ACDX

Air-Cooled Chillers

with Rotary Screw Compressors
270 to 420 Tons

FEATURES

- New high-efficiency compressors
- Minimum of two refrigerant circuits
- Uses HCFC-22 and compatible with new HFC refrigerants
- Advanced proactive microcomputer
- UL/CSA, ASME/CRN approved components

DUNHAM-BUSH®

Form No. 6095B

Special Features and Owner Benefits

Compressor Features

- Thirty five years of rotary screw experience and dedicated technological advancements.
- Simply designed for high reliability with only two rotating parts. No gears to fail.
- Two year warranty on entire compressor at no extra cost.
- Insured continuous oil flow to each compressor through integral high efficiency oil separation for each compressor.
- Chillers use multiple rotary screw compressors on separate refrigerant circuits for maximum reliability/redundancy.

Energy Savings

- 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 utilization of economizer cycle and microcomputer-controlled staging producing greater capacity with fewer compressors.
- Maximized performance through computer-matched components and multiple compressors on separate refrigerant circuits.
- High efficiency oil recovery system guarantees removal of oil carried over in the refrigerant and maintains the heat exchangers at their maximum efficiency at both full and part load.

Installation Ease

- Units are air cooled and therefore require no tower make up water or water treatment.
- Units have optional single point power connection and multiple disconnects to reduce installation costs.
- Dramatic payback in reduced maintenance and overhaul costs both in down time and in labor expenditures.
- Ease of troubleshooting through microprocessor retention of monitored functions.
- Factory run tested.

Safety Code Compliance:

- ASME Boiler and Pressure Vessel Code, Section VIII Division 1 “Unfired Pressure Vessels”
- ASME Standard B31.5 Refrigeration Piping
- ASHRAE Standard 15 Safety Code for Mechanical Refrigeration
- National Electric Code
- Underwriters Laboratories Standard UL508 Industrial Control Panels
- ARI Standard 550/590-98 Water Chilling Packages using the vapor compression cycle
- ETL Listed

Refrigerant Flexibility

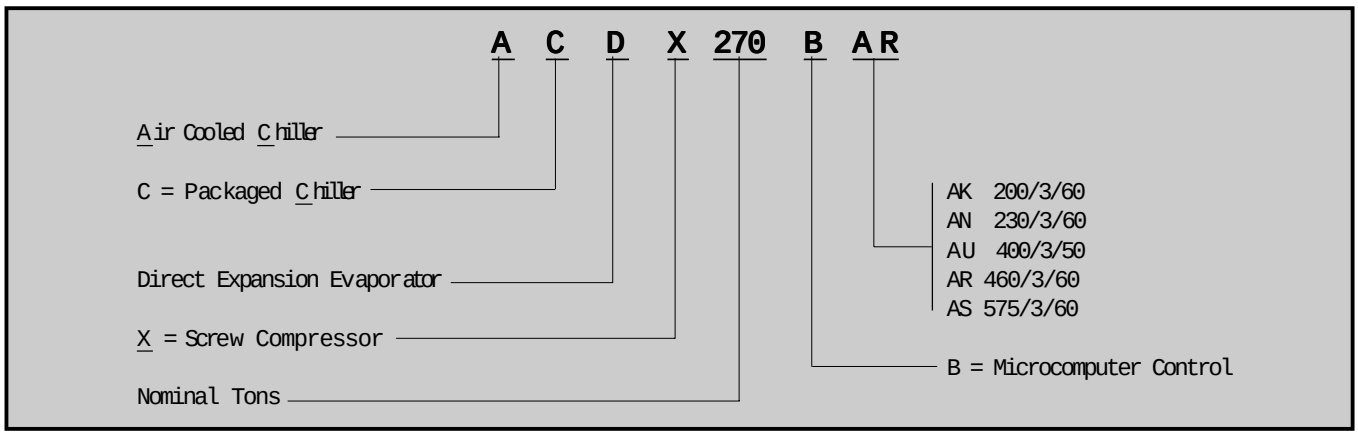
- Designed to operate with environmentally safe and economically smart HCFC-22 with proven efficiency and reliability.
- Consult factory for use of other refrigerants.

Control Capabilities

- 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 start-up and throughout the life of your equipment.
- Insured even compressor loading and optimal energy efficiency through microcomputer 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.
- 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(s) if head or suction pressure approach limits. This will enable unit to stay on the line while warning operator of potential problems.

