maintain condenser inlet water temperature is always higher than 55°F.

Performance Correction - Condenser Fouling Factor

Fouling Factor		Capacity Correction Factor	kW-input Correction Factor
hr.ft ² .°F/BTU	m ² .°C/kW		
0.00025	0.044	1.000	1.000
0.00050	0.088	0.998	1.007
0.00075	0.132	0.996	1.010
0.00100	0.176	0.995	1.014

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 for applications below 39.2°F [4°C], 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.

Table 1 and 2 are to be used to calculate performance and power input with the addition of glycol.

Table 1 : Ethylene Glycol

% E. G. By Weight	Freeze Point		C1 Capacity Factor	K1 kW-input Factor	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-input Factor	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

Note: P.D. – Pressure drop vessels across

CONDENSER PRESSURE CONTROL

Cooling tower control is increasingly becoming an overlooked subject, and it causes problems. The following is a general recommendation that is applicable to all standard packaged chillers.

Most chiller manufacturers recommend that condenser water be controlled so that its temperature never goes below 55°F [12.8°C] (even when the machine is off) and that its rate of change is not rapid. Rapid can be defined as not exceeding 1°F [0.55°C] per minute. This is necessary because a chiller operates in a dynamic environment and is designed to maintain a precise leaving chilled water temperature under varying entering chilled water conditions. The additional dynamic of rapidly varying condenser water temperature subjects the machine to fluctuating pressure on differentials across the evaporator and condenser. This varies the refrigerant flow and, therefore, the capacity. If this occurs faster than the machine can accommodate it, the condenser pressure or evaporator pressure will soon exceed their safety setpoints and the machine will shut down. The

APPLICATION DATA

necessary control can sometimes be attained via fan cycling if the tower is rated at the same capacity as the chiller's heat rejection. On multiple chiller jobs, a single tower is oversized relative to the chiller. On other jobs the tower/chiller might be oversized to the design load and the chiller and tower frequently cycle under light load. Under these conditions, fan cycling might result in very rapid temperature swings, which creates a dynamic situation to condenser, that potentially cause unstable operation. Thus, in this case, either variable speed fans or modulating valve control should be used to regain control of the condenser water. Either type of control provides precise modulating control of the condenser water rather than on-off step control. The control can be initiated either by a condenser water temperature sensor/controller or, even better, by direct control from the chiller's controller based upon the chiller's condenser pressure.

It is further recommended that the condenser water pump be cycled by the chiller. This is to eliminate potentially very cold water from going through the condenser while the chiller is shut down. At the same time it is probable that relatively warmer chilled water is in the evaporator (an inversion). Refrigerant tends to migrate if there is a difference in pressures within the components of the chiller. It will seek the lowest pressure area of the packaged chiller which, in this case, would be the condenser. Starting of a chiller where the refrigerant has migrated to the condenser is not desirable. The presence of highly subcooled liquid

refrigerant in the condenser will cause low suction pressures and possibly liquid slugging of the compressor. If the condenser water pump is off until prior to the chiller starts, the water in the condenser is at the chiller room ambient, which is usually much closer to the evaporator water temperature.

Further to condenser pump control, a 0-10 Vdc analog signal can be output from the chiller's controller to bypass some of the condenser water flow to maintain chiller's condenser pressure. Cooling tower fans control is also available to achieve better system efficiency.

Thus, even though there has been a trend toward fan cycling control of cooling towers, it is not a device that is suitable to every installation. We recommend that the designer carefully evaluate the system to determine if a more precise method of control is indicated. If there is any doubt, the more precise control is required.

Dunham-Bush WCHX-AV Chillers have as standard a control feature called EPCAS (Evaporator Pressure Control at Start) which will allow for an inverted start. This occurs when the chilled water loop in a building is at a higher temperature than the condenser/tower loop. This occurs in many buildings after a weekend shut down. The chilled water loop can be as high as 90°F and the condenser/tower loop as low as 60°F. With the EPCAS feature, the valve feeding the evaporator will be throttled to create a pressure differential to help load the compressor.

