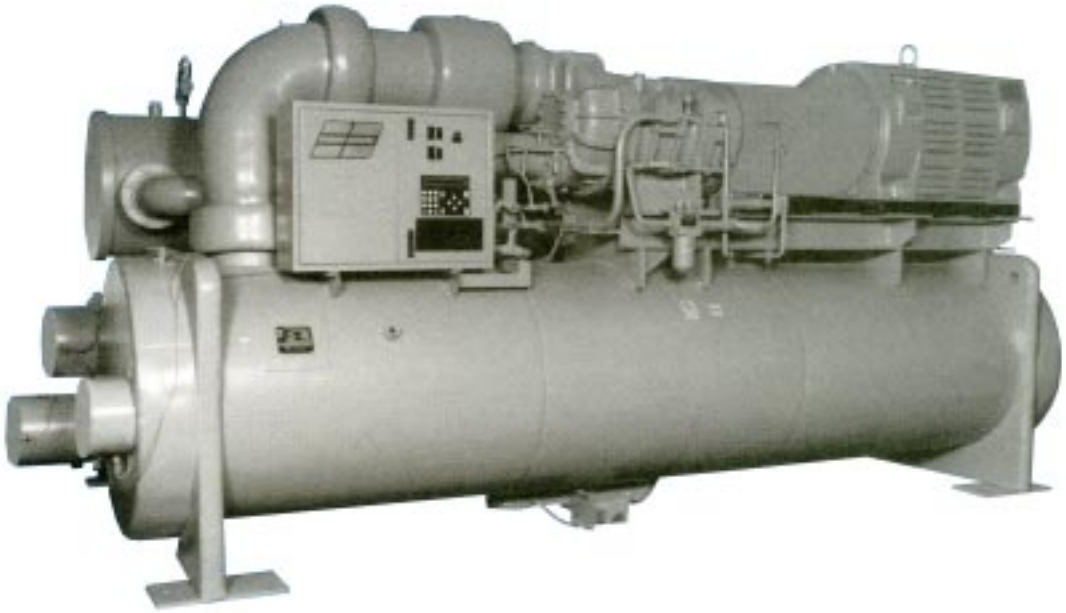
WCOX

Water - Cooled Chillers

with Rotary Screw Compressors
500 to 1100 Tons



Features

- Uses HCFC-22 and compatible with HFC refrigerants
- Advanced microcomputer with open protocol
- Most reliable screw compressor on market
- Smaller footprint than centrifugals
- Low height ideal for retrofit

MANUFACTURER CERTIFIED TO ARI AS COMPLYING WITH CERTIFICATION SECTIONS OF ARI STANDARD 550 — CENTRIFUGAL AND ROTARY SCREW WATER CHILLING PACKAGES

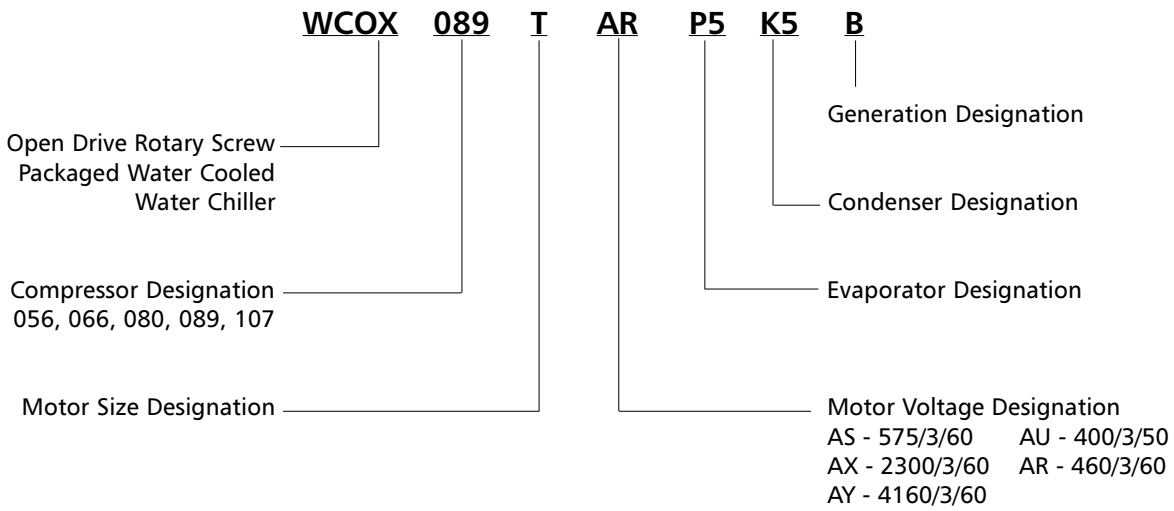
DUNHAM-BUSH®

Form No. 6086B

INTRODUCTION

Dunham-Bush's WCOX water cooled water chiller is the newest addition to a large family of rotary screw chillers, and follows on the heels of thirty years of experience and dedicated rotary screw technology and advancements. Dunham-Bush, the world's largest manufacturer of screw compressorized air conditioning, has over 20,000 screw compressor installations working worldwide - representing over one-half of all the screw compressors in the world today.

NOMENCLATURE



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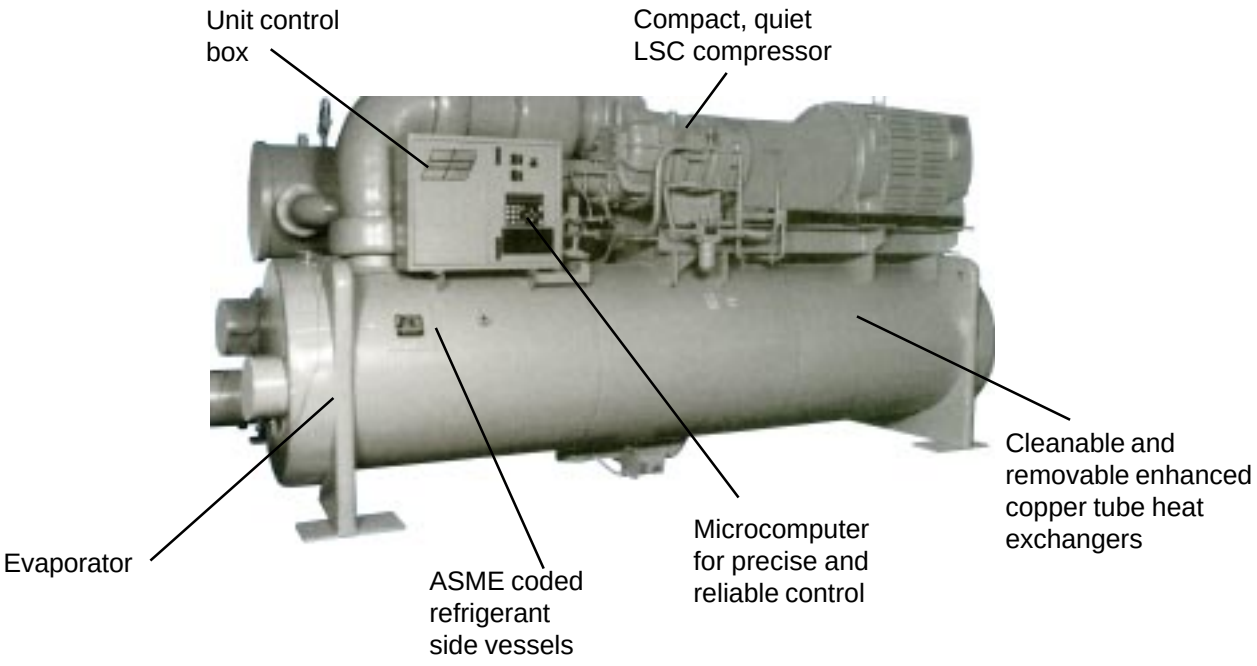
COMPONENTS



ARI CERTIFICATION

ARI CERTIFICATION PROGRAM

The performance of Dunham-Bush Water-Cooled R-22 Rotary Screw Water chillers has been certified by the Air Conditioning and Refrigeration Institute (ARI).

Full load ratings, part load ratings, and water pressure drop data are regularly tested under this program and are certified in accordance with ARI Standard 550/590-98. This provides an independent, third party verification of water chiller performance with a laboratory-rated performance test utilizing instrumentation which has calibration traced to the National Bureau of Standards.

The ARI Seal of Certification on each and every Dunham-Bush WCOX chiller shows our commitment to quality and to our customer's peace of mind. You know you'll get the industry's standard for efficiency and reliability...and more when you purchase a Dunham-Bush water chiller.

COMPUTER PERFORMANCE RATINGS

Dunham-Bush WCOX Water-Cooled Rotary Screw Water Chillers are available from 500 to 1100 tons. The vast number of combinations of heat exchangers, compressors and motors make it impractical to publish tabular ratings for each combination. A chiller may be custom matched to certain building require-ments by your Dunham-Bush Sales Representative utilizing the **WCOX Computer Selection Program** which has ratings which are certified in accordance with ARI Standard 550/590-98. Data which can be provided to you will include:

- **Chiller capacity**
- **KW Input**
- **Evaporator and Condenser Water Pressure Drop**
- **Evaporator and Condenser Tube Water Velocities**
- **IPLV / APLV**
- **Part-Load Performance**

Contact your local Dunham-Bush Sales Representative to discuss what Real Solutions Dunham-Bush can offer to solve your chiller selection questions.