TABLE OF CONTENTS

NOMENCLATURE



STANDARD FEATURES

Size Range

- Rated in accordance with ARI Standard 550/590-98
- 7 Models from 270 to 420 Tons
- Compact, Standard, Extended, and Extra Quiet Versions Available
- Rated with HCFC-22 and Compatible with HFC-407C
- Painted external panels meet or exceed 500 hour salt spray per ASTM 117

Compressor

- Reliable Hermetic Rotary Screw Type at 3550 RPM
- Independent Refrigerant Circuits
- Infinitely Variable Slide Valve Unloading for Precise Load Matching
- Compressor Cycling for Maximum Efficiency

Cooler

- ASME/CRN Stamped for Safety
- Dunham-Bush High Efficiency Inner-Fin® Design for Compactness and Weight Reduction
- 300 PSIG on EX Series Refrigerant Side Design Pressure
- 200 PSIG on Water Side Design Pressure

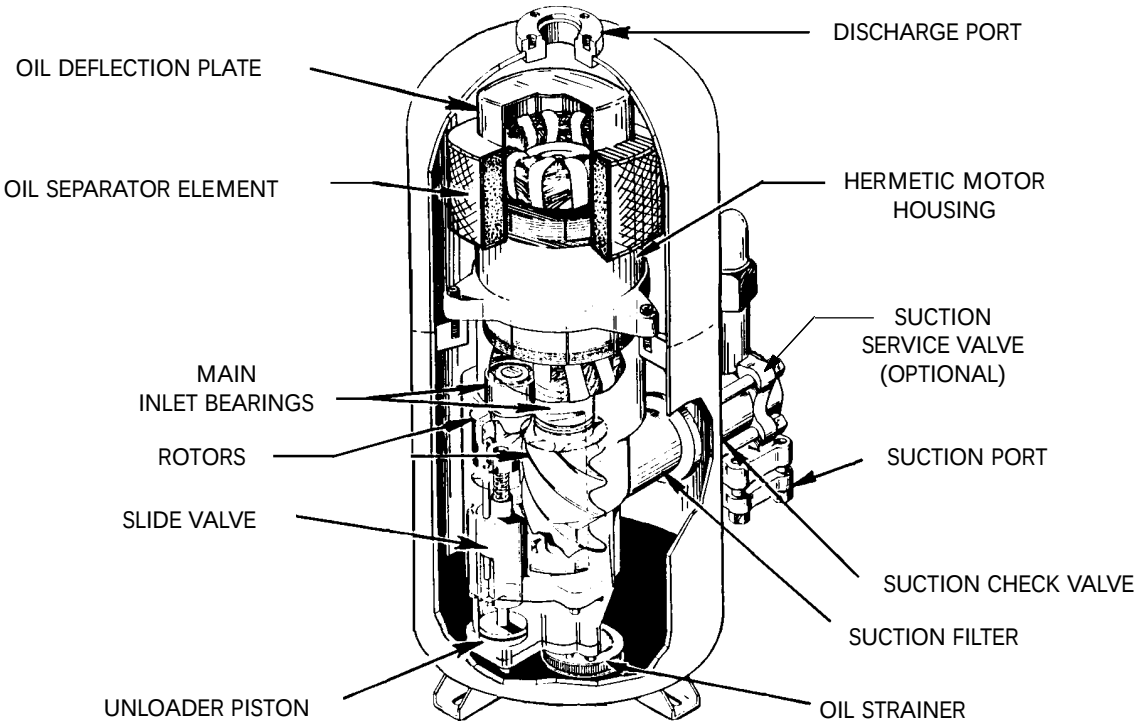
Condenser

- Long Life Copper Tubes with Aluminum Fins
- Sub-Cooling Circuit for Efficiency
- 450 PSIG Test Pressure
- Low Noise 30" Diameter Fans - Direct Drive at 1140 RPM (Optional 855 RPM Quiet Fans)
- All Fan Motors Open Drip Proof with Rain Shield for Safety and Low Maintenance

Electrical/Control

- Advanced Microcomputer for Precise Control
- Chilled Water Pump Control
- Low Ambient Lock-Out
- Separated Power and Control Panels
- ETL Unit Approval (IEC Control Panel Available)
- Certified to CAN/CSA C22.2 No. 236
- MEA Unit Approval

UNIT FEATURES: ROTARY SCREW COMPRESSOR



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

- The compressor consists of two intermeshing helical grooved rotors, a female drive rotor and a male driven rotor, in a stationary housing with suction and discharge gas ports.
- Uniform gas flow, even torque and positive displacement, all provided by pure rotary motion contributes to vibration-free operation over a wide range of operating conditions. Intake and discharge cycles overlap, effectively producing a smooth, continuous flow of gas.
- No oil pump is required for lubrication or sealing purposes. Oil is distributed throughout the compressor by the pressure differential between the suction and the discharge cavities.