GUIDE SPECIFICATIONS

SCOPE

Supply and commissioning of complete factory assembled water cooled rotary screw chiller(s). The rotary screw chiller(s) shall contain rotary screw compressor(s), evaporator, condenser, interconnecting refrigerant piping, electronic expansion valve, variable frequency drive, control panel, chilled liquid connections, condenser water connections. The control panel shall be fully wired by the manufacturer connecting & interlocking controller, variable frequency drive, electrical protection devices with electrical power and control connections. Packaged chiller shall be factory assembled, charged and tested with a full operating refrigerant and oil charge. The refrigerant type shall be R134a. and shall not have phasing out schedule.

Capacity of each chiller shall be not less than _____refrigerant tons (kW output) cooling at _____ USGPM (liters/min.) of water from _____°F[°C] to _____°F[°C]. Power input requirements for the unit(s), incorporating all appurtenances necessary for unit operation, including but not limited to the control accessories and pumps, if required, shall not exceed _____kW input at design conditions. The unit shall be able to unload to _____% of cooling (refrigeration) capacity when operating with

leaving chilled water and entering condenser water at design temperatures. The unit shall be capable of continuous operation at this point, with stable compressor operation, without the use of hot gas bypass.

Heat transfer surfaces shall be selected to reflect the incorporation of a fouling factor of 0.00025 hr.sq.ft.°F/BTU [0.000044m².°C/W] for the water condenser and 0.0001 hr.sq.ft.°F/BTU [0.0000176 m².°C/W] for evaporator. Water pressure drop at design conditions shall not exceed _____ feet of water through the condenser, and _____ feet of water through the evaporator.

QUALITY ASSURANCE

- ✿ ASME standard B31.5 for Refrigerant piping
- ✿ Vessels shall be fabricated and pressure tested in compliance with ASME Boiler and Pressure vessel code, Section VIII, Division 1 "Unfired Pressure Vessels"
- ✿ Manufacturer shall have experience of minimum 10 years in manufacturing water cooled screw chillers in their facility
- ✿ Unit shall be manufactured in ISO9001 registered manufacturing facility

GUIDE SPECIFICATIONS

- ✿ 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

OPERATING REQUIREMENT

The unit shall be capable of starting up with entering fluid temperature to the cooler at 95°F. Unit shall be able to operate with 3-phase 50Hz with unit rated voltage +/-10%. Control Voltage shall be 115V/1ph/50Hz.

COMPRESSOR AND MOTOR

The packaged chiller shall be furnished with single-stage hermetic direct connected positive displacement rotary screw compressor(s) as required, driven by a 2900 RPM 2 pole motor. The oil differential pressure shall be controlled during operation to maintain proper oil lubrication throughout the lubrication system. Each compressor shall have a suction filter. Compressor capacity control shall be obtained by variable frequency driven motor in combination with slide valve at low load. The bearing shall be heavy duty, anti-friction tapered roller type, anti-reverse, shall be able to carry both radial and thrust loads.

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 1 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 for tube cleaning, shall have stubout water connections with victaulic grooves in compliance to ANSI / AWWAC-606. They are to be available in one, two or three pass design as required on the drawings. 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. Evaporators refrigerant side shall be designed, constructed in accordance with the ASME Code for Unfired Pressure Vessels. Evaporator shell side shall undergo pneumatic pressure test at 220psi, shall be designed for working pressure up to 200psi. Tube side shall undergo hydrostatic pressure test at 195psi, shall be designed for 150psi working pressure.

The flooded evaporator shall have an efficient and reliable oil recovery system. The oil recovery system will 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 will not be acceptable.