STANDARD FEATURES

COMPRESSOR EXPERIENCE

- Thirty years of rotary screw experience and dedicated technological advancements
- Simply designed for high reliability with only two rotating parts
- Insured continuous oil flow to compressor through separate oil pump and high efficiency external oil separator
- Many of these compressors have operated over 100,000 hours and never been opened, let alone overhauled

ENERGY EFFICIENCY

- Designed to provide the greatest amount of cooling for the least kilowatt input over the entire operating range of your building
- Delivers outstanding efficiency and total energy savings through the use of microcomputer controlled slide valve and evaporator leaving water control
- High efficiency external oil separator guarantees removal of oil carried over in the refrigerant and maintains the heat exchangers at their maximum efficiency at both full and part load
- Rating certified by ARI Standard 550/590-98 “Centrifugal or Rotary Screw Liquid Chilling Packages”
- Meets or exceeds ASHRAE Standard 90.1 Energy Efficiency Code

INSTALLATION EASE

- The WCOX has a smaller footprint than comparable centrifugal chillers and takes up less equipment room space
- Small size, especially low height, makes the WCOX ideal for retrofit when it comes time to change out obsolete CFC chillers or absorption units

SAFETY CODE COMPLIANCE

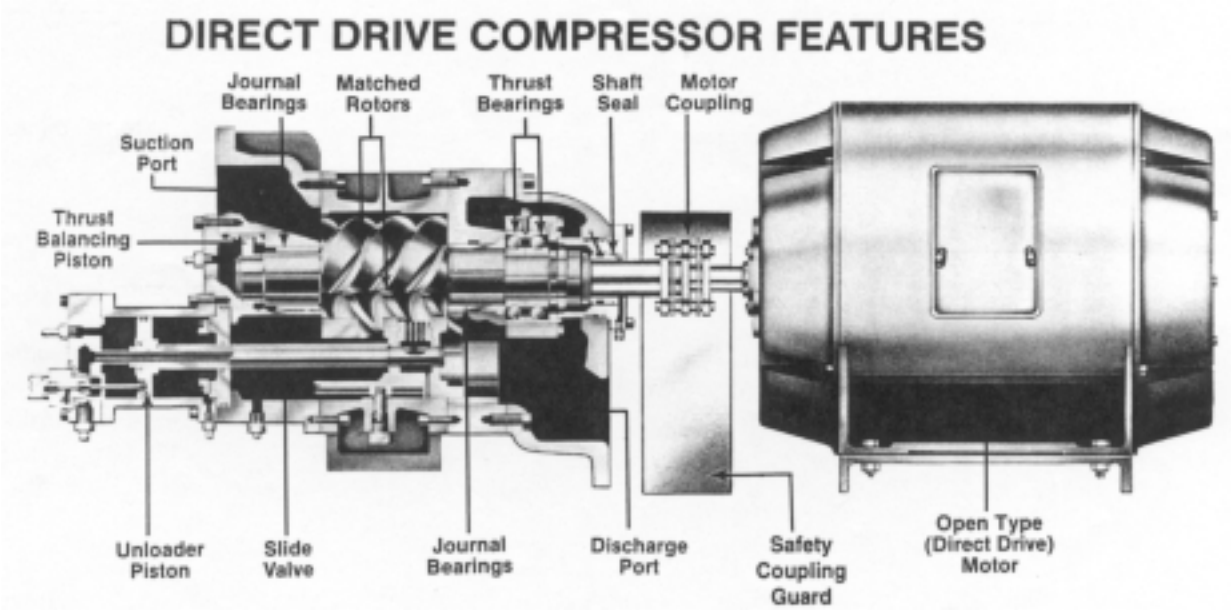
- ASME Boiler and Pressure Vessel Code, Section VIII Division 1 “Unfired Pressure Vessels”
- ASME Standard B31.5 Refrigerant Piping
- ASHRAE Standard 15 Safety Code for Mechanical Refrigeration
- Underwriters Laboratories Standard UL508 Industrial Control Panels

REFRIGERANT COMPATIBILITY

- Designed to operate with environmentally safe and economically smart HCFC-22 with proven efficiency and reliability
- Consult factory for use with new HFC refrigerants

CONTROL FLEXIBILITY

- Microcomputer-based with DDC (direct digital control) features precise push button control over every aspect of operation with built-in standard features that allow extra energy savings on startup and throughout the life of the equipment
- Insured optimum energy efficiency through microcomputer controls which utilize pressure transducers to measure evaporator and condenser pressure
- Lower energy costs resulting from automatic load monitoring
- Monitor your chiller’s key functions from a remote location with a simple, low cost, phone modem option
- Proactive control by microcomputer that anticipates problems and takes corrective action before they occur.
- Controls will unload compressor if head and suction pressure approach limits. This will allow unit to stay on the line while warning operator of potential problems



Compressor Assembly - The Dunham-Bush rotary Compressor is a positive displacement helical-axial design to use with high pressure refrigerants.

- The compressor consists of two intermeshing helical grooved rotors in a stationary housing with suction and discharge gas ports.
- Uniform gas flow, even torque and positive displace ment, all provided by pure rotary motion, contribute to vibration-free operation over a wide range of operating conditions. Intake and discharge cycles overlap effectively, producing a smooth, continuous flow of gas.

Simplified Capacity Control - The slide valve mecha nism for capacity modulation and part load operation is an outstanding feature:

- Moving parts are simple, rugged and trouble free. The slide mechanism is hydrostatically supported with aid from a pressurized oil supply.
- Package capacity reduction can be down to as low as 10% without HGBP by progressive movement of the slide valve away from is stop.
- Capacity reduction is programmed by an exclusive electronically initiated, hydraulically actuated control arrangement.
- Any degree of part-load capacity at any head condi tion can be accepted without duress for any period of time. The screw compressor actually operates cooler at partload conditions.

Positive Motor Alignment - The compressor is directly connected to the motor without any complicated gear systems to speed up the compressor and thus detract from the overall unit reliability. Factory alignment of motor and compressor shafts eliminates the need for field adjustment.

Thrust Bearings - Each rotor is fitted with a pair of pre-loaded, duplex mounted angular contact thrust bearings. These bearings can also safely carry thrust in either direction at or near zero thrust loads. Additionally the bearing races are mechanically locked to assure zero race rotation.

Through the use of hydraulic counterbalance arrange-ments, the thrust bearings carry only a small portion of the total thrust generated. This combined system for carrying the thrust load is not affected by emergencies such as power outage, low oil pressure trip-out or similar inci-dents.

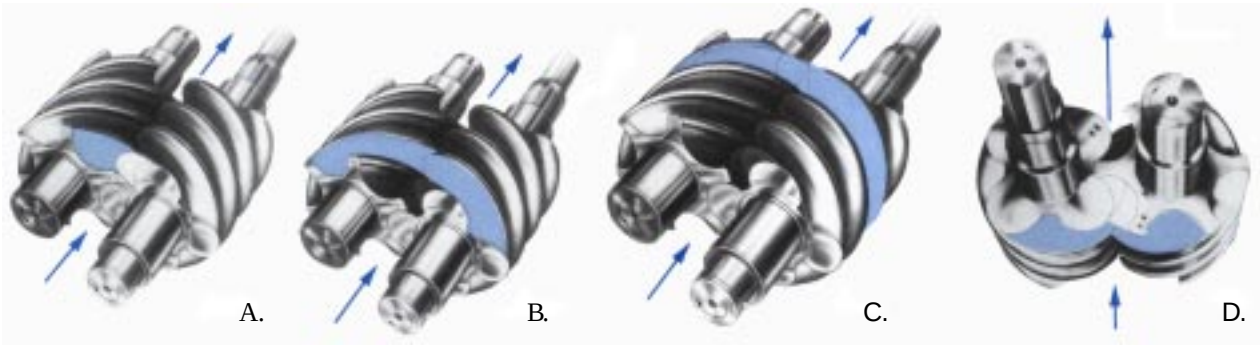
Main Journal Bearings - Heavy duty, steel backed, machined in place babbitt bearings are conservatively loaded even at maximum operating conditions. These bearings are center fed and supplied with lubricant by an independently driven oil pump. Start-up lubrication is provided and “coast down” lubrication is not required as the screw compressor stops within a matter of seconds.

Rotors - The latest asymmetrical design rotor profiles assure operation at highest efficiencies. Rotors are precision machined from AISI 1141 bar stock and dynamically balanced.

Castings - Castings are manufactured with high grade, low porosity cast iron, externally ribbed for structural stability and efficient heat dissipation.

Shaft Seal
An oil flooded, mechanical, process type, balanced shaft seal effectively seals the drive rotor and provides a long operating life.

Oil Cooling - Shaft seal oil is cooled by a refrigerant cooled oil cooler requiring no maintenance or adjustment. Cool oil to the shaft seal insures long shaft life and reduced maintenance.



Compressor Operation
Note: For clarity reasons, the following account of the compressor operation will be limited to one lobe on the male rotor and one interlobe space on the female rotor. In actual operation, as the rotors revolve, all of the male lobes and female interlobe spaces interact similarly with resulting uniform, non-pulsating gas flow.

Suction Phase
As a lobe of the male rotor begins to unmesh from an interlobe space in the female rotor, a void is created and gas is drawn in tangentially through the inlet port - Fig. A. As the rotors continue to turn, the interlobe space increases in size - Fig. B, and gas flows continuously into the compressor. Before the point at which the interlobe space leaves the inlet port, the entire length of the interlobe space is completely filled with drawn-in gas - Fig. C.

Compression Phase
As rotation continues, the gas in the interlobe space is carried circumferentially around the compressor housing. Further rotation meshes a male lobe with the interlobe space on the suction end and squeezes (compresses) the gas in the direction of the discharge port. Thus the occupied volume of the trapped gas within the interlobe space is decreased and the gas pressure consequently increased.

Discharge Phase
At a point determined by the designed “built-in” compression ratio, the discharge port is uncovered and the compressed gas is discharged by further meshing of the lobe and interlobe space - Fig. D. While the meshing point of a pair of lobes is moving axially, the next charge is being drawn into the unmeshed portion and the working phases of the compressor cycle are repeated.

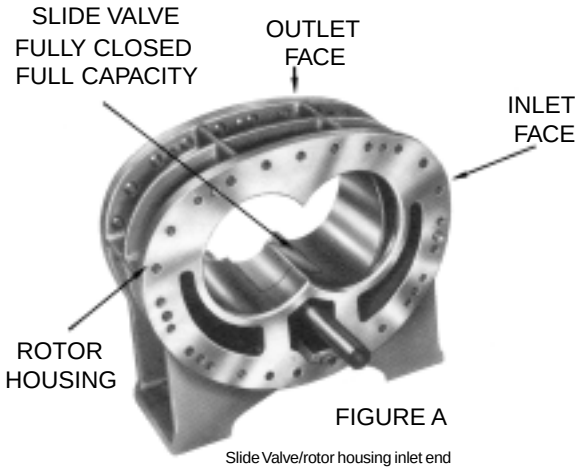


FIGURE A
Slide Valve/rotor housing inlet end

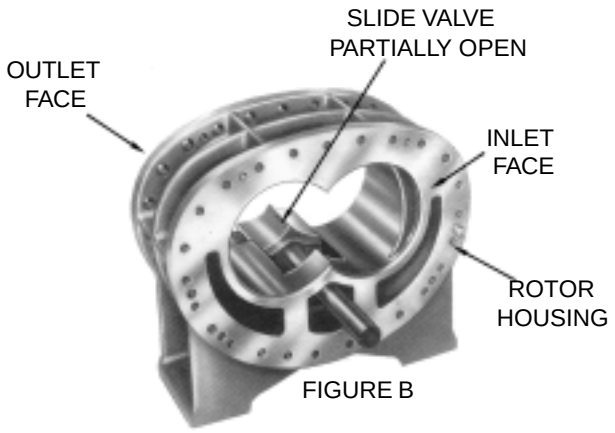


FIGURE B
Slide Valve/rotor housing inlet end

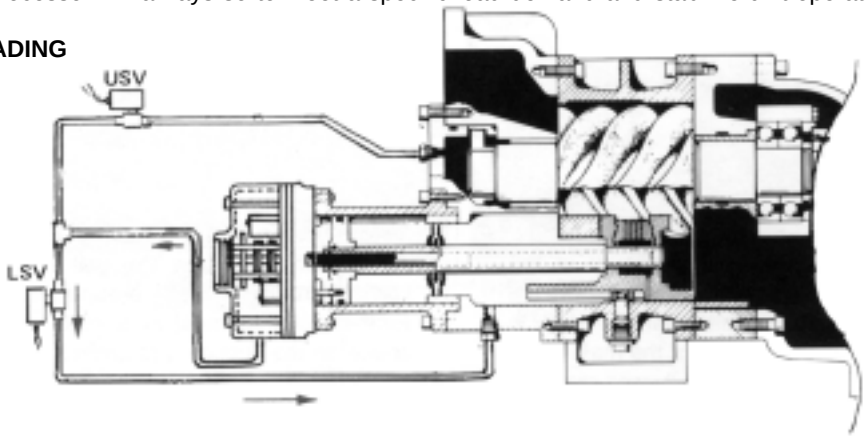
CAPACITY CONTROL SYSTEM

Figures A & B show the capacity control slide valve within the rotor housing. Axial movement of this valve is programmed by an exclusive Dunham-Bush electrically initiated (by variations in leaving chilled water temperature) hydraulically actuated control arrangement. When the compressor is fully loaded, the slide valve is in the closed position (Figure A). Unloading starts when the valve is moved back away from the valve stop (Figure B). Movement of the valve creates an opening in the bottom of the rotor housing. Suction gas can then pass back from the rotor housing to the inlet port area before it has been compressed. Since no significant amount of work has been done on this return gas, no appreciable power losses are incurred. Reduced compressor capacity is obtained from the gas remaining in the rotors which is compressed in the ordinary manner. Capacity reduction down to 10% of full load is possible by progressive movement of the slide valve away from the valve stop.