Simplified Capacity Control
The slide valve mechanism for capacity modulation and part-load operation is an outstanding feature.

- The moving parts are simple, rugged and trouble-free. The slide mechanism is hydraulically actuated.
- Package capacity reduction can be down to as low as 10% without HGBP by progressive movement of slide valves away from their stops.
- Capacity reduction is programmed by an exclusive electronically initiated, hydraulically actuated control arrangement.

Positive Displacement Direct Connected
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.

Oil Separation
Each compressor is provided with an integral oil separator located adjacent to the discharge gas port.

- The separator is a multi-layered mesh element which effectively separates oil from the gas stream.
- The oil drains into the sump and the discharge gas passes through the oil separator. An oil drain valve is located near the bottom of the oil sump.

Main Bearings
Each rotor is fitted with a set of anti-friction tapered roller bearings. They carry both radial and thrust loads.

Rotors
The latest asymmetrical rotor profiles designed exclusively by Dunham-Bush assure operation at highest efficiencies. Rotors are precision machined from AISI bar stock and case hardened.

Castings
All housings are manufactured of high grade, low porosity, cast iron.

Solid State Motor Protection
The motor winding protection module used in conjunction with sensors embedded in the compressor motor windings is designed to prevent the motor from operating at unsafe operating temperatures. The overloads for the motor are also solid state.

Warranty
The compressor(s) is covered by an industry-leading **two-year** warranty as standard.

FIG A

FIG B

FIG C

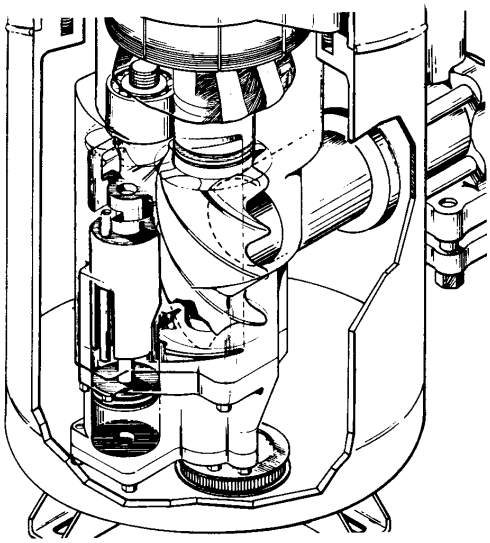
FIG D

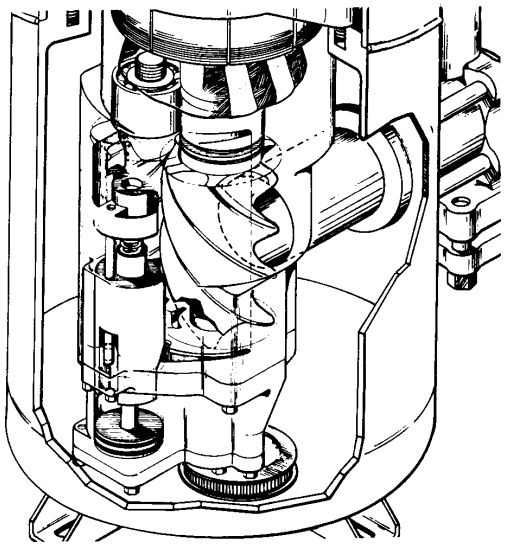
Compressor Operation
Note: For clarity reasons, the following account of the compressor operation will be limited to one lobe on the male rotor and one interlobe space of the female rotor. In actual operation, as the rotors revolve, all of the male lobes and female interlobe spaces interact similarly 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. Just prior to 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 covered 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.





Slide Valve Control
Movement of the slide 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. Unloading starts when the slide valve is moved back away form the valve stop. Movement of the valve creates an opening in the side 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 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. Enlarging the opening in the rotor housing effectively reduces compressor displacement.

Unit Features: Coolers

Water Coolers

The water coolers employ the most advanced vessel technology available today, including the patented Inner-Fin construction of the EX coolers. Vessels are designed and constructed to meet the requirements of the ASME Code, Section VIII, Division 1 for unfired pressure vessels and are stamped accordingly.