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

CONDENSER

Condenser vessel shall be cleanable shell and tube . 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 1 inch and thickness shall be 0.025 inch. Water box shall be removable for tube cleaning, shall have stubout water connections 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 condenser shall have pressure relief valve with provision for refrigerant venting. Condenser refrigerant side shall be designed, constructed in accordance with the ASME Code for Unfired Pressure Vessels. Condenser shell side shall undergo pneumatic pressure test at 220psi, shall be designed for working pressure upto 200psi. Tube side shall undergo hydrostatic pressure test at 195psi, shall be designed for 150psi working pressure.

The condenser shall be sized for full pump down capacity.

REFRIGERANT CIRCUIT

The refrigerant circuit shall include oil filter, replaceable filter drier on oil return line, sight glass on liquid line, pressure relief valves on the cooler and condenser, liquid line angle valve for refrigerant charging. The packaged chiller shall be furnished with an electronic expansion valve for precise modulation of refrigerant flow control and improve efficiency by optimizing the suction and discharge superheat while protecting compressor. Fixed orifice control systems will not be acceptable. (Option Hot gas bypass shall be factory installed for operation down to approximately 10% of full load.)

GUIDE SPECIFICATIONS

ELECTRICAL AND CONTROL PANEL

The electrical switch gears, controller, control sensors and relays shall be housed in NEMA-1 panel. The panel casing shall be of galvanized steel with powder coating for corrosion resistance.

ELECTRICAL POWER PANEL

The chiller manufacturer shall provide a Variable Frequency Drive (VFD) starter for the compressor motor which also to minimize the starting current in addition to capacity modulation function. The VFD shall be factory mounted, wired to the motor and controller. The VFD shall be able to provide adequate starting torque and the required acceleration for the compressor during starting.

NEMA-1 electrical panel compartment shall include:

- ✿ Main incoming power terminal block suitable to receive single entry of three phase 3-wire power supply with specified voltage
- ✿ Compressor motor over current protection module for each phase by VFD
- ✿ Compressor motor overheat protection
- ✿ Under/over voltage phase reversal and imbalance relay

The Variable Frequency Drive shall be wired securely to the main incoming terminal block. Over heating protection, over/under voltage phase relay shall be interlocked with the control to provide adequate protection to the compressor motor.

CONTROL PANEL

The packaged chiller shall be equipped with stand alone proactive advance controller which adapts to abnormal operation conditions. The unit algorithm program and operating parameters shall be stored in flash-memory. Battery back-up is not required. 115V Power supply to the controller shall be provided by a control transformer provided with the panel. External power source to the controller is not required. The controller equipped with a user friendly terminal with color touch screen LED back lit graphical display and dedicated touch keys that provides easy access to the unit operating parameters, control set points and alarm history. There shall be dedicated physical buttons and touch keys 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 board provided with a set of terminals that connected to various devices such as temperature sensors, pressure transducers, current transducers, solenoid valves, variable frequency drive, electronic expansion valve, and controls relays. The controller able to configured and connected multiple unit that allow sequencing control without additional hardware. The controller able to carry out all program operations.

It able to display unit operating parameters, compressor information, alarm history and shall able to modify the parameters.

The controller able to carry out its own diagnose 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. shall be displayed either in 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 modulate the VFD (and slide valve if required) 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 complete with all hardware and software necessary to enable remote monitoring of all data through the addition of an optional web card if accessing the controller via web or network cards if linking chiller to the Building Management Systems. The controller shall be complete with a RS485 long distance differential communications port, the remote connection shall be established by a twisted pair of wire. The controller shall also accept a remote start and stop signal, 0 to 5VDC [optional], chilled water temperature reset signal [optional] and compressor current limit reset signal [optional].