CAPACITY CONTROL

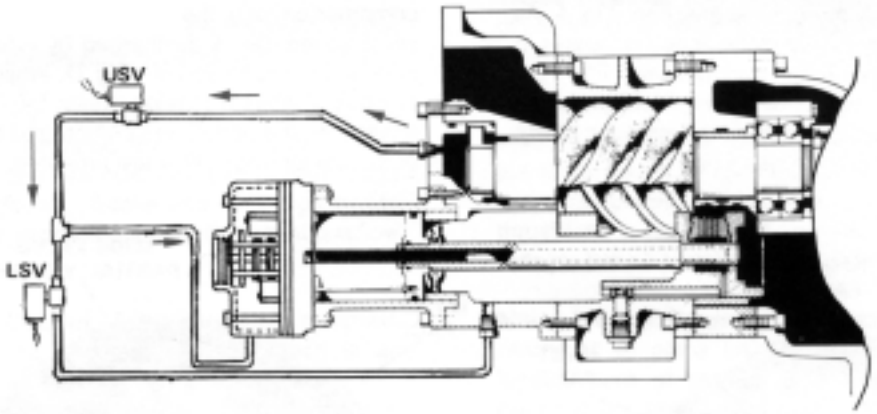
The advanced microprocessor supplies power to the load solenoid valve (LSV) and unload solenoid valve (USV) to control the position of the compressor slide valve piston. Control is achieved by monitoring leaving chilled fluid temperature. The sophisticated microprocessor will always so to meet a specific load demand and stabilize unit operation.

COMPRESSOR LOADING



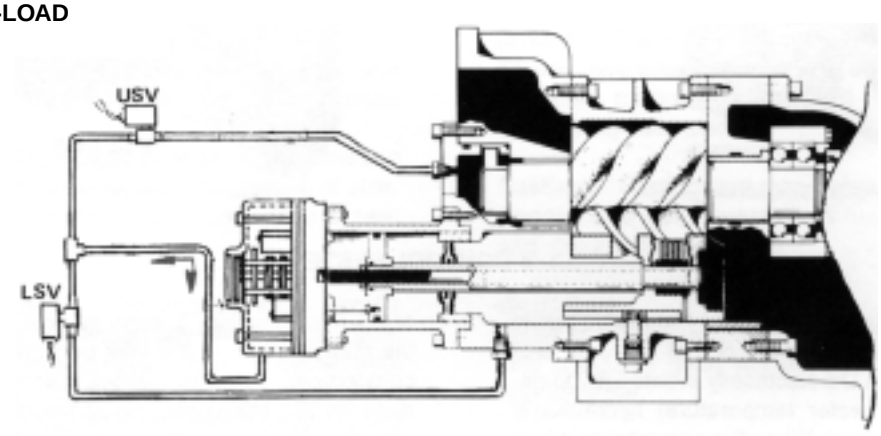
Loading - When energized, the load solenoid valve (LSV) opens and discharge pressure pushes the slide valve towards load, forcing oil out of the cylinder into the suction housing.

COMPRESSOR UNLOADING

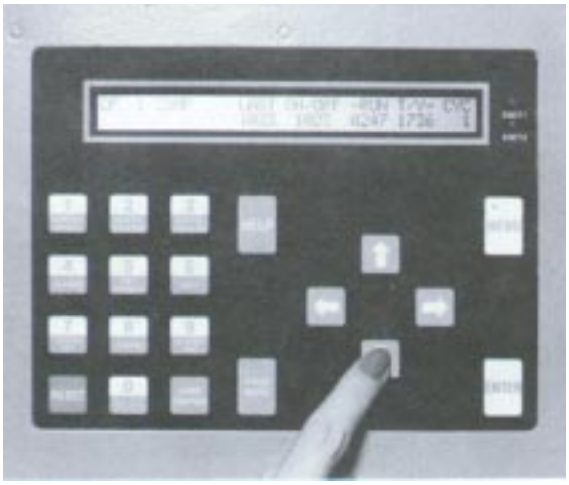


Unloading - When energized, the unload solenoid valve (USV) opens. The combination of discharge plus oil pressure on the slide valve piston will move the slide valve toward the unload position.

COMPRESSOR PART-LOAD



Part-Load - The unit will remain in the part-load position as long as the leaving chilled fluid temperature remains at the desired temperature. Both load and unload solenoid valves will be closed and the piston will be stationary at the part-load position.



Advanced Microcomputer Control is a standard feature on all Dunham-Bush Rotary Screw Chillers monitoring analog and digital inputs to achieve precise control of the major operational and protective functions of the unit.

Direct digital control (DDC) allows finger-tip user interaction. Its simple-to-use push button keyboard and menu-driven software provide access to operating conditions, control setpoints and alarm history clearly displayed on a prominent mufti-line 80 character alphanumeric display.

An easy-to-install, inexpensive modem option allows remote reading of operating parameter updates. The Dunham-Bush microcomputer insures its owner state-of-the-art efficiency and reliability.

DISPLAY INFORMATION

The 80 character alphanumeric liquid crystal display utilizes easy-to-understand menu-driven software. Inexperienced operators can quickly work through these menus to obtain the information they require or to modify control parameters. More experienced operators can bypass the menu systems, if desired, and move directly to their requested control function. At all times, assistance is available to the operator by simply pressing the help key. Easily accessible measurements include:

- Leaving chilled water temperature
- Evaporator pressure
- Condenser pressure
- Oil pressure
- Compressor amp draw
- Compressor elapsed run time
- Percent of slide valve loading
- Reservoir oil temperature
- Seal oil temperature
- Water temperature reset value
- Demand limit reset value
- Compressor starter status
- Oil pump starter status
- Water flow switch status
- External start / stop command status

Optional entering chilled water temperature sensor is available, as well as entering and leaving condenser water temperature sensors. With this option the operator can quickly and accurately read the water temperatures and eliminate the need for often inaccurate thermometers.

CAPACITY CONTROL

Leaving chilled water temperature control is accomplished by entering the water temperature setpoint and placing the microcomputer in automatic control. The unit will monitor all control functions and move the slide valve to the required operating position. 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 through either direct connection via terminal or modem connected to the RS232 communication port, or from an external Building Automation System supplying a simple 0 to 5VDC signal. Remote reset of compressor current limit may 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 microcomputer may be programmed with a seven-day operating cycle or other Dunham-Bush control packages may start and stop the system through connection with the RS485 long distance differential communications port.

SYSTEM PROTECTION

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

- Low suction pressure
- High discharge pressure
- Low oil temperature
- Freeze protection
- High receiver oil temperature
- High seal oil temperature
- Compressor starter failure
- Oil pump starter failure

- Low suction pressure
- High discharge pressure
- Low oil temperature
- Freeze protection
- High receiver oil temperature
- High seal oil temperature
- Compressor starter failure
- Oil pump starter failure

The microcomputer will retain the latest eight alarm conditions complete with time of failure in an alarm history. This tool will aid service technicians in troubleshooting tasks, minimizing downtime.

REMOTE MONITORING CAPABILITY

The microcomputer is complete with an RS232 communications port and all hardware and software necessary to remotely monitor and control the packaged chiller up to 50 feet away (hard wired) or by optional phone modem to extended distance. This valuable enhancement to the refrigeration system allows the ultimate in serviceability. The microcomputer as standard is additionally equipped with history files which may be used to take logs which may be retrieved via the phone modem periodically. Now owners of multiple buildings have a simple and inexpensive method of investigating potential problems quickly and in a highly cost effective manner.

There are three methods of remote monitoring and operating of our package chillers.

1. The **RMDT** (Remote Monitor Display Terminal) can be hard wired up to 50 feet away from the chiller or connected thru a modem for remote monitoring and operating of multiple chillers. The RMDT is supplied with a 14" monitor, two RS232 serial ports, a 6 foot 115 volt power cord and an enhanced PC keyboard.

2. An **IBM PC Compatible** computer with communication software installed (simple terminal) can interface with the chiller in the same manner as the RMDT (Remote Monitor Display Terminal).

3. A **BMS** (Building Management System) may interface with the chiller microcomputer and provide the same level of monitoring and operating control as above, when the BMS company has implemented the commu nications protocol. Dunham-Bush has an open communications protocol policy with most BMS companies.

COMPUTER GRAPHICS OPTIONS

All units can be fitted with this on-line graphics package which gives an on-screen view of the equipment and real time display of temperatures, pressures and device status.

Dunham-Bush Rotary Screw Water Chillers possess superior part-load performance characteristics. This is accomplished with the infinite capacity control capability of the slide valve equipped compressor.

Actual building system loads are significantly less than full load design conditions, therefore chillers operate at full for a fraction of the operating time.

Dunham-Bush Rotary Screw Water Chillers combine the efficient operation of the rotary screw compressor with finite refrigerant management and micro-processor control to yield the best total energy efficiency and significant operating savings under any load.

When specifying air conditioning equipment it is important to consider the system load characteristics of 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 (ARI) has established a system, in ARI 550/590-98, for measuring total chiller performance over full and part-load conditions. The Integrated Part-Load Value (IPLV) is 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 ARI Rating Conditions.