The EX coolers incorporate 5/8 inch (15.9 mm) rolled copper tubes and removable heads for ease of tube maintenance.

Vent and drain connections are included on all vessels.

See Table 7A below for appropriate pressure ratings, physical specifications for connection sizes, and pages 18 and 19 for pressure drop data.

Typical for 2 Circuit Coolers

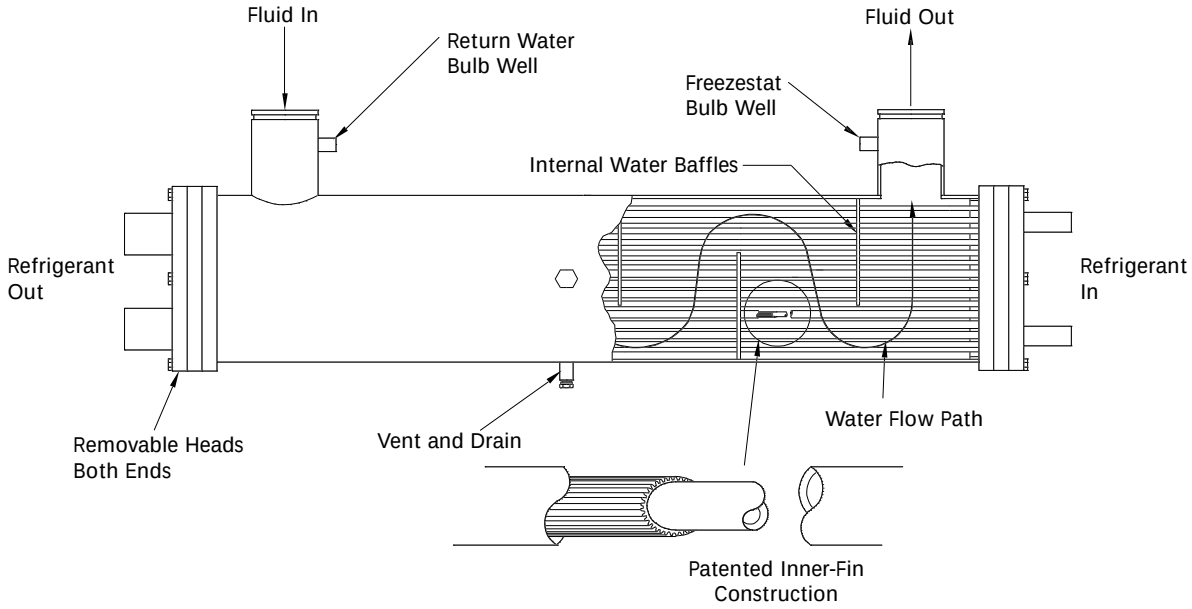


Table 7A

Shell & Tube Heat Exchanger	Water Side		Refrigerant Side	
	Design Pressure (PSIG) (kPa)	Test Pressure (PSIG) (kPa)	Design Pressure (PSIG) (kPa)	Test Pressure (PSIG) (kPa)
Water Cooler EX	200 (1379)	300 (2068)	300 (2068)	333 (2296)

Unit Features: Air-Cooled Condensers

All units have direct drive propeller fans and motors. Close blade tip clearance with the fan venturis assure smooth, quiet operation. Low noise 30" diameter fans—direct drive at 1140 RPM.

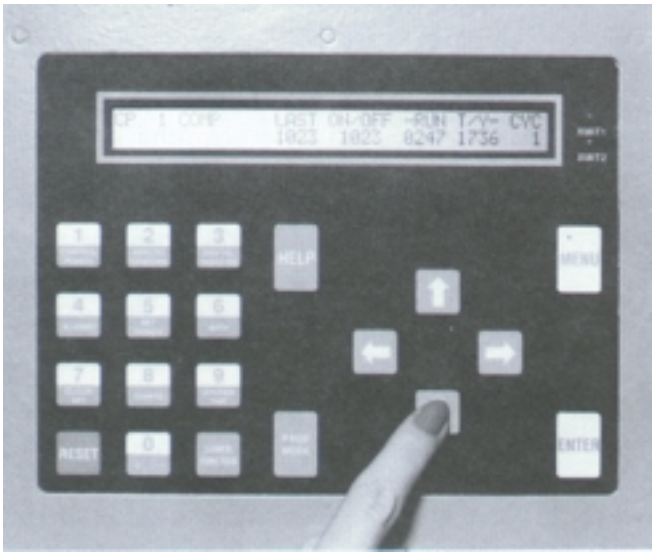
All air-cooled condensers are formed of 3/8 inch (9.53 mm) diameter copper tubes mechanically expanded into aluminum fins for maximum efficiency of heat transfer between the circulating refrigerant and air. The fins have full-spacing collars which completely cover each tube. The staggered tube design improves the thermal efficiency of the coil and eliminates bypassing of air around the tubes. The return bends, headers and nipples are all copper, sized for minimum pressure drop, brazed with inert gas in the tubes and tested after fabrication to 450 psig (3103kPa).