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:

MANUAL CONTROLS

- ✿ Compressor over current
- ✿ Compressor anti-recycle
- ✿ Programmable with Seven day operation cycle
- ✿ [Optional] chilled liquid and condenser water pump on/off control

AUTOMATIC CONTROLS

- ✿ Variable frequency drive
- ✿ Start delay timer
- ✿ Anti-recycle timer
- ✿ Oil flow interlock

GUIDE SPECIFICATIONS

REFRIGERANT FLOW CONTROLS

- ✿ Refrigerant flow control shall be carried out electronically by a precision electronic expansion valve
- ✿ Compressor VFD and load and unload solenoid valves

SYSTEM OPERATION INFORMATION

The chiller display shall provide following operating information

- ✿ Leaving chilled water temperature
- ✿ Leaving chilled water temperature derivative
- ✿ Evaporator pressure
- ✿ Condenser pressure
- ✿ Compressor amps draw for each compressor
- ✿ Operating supply Voltage [optional]
- ✿ Compressor elapsed run time of each compressor
- ✿ Compressor start status
- ✿ Oil flow status
- ✿ Water temperature re-set value [optional]
- ✿ Water flow switch status
- ✿ External start/stop command status
- ✿ Percentage of compressor capacity
- ✿ Electronic expansion valve percentage of opening

SAFETY PROTECTIONS

- ✿ Compressor motor over load protection (3 phase)
- ✿ Compressor motor overheat protection
- ✿ High discharge temperature protection
- ✿ Under voltage phase failure relay
- ✿ Low oil flow
- ✿ High condenser pressure
- ✿ Low evaporator pressure
- ✿ Freeze protection (low chilled liquid leaving temperature)
- ✿ Chilled water flow loss
- ✿ Compressor run error
- ✿ Power loss
- ✿ Sensor error
- ✿ Refrigerant loss
- ✿ Reverse rotation

Controller shall be able to retain upto 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.

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.

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 a authorized service personnel and the warranty is limited to part replacement excluding labor and consumables such as refrigerant, oil & filter driers etc.

EXECUTION

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.

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.



Malaysia

Lot 5755-6,
Kidamai Industrial Park,
Bukit Angkat,
43000 Kajang,
Selangor, Malaysia

Tel: +603-8924 9000
Fax: +603-8739 5020

China

No. 1 Dunham-Bush Road,
Laishan District,
Yantai,
Shandong Province,
China 264003

Tel: +86-535-739 7888
Fax: +86-535-739 7999

United Kingdom

8 Downley Road,
Havant,
Hampshire,
England PO9 2JD

Tel : +44-23-9247 7700
Fax: +44-23-9245 0396

United States of America

1800 SE 38th Avenue,
Homestead,
Florida 33035
United States of America

Tel: +1(786)-800 9999
Fax: +1(786)-527 3539

United Arab Emirates

Office # 2606,
Fortune Executive Towers,
Cluster T1, Jumeirah Lake Tower
Dubai, UAE

Tel: +971-4-443 9207
Fax: +971-4-443 9208

South Africa

No. 57 Sovereign Drive
Route 21 Corporate Park
Irene, Pretoria
South Africa

Tel: +27-12-345 4202
Fax: +27-12-345 4203

India

Unit no : 804 , 8th Floor
Spaze Platinum Towers,
Sector-47, Sohna Road,
Gurgaon-122018, India

Tel: +91-124-414 4430

Indonesia

The Boulevard Office,
3F2 Jl. Fachrudin No.5,
Kp. Bali, Tanah Abang
Jakarta Pusat - 10250, Indonesia

Tel: +62-21-2123 1392

Thailand

48/39 Soi Praditmanutham 19
Praditmanutham Road,
Lat Pharo, Bangkok 10230
Thailand

Tel: +66-0-2610 3749
Fax: +66-0-2610 3601

Singapore

2 Kallang Pudding Road
#07-07 Mactech Building
Singapore 349307

Tel: +65-6842 2012
Fax: +65-6842 2013

Vietnam

10th Floor, Nam A Bank Tower,
201-203 Cach Mang Thang 8 Street,
District 3, Ho Chi Minh City,
Vietnam

Tel: +84-8-6290 3108
Fax: +84-8-6290 3109

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info@dunham-bush.com
www.dunham-bush.com



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