SI Metric Units

$$\text{IPLV or APLV} = 0.01A + 0.42B + 0.45C + 0.12$$

U.S. Standard Units

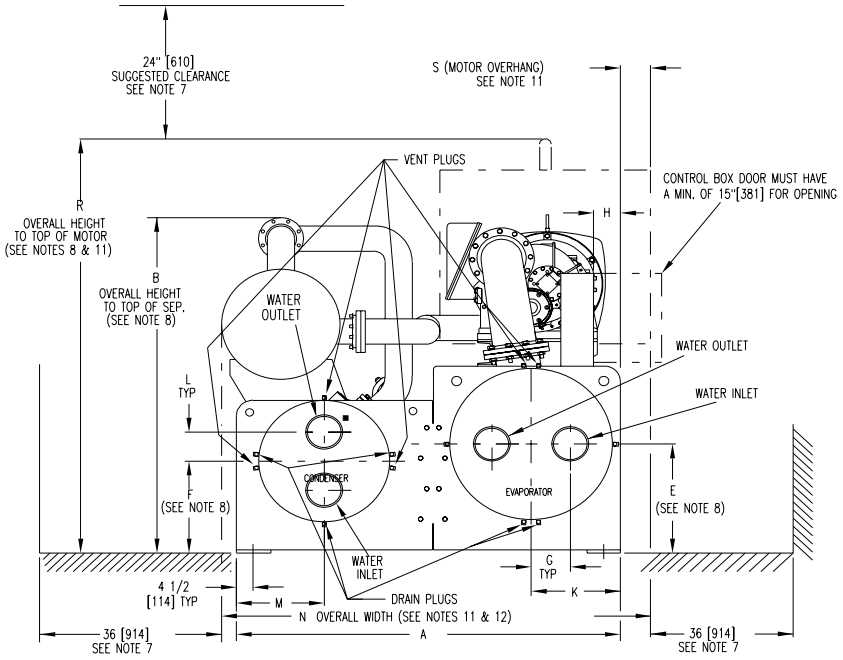
$$\text{IPLV or APLV} = \frac{1}{\frac{0.01}{A} + \frac{0.42}{B} + \frac{0.45}{C} + \frac{0.12}{D}}$$

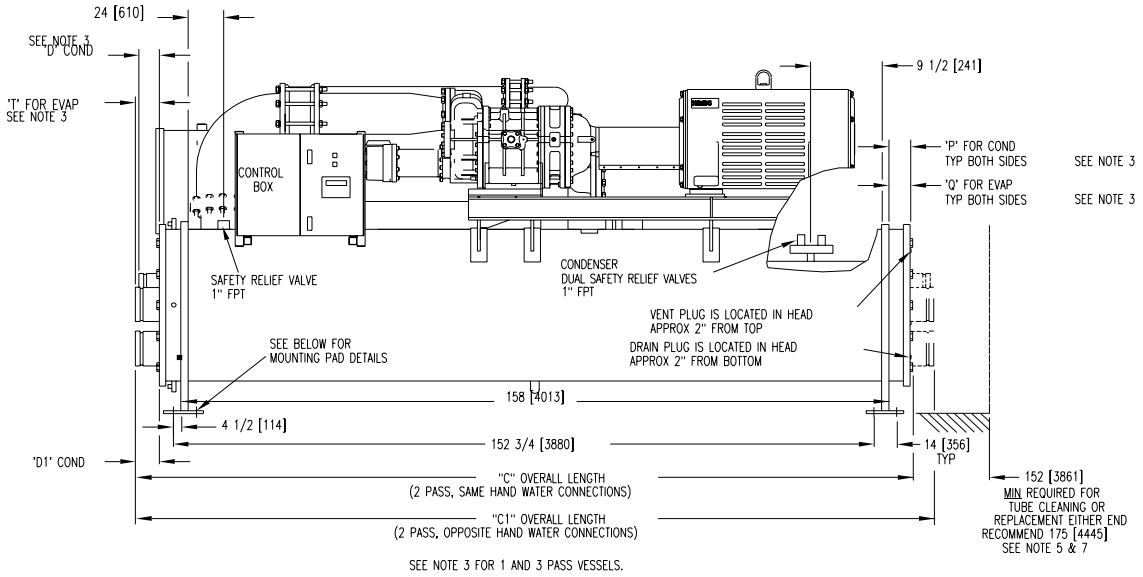
where: A=kW/ton at 100% load point
B=kW/ton at 75% load point
C=kW/ton at 50% load point
D=kW/ton at 25% load point

Application Part-Load Values (APLV) also give a single number estimate for the part-load performance of a chiller but at Selected Application Rating Conditions.

Integrated Part-Load Values and Application Part-Load Values are available from your Dunham-Bush Representative and will be calculated for your specific conditions. These points, as well as the full load selection point, are all covered under the ARI Large Tonnage Certification Program for Centrifugal and Rotary Screw Water-Chilling Packages.

DIMENSIONAL DATA





WATER CONNECTION SELECTION

EVAPORATOR

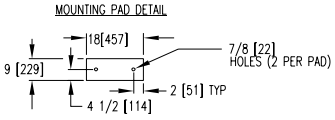
1 PASS, LH	←	
1 PASS, RH	→	
2 PASS, LH	↩	
2 PASS, RH	↪	
3 PASS, LH	↩	
3 PASS, RH	↪	

CONDENSER

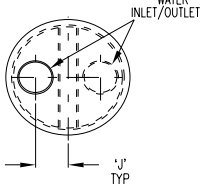
1 PASS	←	
2 PASS, LH	↩	
2 PASS, RH	↪	

HAND = LEAVING WATER
CONNECTION LOCATION
WHEN VIEWED FACING
CONTROL BOX

MOUNTING PAD DETAIL

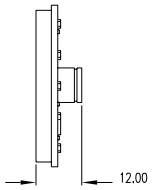


DETAIL OF 3 PASS
EVAPORATOR HEAD



DETAIL 'A'

SIDE DETAIL OF 1 & 3 PASS
EVAPORATOR AND CONDENSER HEADS



DIMENSIONAL DATA

			DIMENSIONS									
Model	Evap	Cond	A	B	C	C1	D	D1	E	F	G	H
056 *	K5	G5	77 (1956)	81-1/8 (2061)	178-3/4 (4540)	183-1/4 (4655)	5 (127)	8-1/8 (206)	22 (559)	19 (483)	8-5/8 (219)	1-3/4 (44)
	M5	H5	79 (2007)	83-1/8 (2111)	177-1/4 (4502)	181-1/4 (4604)	5 (127)	5 (127)	24 (610)	20 (508)	8-5/8 (219)	3-3/4 (95)
	N5	J5	82-3/8 (2092)	85-1/8 (2162)	184-1/2 (4686)	189 (4801)	9 (229)	12-3/4 (324)	25-1/2 (648)	21 (533)	10-1/4 (260)	5-1/4 (133)
066	K5	G5	77 (1956)	81-1/8 (2061)	178-3/4 (4540)	183-1/4 (4655)	5 (127)	8-1/8 (206)	22 (559)	19 (483)	8-5/8 (219)	1-3/4 (44)
*	M5	H5	79 (2007)	83-1/8 (2111)	177-1/4 (4502)	181-1/4 (4604)	5 (127)	5 (127)	24 (610)	20 (508)	8-5/8 (219)	3-3/4 (95)
	N5	J5	82-3/8 (2092)	85-1/8 (2162)	184-1/2 (4686)	189 (4801)	9 (229)	12-3/4 (324)	25-1/2 (648)	21 (533)	10-1/4 (260)	5-1/4 (133)
	P5	K5	84-1/8 (2137)	87-1/8 (2213)	177-1/4 (4502)	181-3/4 (4616)	5 (127)	5 (127)	26-1/2 (673)	22 (559)	10-1/4 (260)	6-1/4 (159)
080	M5	H5	79 (2007)	83-1/8 (2111)	177-1/4 (4502)	181-1/4 (4604)	5 (127)	5 (127)	24 (610)	20 (508)	8-5/8 (219)	3-3/4 (95)
*	N5	J5	82-3/8 (2092)	85-1/8 (2162)	184-1/2 (4686)	189 (4801)	9 (229)	12-3/4 (324)	25-1/2 (648)	21 (533)	10-1/4 (260)	5-1/4 (133)
	P5	K5	84-1/8 (2137)	87-1/8 (2213)	177-1/4 (4502)	181-3/4 (4616)	5 (127)	5 (127)	26-1/2 (673)	22 (559)	10-1/4 (260)	6-1/4 (159)
	S5	L5	89-1/4 (2267)	89-1/8 (2264)	181-1/4 (4604)	185-3/4 (4718)	5 (127)	9 (229)	28-1/2 (724)	23 (584)	10-3/4 (273)	8-1/4 (210)
089	N5	J5	82-3/8 (2092)	90-1/2 (2299)	184-1/2 (4686)	189 (4801)	9 (229)	12-3/4 (324)	25-1/2 (648)	21 (533)	10-1/4 (260)	5-1/4 (133)
*	P5	K5	84-1/8 (2137)	92-1/2 (2350)	177-1/4 (4502)	181-3/4 (4616)	5 (127)	5 (127)	26-1/2 (673)	22 (559)	10-1/4 (260)	6-1/4 (159)
	S5	L5	89-1/4 (2267)	94-1/2 (2400)	181-1/4 (4604)	185-3/4 (4718)	5 (127)	9 (229)	28-1/2 (724)	23 (584)	10-3/4 (273)	8-1/4 (210)
107	P5	K5	84-1/8 (2137)	95-3/4 (2432)	177-1/4 (4502)	181-3/4 (4616)	5 (127)	5 (127)	26-1/2 (673)	22 (559)	10-1/4 (260)	6-1/4 (159)
*	S5	L5	89-1/4 (2267)	97-3/4 (2483)	181-1/4 (4604)	185-3/4 (4718)	5 (127)	9 (229)	28-1/2 (724)	23 (584)	10-3/4 (273)	8-1/4 (210)