A separate subcooling circuit is standard on all units to maximize energy efficiency.

Partitions separate each fan section to eliminate possible back spin. Fan cycling control is supplied as standard. This lowers the minimum ambient temperature at which the package equipment will effectively start and operate. For lower ambient requirements than standard, variable speed options are available.

All unit cabinetry is heavy-gauge galvanized steel construction with aluminum tube sheets. Control panels, condenser fan discharge panels, and unit end panels are finished with baked enamel paint.

UNIT FEATURES: MICROCOMPUTER CONTROL



Advanced Microcomputer Control is a standard feature on all Dunham-Bush Rotary Screw Air Cooled 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 multi-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
- Cooler pressure of each refrigerant circuit
- Condenser pressure of each refrigerant circuit
- Amp draw of each compressor motor
- Elapsed run time of each compressor
- Percent of full load capacity of each compressor
- Fan on/off status
- Ambient temperature
- Number of compressor starts
- Compressor status
- Remote chilled water reset value
- Demand current limit reset value
- Water flow switch status
- External start/stop command status
- Alarm status and history
- System time, day and date for unit scheduling

Optional entering chilled water temperature sensor is available. With this option the operator can quickly and accurately read the significant 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 inter-connecting wiring.

System Protection

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

- Low suction pressure
- High discharge pressure
- High oil temperature

- High motor temperature/overcurrent
- Freeze protection
- Compressor run error
- Low oil level
- Power loss
- Chilled water flow loss
- Sensor error
- Anti-recycle time delay

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 enabling downtime and nuisance trip-outs to be minimized.

Proactive Control

The advanced microcomputer will minimize nuisance shutdowns by automatically unloading the compressor(s) as the following limits are approached:

- High discharge pressure
- Low suction pressure
- Over current

Remote Monitoring and Controlling 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 by phone system. This valuable enhancement to the refrigeration system allows the ultimate in serviceability. The microcomputer as standard is additionally equipped with history files and 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 four optional control accessories for remote monitoring and controlling of our package chillers.

1) RMDT - Remote Monitor Display Terminal

The RMDT (Remote Monitor Display Terminal) can be hard wired up to 50 feet away from the chiller 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.

This accessory allows remote start-stop, chilled water set-point changes, and reading of all microcomputer screens including operating conditions, faults and fault history.

2) IBM PC Compatible Computer Terminal

A customer-supplied 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). Again, this method of communication interfaces with the chiller microcomputer CPU and provides the same level of communication.

3) BMS - Building Management System Terminal

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 communications protocol.

Dunham-Bush has an open communications protocol policy with most BMS companies.

4) CHLK - Chiller*LINK*

Dunham-Bush has always been a strong advocate of open systems communications. In addition to BACnet, the modular design of our Chiller*LINK* also supports Modbus protocol. Consult with Dunham-Bush to verify compatibility with other protocols.

Dunham-Bush's Chiller*LINK* is a microprocessor-based communication device designed to provide seamless, two-way translation between a Dunham-Bush microcomputer and a BACnet compliant network or work station. Chiller*LINK* devices are available for a variety of Data Link/Physical Layer configurations including PTP (point-to-point) via EIA-232 standard approved for BACnet.

In addition to providing seamless interoperability with BACnet systems, Chiller*LINK* can be specially designed for full custom programmability of the data flowing between the Dunham-Bush/BACnet networks.

UNIT FEATURES: REFRIGERATION CYCLE

Dunham-Bush Rotary Screw Airr-Cooled Chillers are designed for efficiency and reliability. The rotary screw compressor is a positive displacement, variable capacity compressor that will allow operation over a wide variety of conditions.

Even at high head and low capacity, a difficult condition for centrifugal compressors, the rotary screw performs easily. **It is impossible for this positive displacement compressor to surge.**

The refrigerant management system, however, is very similar to centrifugal water chillers and is shown in the refrigerant cycle diagram below.