* Standard Vessel Set

			DIMENSIONS									
Model	Evap	Cond	J	K	L	M	N	P	Q	R	S	T
056 *	K5	G5	10-3/8 (264)	17 (432)	6-7/8 (175)	14 (356)	86 (2184)	5-1/4 (133)	6-7/8 (175)	82 (2083)	8-1/2 (216)	5 (127)
	M5	H5	12-1/4 (311)	19 (483)	7-3/8 (187)	15 (381)	86 (2184)	6-3/8 (162)	6-7/8 (175)	84 (2134)	6-1/2 (165)	5 (127)
	N5	J5	13-3/4 (349)	20-1/2 (521)	8 (203)	16 (406)	87-1/4 (2216)	6-1/4 (159)	6-7/8 (175)	85 (2159)	5 (127)	5 (127)
066	K5	G5	10-3/8 (264)	17 (432)	6-7/8 (175)	14 (356)	86 (2184)	5-1/4 (133)	6-7/8 (175)	82 (2083)	8-1/2 (216)	5 (127)
*	M5	H5	12-1/4 (311)	19 (483)	7-3/8 (187)	15 (381)	86 (2184)	6-3/8 (162)	6-7/8 (175)	84 (2134)	6-1/2 (165)	5 (127)
	N5	J5	13-3/4 (349)	20-1/2 (521)	8 (203)	16 (406)	87-3/8 (2219)	6-1/4 (159)	6-7/8 (175)	85 (2159)	5 (127)	5 (127)
	P5	K5	13-5/8 (346)	21-1/2 (546)	8-1/8 (206)	16-5/8 (422)	89-5/8 (2283)	6-7/8 (175)	6-7/8 (175)	88 (2235)	4 (102)	5 (127)
080	M5	H5	12-1/4 (311)	19 (483)	7-3/8 (187)	15 (381)	86 (2184)	6-3/8 (162)	6-7/8 (175)	84 (2134)	6-1/2 (165)	5 (127)
*	N5	J5	13-3/4 (349)	20-1/2 (521)	8 (203)	16 (406)	87-1/4 (2216)	6-1/4 (159)	6-7/8 (175)	105 (2667)	5 (127)	5 (127)
	S5	L5	13-5/8 (346)	21-1/2 (546)	8-1/8 (206)	16-5/8 (422)	89-5/8 (2283)	6-7/8 (175)	6-7/8 (175)	107 (2718)	4 (102)	5 (127)
	P5	K5	15-5/8 (397)	23-1/2 (597)	8-7/8 (225)	18 (457)	91-1/4 (2318)	6-7/8 (175)	6-7/8 (175)	109 (2769)	2 (51)	5 (127)
089	N5	J5	13-3/4 (349)	20-1/2 (521)	8 (203)	16 (406)	103-1/4 (2623)	6-1/4 (159)	6-7/8 (175)	105 (2667)	12 (305)	5 (127)
*	P5	K5	13-5/8 (346)	21-1/2 (546)	8-1/8 (206)	16-5/8 (422)	101-1/2 (2578)	6-7/8 (175)	6-7/8 (175)	120-1/2 (3061)	11 (279)	5 (127)
	S5	L5	15-5/8 (397)	23-1/2 (597)	8-7/8 (225)	18 (457)	103 1/8 (2619)	6-7/8 (175)	6-7/8 (175)	124-1/2 (3162)	9 (229)	5 (127)
107	P5	K5	13-5/8 (346)	21-1/2 (546)	8-1/8 (206)	16-5/8 (422)	103 1/8 (2619)	6-7/8 (175)	6-7/8 (175)	120-1/2 (3061)	11 (279)	5 (127)
*	S5	L5	15-5/8 (397)	23-1/2 (597)	8-7/8 (225)	18 (457)	101-1/8 (2569)	6-7/8 (175)	6-7/8 (175)	124-1/2 (3162)	9 (229)	

* Standard Vessel Set

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VICTAULIC WATER CONNECTION SIZES (INCHES)						
VESSEL	EVAPORATOR			VESSEL	CONDENSER	
CODE	1 PASS	2 PASS	3 PASS	CODE	1 PASS	2 PASS
K5	14"	10"	8"	G5	14"	10"
M5	14"	10"	8"	H5	14"	10"
N5	16"	12"	8"	J5	16"	12"
P5	18"	12"	10"	K5	18"	12"
S5	18"	14"	10"	L5	18"	14"

NOTES:

1. Water piping to be supported to minimize load on unit.
2. All dimensions are in inches and (millimeters).
3. If condenser or evaporator are 1 or 3 pass, see detail 'A' for head length. To calculate the overall length of the unit when using 1 or 3 pass vessels, add 158 (4013) to the length of the longer head on each side.
4. Vent and drain connections provided on evaporator and condenser heads.
5. If a doorway or other properly located opening is used for tube removal, the suggested minimum clearance is 36" (914).
6. Sufficient room must be allowed for evaporator and condenser connections.
7. Suggested clearances around the machine are minimum requirements. It is strongly recommended that at least one of these clearance requirements exceed the minimum to allow for compressor or motor servicing.
8. If unit is equipped with skid option, add an additional 1/2" to all vertical dimensions, that dimension being from the bottom of the pads.
9. When looking at 2 pass evaporator head connections, water outlet is left connection, water inlet is right connection, as supplied by factory. Customer may reverse this arrangement, but leaving water temperature sensor must be relocated to water outlet.
10. Water connections of 1 pass vessels are on center line of vessel. For evaporator, use dimension 'E' and K'. For condenser, use dimension 'F' and M'.
11. Dimensions 'N' and 'R' and 'S' accommodate largest motor frame size offered. Smaller motor frames will reduce these dimensions.
12. Dimension 'N' accommodates oil separator overhang and motor overhang.

TYPICAL SEQUENCE OF OPERATION

The Dunham-Bush Rotary Screw Water Chiller depends mainly on its on-board microcomputer for control. For initial start-up, the following conditions must be met:

- Chilled water pump running
- Chilled water flow switch made
- Customer (optional) control contact closed
- Control and compressor switch on
- Circuit breakers on
- All safety conditions satisfied
- Reset pressed on microcomputer keypad
- Compressor has not started within the last 20 minutes
- Leaving chilled water temperature 2°F(1/2°C) or more above set point
- Oil sump temperature is greater than 70°F(21°C)

The microcomputer starts the oil pump by energizing 4CP. If capacity indicator is below 8% and a minimum of 27 psid (186 kPa) oil pressure is established, seconds later the microcomputer signals 2CR which starts the compressor motor.

When the compressor starts, the microcomputer monitors leaving water temperature, ramp schedule, and load limiting to control load and unload solenoids. The refrigerant level sensor and discharge temperature are used to control the refrigerant modulating motor. When minimum compressor capacity exceeds system load and water temperature falls below set point, the compressor and oil pump are shut down.

The control system is composed of four microcomputer boards, a display board and analog and digital sensors. The display board has a 20-key keypad and a 2 x 40 LCD display. The keypad and display can be used to determine the status of the compressor, oil pump, and refrigeration system. Various set points can also be displayed and altered.

The status of the machine can also be monitored by a computer terminal either locally or remotely by a modem. The terminal must be able to handle RS232 communications.

The microcomputer controls the leaving water temperature within a narrow dead band by pulsing load and/or unload solenoids on the compressor. The load and unload solenoids position the compressor's slide valve to control the capacity. The microcomputer determines a desired level of loading and varies pulse duration depending on the difference between load target and actual load. The load target is varied based on rate of approach to desired temperature (derivative control) preventing significant temperature oscillations. The current limit functions over-ride the temperature control.

On packages with wye-delta starters, a refrigerant bypass is used to start unit. The microcomputer turns the bypass solenoid on when the oil pump starts and turns it off 30 seconds after the compressor starts.

Another feature of the microcomputer is ramp control, which is the ability to vary load time of the package from start. The user can program the computer so that it loads at a pre-determined rate. Two variables are used to define the ramp profile: Ramp Rate and Start Point. Ramp rate defines the length of time the unit takes to load from start point to full load. Start point is the point of full load at which the ramp begins.

When optional hot gas bypass has been supplied, an output from the computer controls the solenoid. The solenoid is turned on if the target percent capacity of the compressor drops below the hot gas bypass set point. If the target percent capacity then climbs above the set point. the solenoid is turned off.

When a maximum desired current is specified by amp limit, the compressor will not load above that point. If the amps rise above the set point, the computer will give an unload signal to the compressor until the current drops below the set point.

If desired, the chilled water temperature can be (optionally) raised by a 0-5 VDC analog signal provided by an external controller. The reset signal must be between 0 VDC and 5 VDC, with 0 VDC being no reset and 5 VDC being maximum reset. The maximum temperature reset (increase) desired must be stored in CWR MAX. For example, to raise the chilled water set point from 44°F (6.7°C) to 50°F(10°C with a 5 VDC input, 6.0(3.3) is stored in CWR MAX.

If (optional) demand limiting is desired, a 0 to 5 VDC signal must be supplied to the Demand Limit terminals shown on the wiring diagram. Supplying 0 volts will have no effect, and 5 volts will have maximum limiting. The demand limit works automatically lowering the HOLD and UNLOAD amp limits for the compressor. This does not change the amp limit set points.

PHYSICAL DATA

WCOX MODELS

Model No.	056 MAR K5G5	066 PAR M5H5	080 PAR N5J5	089 TAR P5K5	107 VAR S5L5
Nominal Tons	560	660	800	890	1070
Compressor Model	2510	2512	2515	2516	2519
Motor RPM	3550	3550	3550	3550	3550
Evaporator	K5	M5	N5	P5	S5
Water Volume Gal (L)	119(451)	145(549)	175(661)	194(733)	234(866)
Min. GPM(L/s) - 1 Pass	852(54)	1022(64)	1234(78)	1366(86)	1646(104)
Min. GPM(L/s) - 2 Pass	426(27)	511(32)	617(39)	683(43)	823(52)
Min. GPM(L/s) - 3 Pass	273(17)	332(21)	408(26)	448(28)	546(34)
Max. GPM(L/s) - 1 Pass	4260(269)	5104(322)	6168(389)	6830(431)	8224(519)
Max. GPM(L/s) - 2 Pass	2130(134)	2552(161)	3084(195)	3415(215)	4112(259)
Max. GPM(L/s) - 3 Pass	1303(82)	1560(98)	1909(120)	2166(137)	2625(166)
Condenser	G5	H5	J5	K5	L5
Water Volume Gal(L)	105(399)	131(496)	156(590)	178(673)	210(794)
Min. GPM(L/s) - 1 Pass	876(55)	1054(66)	1262(80)	1416(89)	1688(106)
Min. GPM(L/s) - 2 Pass	438(28)	527(33)	631(40)	208(45)	844(53)
Max. GPM(L/s) - 1 Pass	4382(276)	5272(333)	6308(398)	7087(446)	8436(532)
Max. GPM(L/s) - 2 Pass	2191(138)	2636(166)	3154(199)	3539(223)	4218(266)
General Data					
Shipping Wt. lb.(kg)	26161/(11877)	30560/(13875)	34016/(15443)	38881/(17652)	44992/(20426)
Operating Wt. lb. (kg)	28134/(12773)	32976/(14971)	36915/(16760)	42147/(19135)	48888/(22195)
R-22 Charge, lb. (kg)	1185/(538)	1405/(638)	1700/(772)	1870/(849)	2240/(1017)

NOTES a) Evaporator and condenser design pressure 200 PSI water side, 260 PSI refrigerant side
b) See page 2 for model number nomenclature

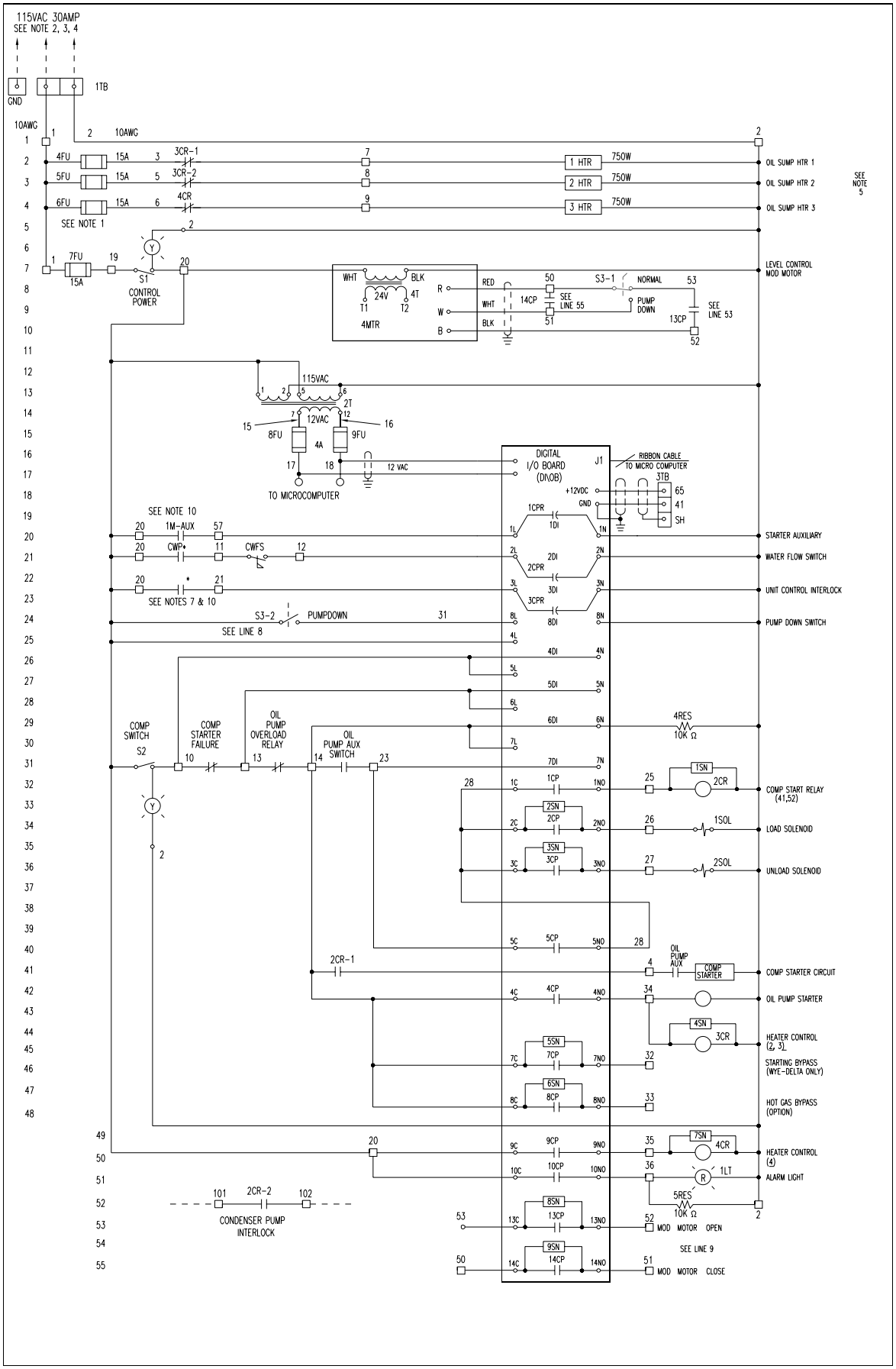
ELECTRICAL DATA

Motor Size		J	K	L	M	N	P	Q	R	S	T	U	V
Max. Motor KW 60 Hz only		304	347	390	432	475	519	565	600	653	686	730	772
Max. Motor KW **50 Hz only**		251	286	322	357	393	429	465	501	536	572	608	644
460V/3/60, 400V/3/50	FLA	448	498	562	602	715	770	835	895	976	1038	1069	1137
Star	LRA	932	936	1142	1303	1305	1490	1832	1835	1807	1810	1817	2012
Delta	LRA	2825	2835	3461	3950	3955	4515	5551	5560	5476	5485	5506	6096
	MCA	565	628	708	758	899	968	1049	1124	1225	1303	1341	1426
	MFS	1000	1000	1200	1200	1600	1600	1600	2000	2000	2000	2000	2500
575V/3/60	FLA	368	404	456	516	572	616	668	716	781	830	855	910
Star	LRA	745	853	946	952	1044	1192	1465	1468	1446	1448	1454	1609
Delta	LRA	2256	2584	2868	2884	3164	3612	4438	4448	4381	4389	4405	4877
	MCA	464	509	574	649	719	774	835	889	980	1041	1073	1141
	MFS	800	800	1000	1000	1200	1200	1200	1600	1600	1600	1600	2000
2300V/3/60	FLA	92	101	114	129	143	154	167	179	193	208	219	235
	LRA	564	646	717	721	791	903	1111	1112	1010	1096	1284	1392
CKT1	MCA	115	126	143	161	179	193	209	224	241	260	274	294
(See note d)	MFS	200	225	250	250	300	300	350	400	400	450	450	500
CKT2	MCA	13	13	13	13	13	13	13	13	13	13	13	13
460V	MFS	15	15	15	15	15	15	15	15	15	15	15	15
4160V/3/60	FLA	52	58	65	75	82	90	96	103	108	122	128	130
	LRA	318	370	409	452	460	585	638	636	637	687	806	808
CKT1	MCA	65	73	81	94	103	113	120	129	135	153	160	163
(See note d)	MFS	110	125	125	150	175	200	200	225	225	250	250	250
CKT2	MCA	13	13	13	13	13	13	13	13	13	13	13	13
460V	MFS	15	15	15	15	15	15	15	15	15	15	15	15

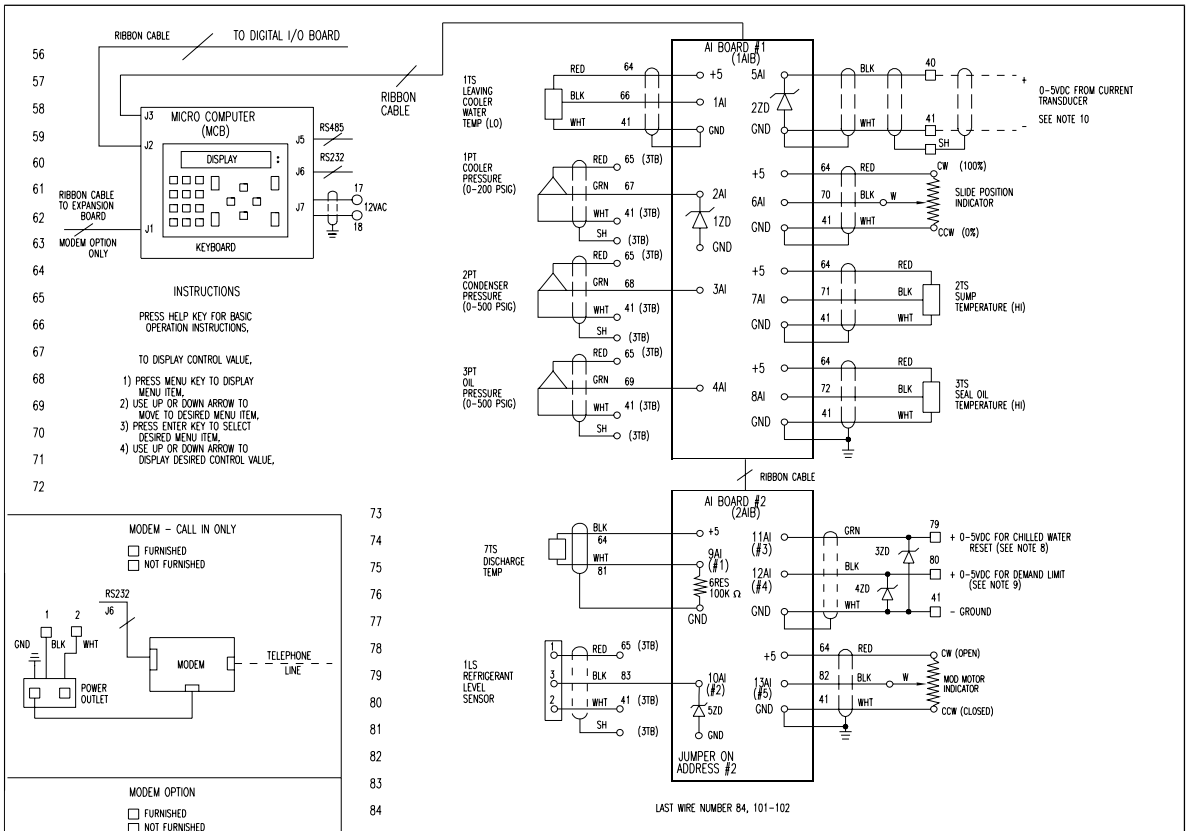
NOTES: a. Max. motor kW is the maximum power a motor will provide without operation in the safety margin.
b. Motors are not allowed to be selected for duties greater than “Max. Motor kW”.
c. 575V, 460V, 400V units will be provided with control power transformers in the starters for single power connection.
d. 4160V & 2300V units will require a separate 460/3/60 service for oil pump and control transformer.

LEGEND:FLA - Full Load Amps
Star LRA - Locked Rotor Amps for “Star” windings (in rush - Star Delta)
Delta LRA - Locked Rotor Amps for “Delta” windings (in rush - across the line)
MCA - Minimum Circuit Ampacity (unit)
MFS - Maximum Fuse Size (unit)

TYPICAL WIRING DIAGRAM



TYPICAL WIRING DIAGRAM

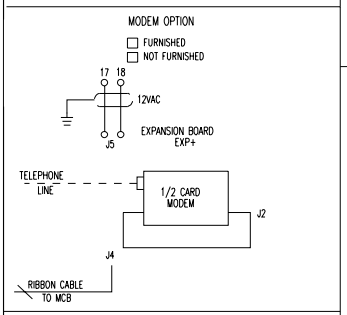


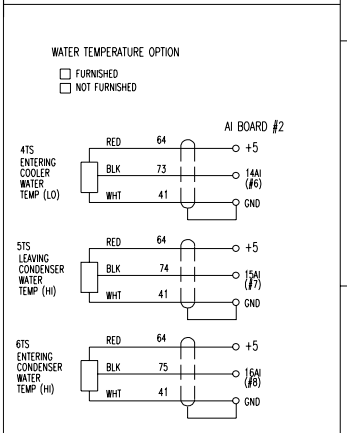
INSTRUCTIONS

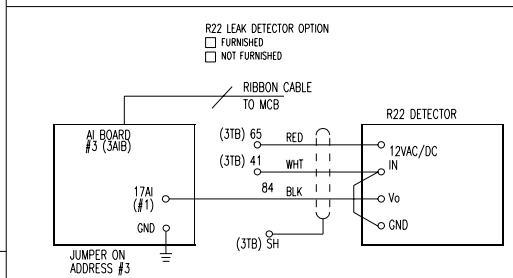
PRESS HELP KEY FOR BASIC OPERATION INSTRUCTIONS.

TO DISPLAY CONTROL VALUE,

1) PRESS MENU KEY TO DISPLAY MENU ITEM.
2) USE UP OR DOWN ARROW TO MOVE TO DESIRED MENU ITEM.
3) PRESS ENTER KEY TO SELECT DESIRED MENU ITEM.
4) USE UP OR DOWN ARROW TO DISPLAY DESIRED CONTROL VALUE.







SET POINTS

	NAME	A	B
1	TLW TEMP.	TLW ° F	
2	RAMP UP	0.1	20.0%
3	AMP LIMIT	(UNLOAD)	(HOLD)
4	PWR LOSS		0.0
5	HI/LO PRESSURE	234 PSIG	58 PSIG
6	FREEZE		35.0 ° F
7	H.G. BYPASS	25.0%	10.0%
8	OIL PRESSURE	26.0 PSID	25.0 PSID
9			
10	CWR MAX. 0-5VDC		0.0
11	DEMAND LIMIT		0.0
15	LEAK DETECT	2000 PPM	1900 PPM
	ANTIRECYCLE	20 MIN.	

LEGEND

AI	ANALOG INPUT
CAL	CALIFORNIA
COMP	COMPRESSOR
CP	CONTROL POINT
CPR	CAPACITOR
CR	CONTROL RELAY
CW	CLOCKWISE (POINTER END)
CWFS	CHILLED WATER FLOW SWITCH
CWP	CHILLED WATER PUMP
CWR	CHILLED WATER RESET
DI	DIGITAL INPUT
ETM	ELAPSED TIME METER
FS	FLOAT SWITCH
FU	FUSE
GND	GROUND
HTR	HEATER
I/O	INPUT/OUTPUT
LS	LEVEL SENSOR
LT	LIGHT
M	CONTACTOR
MTR	MOTOR
NC	NORMALLY CLOSED
NO	NORMALLY OPEN
OL	OVERLOAD
PPM	PARTS PER MILLION
PT	PRESSURE TRANSDUCER
RES	RESISTOR
S	SWITCH
SC	STARTS COUNTER
SH	SHIELD
SN	SNUBBER
SOL	SOLENOID
TAS	THERMOSTAT
TB	TERMINAL BLOCK
TLW	TEMP. LEAVING WATER
TR	TIMER
TS	TEMP. SENSOR
TSF	TRANSFORMER
ZD	ZENER DIODE (5.1VDC)
▲	MANUAL RESET
□	FACTORY TERMINAL
— — —	FIELD WIRING
•	FIELD SUPPLIED

CAL CODE OPTION

DOOR LATCH SOLENOID

8SOL

FURNISHED
NOT FURNISHED

SI. SOFTWARE OPTION
FURNISHED
NOT FURNISHED

SETPOINTS

	NAME	A	B
1	TLW TEMP	TLW C	
2	RAMP UP	0.1	20.0%
3	AMP LIMIT	(UNLOAD)	(HOLD)
4	POWER LOSS		0.0
5	HI/LO PRESSURE	16.00 BARS	4.00 BARS
6	FREEZE		1.7 C
7	H.G. BYPASS	25.0%	10.0%
8	OIL PRESSURE	1.90 BARS	1.80 BARS
9			
10	CWR MAX. 0-5VDC		0.0
11	DEMAND LIMIT		0.0
15	LEAK DETECT	2000 PPM	1900 PPM
	ANTIRECYCLE	20 MIN.	

HOT GAS BYPASS OPTION

7SOL

FURNISHED
NOT FURNISHED

STARTING BYPASS (WYE-DELTA ONLY)

5SOL

FURNISHED
NOT FURNISHED

NOTES

1- FUSES SHALL BE TIME DELAY TYPE.
2- ALL FIELD WIRING SHALL COMPLY WITH LOCAL, STATE AND NATIONAL CODES.
3- WHEN CONTROL TSF IS NOT SUPPLIED, A DIRECT CONNECTED 115VAC CONTROL CIRCUIT WITH OVERCURRENT PROTECTION AT 30A OR LESS (FIELD SUPPLIED) IS REQUIRED, USE #10 AWG COPPER CONDUCTORS, WIRE TO 1TB, USE TERMINAL #2 FOR CONNECTION OF THE GROUND SUPPLY CONDUCTOR.
4- DISCONNECT MEANS AND BRANCH CIRCUIT PROTECTION SHALL BE PROVIDED BY INSTALLER
5- IF POWER SUPPLY HAS BEEN INTERRUPTED FOR A PROLONGED PERIOD, OIL SUMP HEATERS MUST BE ENERGIZED FOR 24 HOURS MINIMUM BEFORE STARTING COMPRESSORS.
6- USE COPPER CONDUCTORS ONLY. CONTROL WIRING 14AWG.
7- CUSTOMER CONTROL CONTACTS MUST BE WIRED BETWEEN 20 & 21. THE CONTACTS MUST CLOSE TO START THE UNIT.
8- IF 0-5VDC CWR IS USED, SET SETPOINT 10B TO RESET DESIRED AT 5VDC INPUT.
CAUTION: DO NOT SUPPLY OVER 5.0VDC TO 11AI.
9- IF 0-5VDC DEMAND LIMIT IS USED, SET SETPOINT 11B BETWEEN 0.0 AND 10.0. MAX DEMAND LIMIT OCCURS WITH A 10.0 SETTING
CAUTION: DO NOT SUPPLY OVER 5.0VDC TO 12AI.
10- ALL FIELD CONTROL WIRING SHOULD UTILIZE SHIELDED WIRE. GROUND SHIELD TO SUBPANEL OR SH TERMINAL (IF SHOWN) ONLY. DO NOT ROUTE WITH HIGH VOLTAGE WIRES.

Head Pressure Control

Normal head pressure control is by cycling tower fan(s) as long as this can provide condenser entering water no lower than 60°F(15°C) with no more than a 2°F(1/2°C) change per minute. If this cannot be guaranteed, then other controls such as tower dampers, tower sump heater, 3-way tower bypass valve, 2-way tower throttling valve or variable speed condenser pumping must be utilized. With an optional analog output board, the microcomputer can control the bypass or throttling valve directly from condenser pressure by sending a 0 to 10 VDC signal to a direct current valve motor actuator.

The Dunham-Bush microcomputer can provide a digital signal to enable any of these devices so that the tower and its requested accessories can be controlled by the chiller.

Dunham-Bush Water-Cooled 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/32 C and the condenser/tower loop as low as 60 F/16 C. With the EPCAS feature, the valve feeding the evaporator will be throttled to create a pressure differential to help load the compressor.

Splittable Units

Where existing equipment room makes it difficult to go a new unit into the building, special fittings can be provided. This will allow the unit(s) to be separated into (2) pieces at the job site to facilitate installation. Refrigerant charge can be removed after factory test or isolated in one of the vessels.

Chilled Water Flow

The Dunham-Bush WCOX Packaged Water Chiller is designed for a constant chilled water flow rate even when the cooling load is varying. The machine will generally perform satisfactorily with steady flow rates deviating from design by as much as +10%/-50%. However, varying water flow rates can cause control instability which will result in undesirable system effects, particularly poor control of leaving chilled water temperature. If two-way valves are used to control flow through cooling coils, some means such as an automatic modulating valve should be provided in the system to maintain steady flow through the cooler.

If the chilled water system is arranged for the dual purpose of coding and heating, the cooler must incorporate valves to prevent the flow of hot water through it. This can be done with either manual or automatic shutoff valves, but the method of control must be such that water temperature entering the cooler never exceeds 90 F/32 C.

Ice Storage

With a positive displacement rotary screw compressor, the Dunham-Bush water chiller can easily cool low temp-reature glycol down to 22 F/-6 C with entering condenser water of 85 F(29 C). The same chiller can also produce warmer (40 F/4 C to 45°F/7°C) leaving glycol for those building systems designed for only peak shaving. This can be accomplished by an external signal to the unit micro-computer. No matter what your ice storage needs, the Dunham-Bush Rotary Screw Water-Cooled Chiller can handle it better than any other chiller.

When used with Dunham-Bush Ice-Cels, the microcomputer can be programmed to provide dual mode leaving chilled liquid set points for both air conditioning arid ice freezing duty, plus start and stop of chilled liquid and condenser pumps.

In addition, the following thermal storage controls can be provided.

a. Freeze only
b. Freeze plus cooling
c. Cooling with ice only
d. Cooling with chiller plus ice
e. Cooling with chiller only
f. Off

Plus they can provide daily scheduling of above modes in as many different daily schedules as desired. These schedules can be assigned to days of the week and holidays.

Multiple Unit Control

One of the most perplexing problems to system designers is control of multiple chillers on the same water loop. The first decision is whether to put the chillers in parallel or series on the chilled water side. If lower pumping cost is paramount, then putting chillers in series is often preferable. If primary/secondary pumping is utilized with normal 10 F/6 C range, then putting chillers in parallel is normally used. In either case, the Dunham-Bush microcomputer can control up to three chillers. This eliminates the need for external control interface which often becomes difficult. If more than three chillers need to be controlled, a Utility Manager can be supplied for controlling/monitoring up to ten units.

Condensing Water Treatment

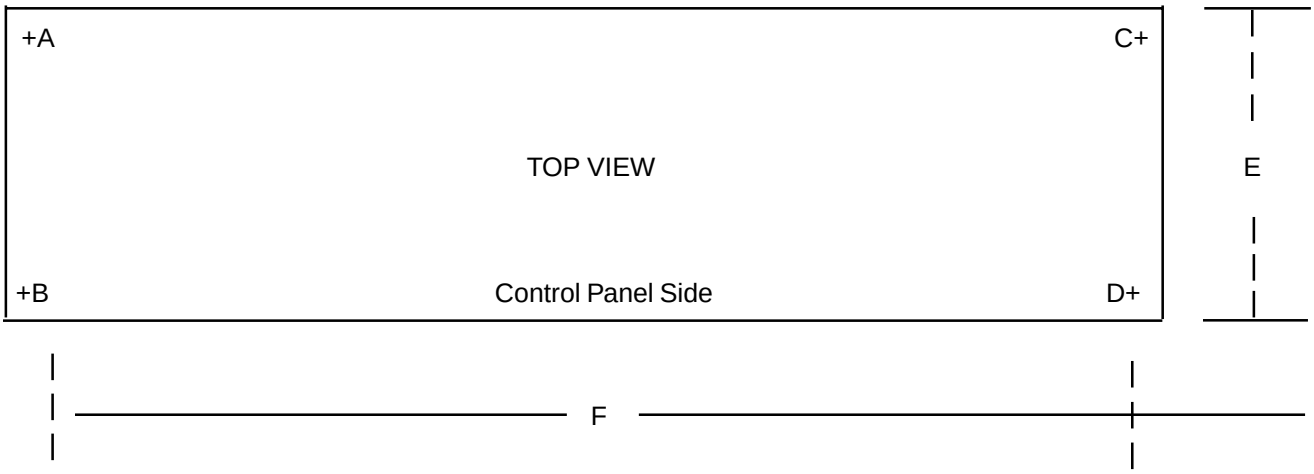
Condensing water tends to leave silt, algae and mineral deposits in the condenser tubes. This fouling gradually decreases unit efficiency. For this reason, a program of water treatment should be employed. Also, at regular intervals depending an water quality, the unit should be shut down, condenser heads removed and tubes cleaned.

Foundation

A flat, level concrete foundation or floor capable of supporting the weight of the unit must be provided. The unit must be levelled to within 1/16 per foot/1.6mm per 30.5cm for proper operation.

Vibration Isolation

Where structure-borne vibration may be of concern, it is recommended that the unit be mounted on vibration isolators. Spring isolators are available for this unit as optional equipment. If spring isolators are installed, it is also necessary to provide isolation in condenser water and chilled water pipes by means of flexible connectors and in main power supply conduit through use of flexible conduit. Isolation of piping and electrical conduit is desirable in any event to avoid noise transmission.



POINT LOADING, lbs. - in.

WCOX	A	B	C	D	E	F
056	5982	7340	6651	8161	67 7/16	166 3/4
066	7122	8370	8038	9446	69 13/16	166 3/4
080	8177	9462	8936	10340	73 1/4	166 3/4
089	9250	10550	10440	11907	75 3/16	166 3/4
107	10733	12041	12307	13807	79 3/8	166 3/4

POINT LOADING, kg - cm

WCOX	A	B	C	D	E	F
056	2716	3332	3020	3705	171	424
066	3234	3800	3649	4288	177	424
080	3713	4296	4057	4694	186	424
089	4200	4790	4740	5405	191	424
107	4873	5467	5587	6268	202	424

STANDARD EQUIPMENT AND FACTORY INSTALLED OPTIONS

Dunham-Bush Rotary Screw Water-Cooled Chillers, like many other Dunham-Bush products, distinguish themselves by offering as standard many features that other manufacturers provide only as costly options.

Some of the **Standard Features** of these chillers which provide for efficiency and reliability are:

- Industrial grade Dunham-Bush rotary screw com pressor with double acting slide valve for infinite capacity control
- Suction and discharge check valves for ease of maintenance
- Open Drip Proof Squirrel Cage motor, factory mounted and aligned.
- Microcomputer monitoring of cooler leaving water temperature to ± 1/2 to 3/4°F/C via proportional derivative control
- Proactive microcomputer monitoring of evaporator and condenser pressures to unload compressor if operation is approaching operating limits
- Microcomputer monitoring of oil pressure, discharge temperature and evaporator refrigerant level to optimize unit performance
- One, two, or three pass evaporator and one or two pass condenser for flexibility in design
- Units shipped completely factory tested, charged and adjusted for ease of installation and minimal field start-up adjustments
- Chilled water reset from control panel or external building automation system
- High oil temp, high motor temp, low oil level, freeze, low suction pressure, high discharge pressure, and solid state overload protection are all featured

Dunham-Bush offers **Factory Installed Options** for "custom solutions" to meet owner and operator requirements:

- Insulation of all low temperature surfaces
- Double insulation for ice bank application
- Hot gas bypass for very low load situations
- Microprocessor monitoring of return chilled water and entering and leaving condenser water in addition to the standard leaving chilled water temperature by the addition of factory mounted and wired temperature sensors
- Phone modem communication to simple terminal or personal computer with communication software to enable the remote monitoring of all functions and inputs to the microprocessor
- Marine Water Boxes (on condensers only) with individual bolted-on cover plates permitting access for tube cleaning without "breaking" water piping connections
- Flanged Water Connections can be supplied on both evaporator and condenser water in lieu of standard Victaulic connections
- Unit can be supplied with additional fittings to allow it to be split into two sections in field for special site conditions
- Computer graphics display with on-screen view of the equipment and a real time display of temperatures, pressures and device status
- Control of up to three packages requiring only two shielded cables between units. Up to ten packages can be controlled via a utilities manager
- Special panel interlocks and controls can be provided to meet local code or customer requirements
- Skidding to allow movement of the unit with a forklift

General

The contractor shall in accordance with the plans, furnish and install _____ Dunham-Bush packaged liquid chiller(s), model number WCOX _____. The unit(s) shall be completely factory packaged including open drive rotary screw compressor, factory mounted open drip-proof motor, evaporator, condenser complete with internal oil separator, positive displacement open-drive oil pump, and microcomputer control center. The packaged chiller shall be factory assembled, charged and tested with a full operating refrigerant and oil charge. The refrigerant type shall be R-22.

Capacity

Capacity of each shall not be less than refrigeration tons cooling __ GPM of water from __ F to __ F. Power input equirements for the unit(s), incorporating all appurtenances necessary for unit operation, including but not limited to the control accessories and oil pump or pumps, if required, shall not exceed ___ kW input at design conditions. The unit(s) shall have an ARI Integrated Part-Load Value (IPLV) [NOTE: "Application Part-Load Value (APLV)" if other than ARI Standard Conditions] that does not exceed __ when calculated at the above conditions per ARI Standard 550/590-98. The unit shall be able to unload to ____% of cooling (refrigeration) capacity when operating with the leaving chilled water and entering condenser water temperatures mentioned above. The unit shall be capable of continuous operation at this point, with stable compressor operation, without the use of hot gas bypass. Performance shall be certified in accordance with ARI Standard 550/590-98. Only chillers that are listed in the ARI Certification Program for Centrifugal and Rotary Screw Water Chillers are acceptable. Heat transfer surfaces shall be selected to reflect the incorporation of a fouling factor of .0001 and a maximum water pressure drop of feet through the evaporator. The condenser shall be selected with a fouling factor of .00025 and a maximum water pressure drop of __feet.

Compressor

The compressor shall be a single-stage open drive, positive displacement rotary screw compressor of the oil injected type, operating at no more than 3550 RPM at 60 HZ (2960 RPM at 50 HZ). The compres-sor motor shall be of the open drip-proof, squirrel cage induction type, factory mounted for rigid alignment of the compressor and motor shafts. Compres-sor rotors shall be of the asymmetrical profiles and be precision machined from AISI 1141 bar stock and dynamically balanced. The shaft seal shall be of the oil flooded, mechanical, process type. Compressor capacity control shall be obtained by an electrically initiated, hydraulically actuated slide valve within the compressor housing.

Oil System

The compressor shall be provided with a complete pressure fed lubrication system including a positive displacement gear type open-drive oil pump independently driven. Positive lubrication shall be provided prior to compressor start-up. A replaceable core oil filter shall be provided to filter 100% of the oil supplied to the compressor. System pressure differential oil systems will not be acceptable unless the packaged chiller's refrigerant management system is equipped with the ability to modulate refrigerant flow into the evaporator, allowing the microcomputer to insure the proper minimum oil pressure for safe operation. Shaft seal oil shall be cooled by a refrigerant cooled oil cooler to provide extended shaft seal life, a water-cooled oil cooler may only be utilized if it is of the cleanable type.

Evaporator

The evaporator shall be of the cleanable "shell and tube" flooded type with integral finned copper tubes mechanically expanded into heavy fixed steel tube sheets. Tubes shall be high efficiency, internally enhanced type. It is to be available in one, two or three-pass design as indicated on the drawings with victaulic water connections. Flanges or stub-out water connections will not be acceptable. The shell side of the evaporator is to be equipped with a single pressure relief device and shall be designed, constructed and stamped in accordance with the ASME code for Unfired Pressure Vessels. The evaporator shall also 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 heads are to be removable for tube cleaning. Vent and drain plugs are to be provided in each head. The evaporator shall be fitted with an oil recovery system. The oil recovery system will insure that the evaporator is operating at peak efficiency at all times. Units without oil recovery systems mounted externally on the evaporator will not be acceptable.

Condenser

The condenser shall be of the cleanable “shell and tube” type with integral finned copper tubes mechanically expanded into heavy fixed steel tube sheets. Tubes shall be a high efficiency, internally enhanced type. They are to be available in one, or two pass design as indicated on the drawings with Victaulic water connections. Flanges or stub-out water connections will not be acceptable. The shell side of the condenser is to be equipped with dual pressure relief devices and shall be designed, con-structed, and stamped in accordance with the ASME Code for Unfired Pressure Vessels. The condenser shall be sized for full pumpdown capacity. Water heads are to be removable for tube cleaning. Vent and drain plugs are to be provided in each head.

Oil Separator

An oil separator shall be provided between the compressor and condenser. The oil separator shall have no moving parts and shall achieve separation of refrigerant and oil through gravity drop-out. Fine mesh eliminators will be provided for final separation. Multiple thermostatically controlled immersion heaters shall be provided in the oil reservoir to insure the separation of refrigerant and oil and shall be automatically energized upon shutdown of the compressor.

Refrigerant Control System

The packaged chiller shall be furnished with a finite refrigerant control system to optimize efficiency and compressor protection. This refrigerant control system will prevent the flow of efficiency robbing refrigerant vapor in the condenser from entering the evaporator at reduced load by directly modulating a motorized refrigerant valve in the liquid line entering the evaporator. In addition, the refrigerant control system shall measure the level of liquid refrigerant in the flooded evaporator and restrict refrigerant flow entering the evaporator upon a rise in the level, protecting the compressor from slugging liquid refrigerant. Fixed orifice ice control systems will not be acceptable.

Microcomputer Control

The packaged chiller shall be equipped with micro-computer control. The control shall provide for compressor loading based on leaving chilled water temperature. It shall provide for high and low refrigerant pressure protection, low oil pressure protection, evaporator water freeze protection, high reservoir oil temperature or seal oil temperature protection, incomplete start protection sensor error protection, and motor load control (demand limiter) based on amp draw. Anti-recycle protection shall also be provided. The computer shall have a simple keyboard accessed input system and be complete with a two line 80 character alphanumeric display. Input shall be accomplished through simple menu driven display screens, with on-line help available by pressing a help button at anytime during operation. The microcomputer shall continuously monitor evaporator leaving water temperature; evaporator, condenser and oil pressure; compressor amp draw; compressor slide valve position; oil reservoir temperature; seal oil temperature. The computer shall be complete with all hardware and software necessary to enable remote monitoring of all data through the addition of only a simple, optional, phone modem and terminal. The microcomputer shall be complete with an RS232 “local” communications port and an RS485 long distance differential communications port. The microcomputer shall also accept a remote start and stop signal, 0 to 5VDC chilled water temperature reset signal and 0 to 5VDC compressor current limit reset signal.

Electrical Control Panel

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

MANUAL CONTROLS
- Control circuit stop and start switches
- Compressor enable switch

SAFETY CONTROLS
- Low oil pressure
- High oil reservoir temperature
- High seal oil temperature
- High condenser pressure
- Low evaporator pressure
- Freeze protection
- Chilled water flow loss

AUTOMATIC CONTROLS
- Compressor starter transition timer
- Anti-recycle timer
- Oil reservoir heater interlock

REFRIGERANT CONTROLS
- Finite refrigerant motorized refrigerant valve
- Liquid refrigerant level sensor for evaporator
- Compressor load and unload solenoid valves

INDICATOR LIGHTS
- Power on
- Compressor enabled
- Alarm

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