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

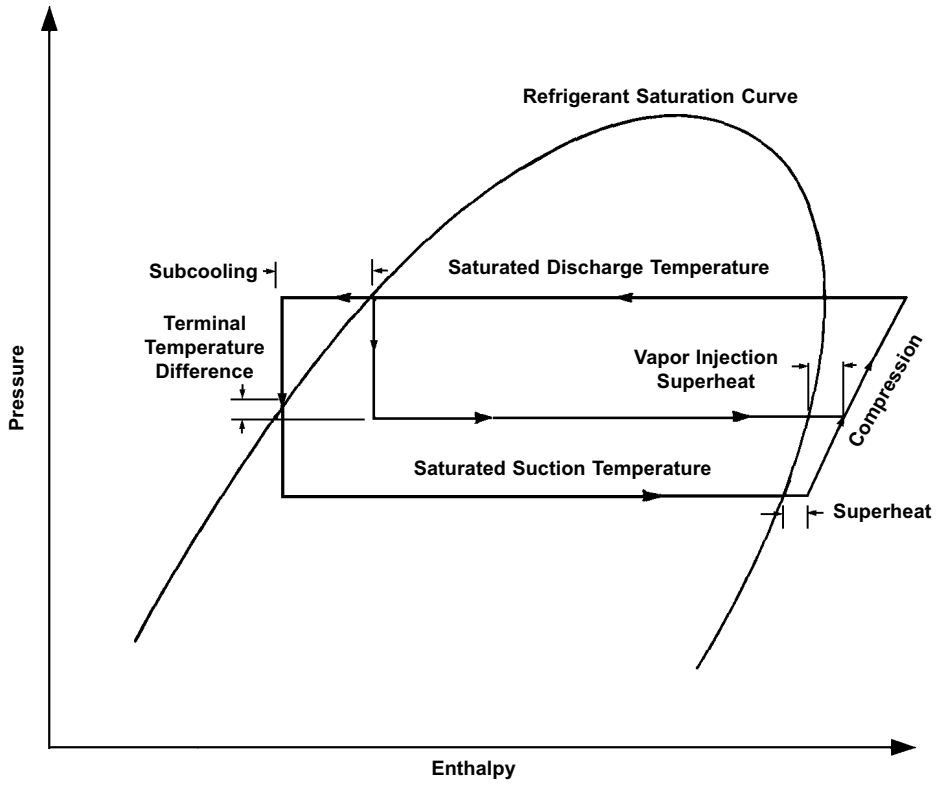
This partially compressed gas is then joined by additional gas from the flash economizer subcooler as the rotors rotate past the vapor injection port at an intermediate pressure. Compressed gaseous refrigerant is then discharged into the integral oil separator where oil, which is contained in the refrigerant vapor, is removed and returned to the oil sump.

Fully compressed and superheated refrigerant is then discharged into the condenser, where ambient air cools and condenses the refrigerant. Liquid refrigerant then passes through the expansion valve and into the economizer subcooler before entering the main evaporator expansion valve.

A separate source of liquid from the condenser is supplied the economizer subcooler where it fully evaporates and enters the vapor injection port of the compressor.

By removing the vapor from the economizer subcooler at an intermediate pressure, the enthalpy of the refrigerant flowing into the evaporator is reduced which increases the refrigeration effect and improves the efficiency of the refrigeration cycle.

Vapor Injection Cycle
w/ DX Subcooler



UNIT FEATURES: PART-LOAD PERFORFMANCE

Through the use of economizer subcooler and multiple compressors, Dunham-Bush Rotary Screw Air-Cooled Chillers have excellent full and part-load performance characteristics when measured in accordance with ARI Standard 590-92.

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 Rotary Screw Chillers combine the efficient operation of multiple rotary screw compressors with an economizer cycle and microprocessor 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 for the building application. In a typical city, the air conditioning load will vary according to changes in the ambient temperature. Weather data compiled over many years will predict the number of hours that equipment will operate at various load percentages.

The Air Conditioning and Refrigeration Institute (ARI) has established a system, in ARI Standard 550/590-98, for measuring total chiller performance over full and part-load conditions. It defines the Integrated Part-Load Value (IPLV) as an excellent method of comparing diverse types of equipment on an equal basis. The IPLV is a single number estimate of a chiller's power use weighted for the number of hours the unit might spend at each part-load point. IPLV's are based on Standard Rating Conditions.

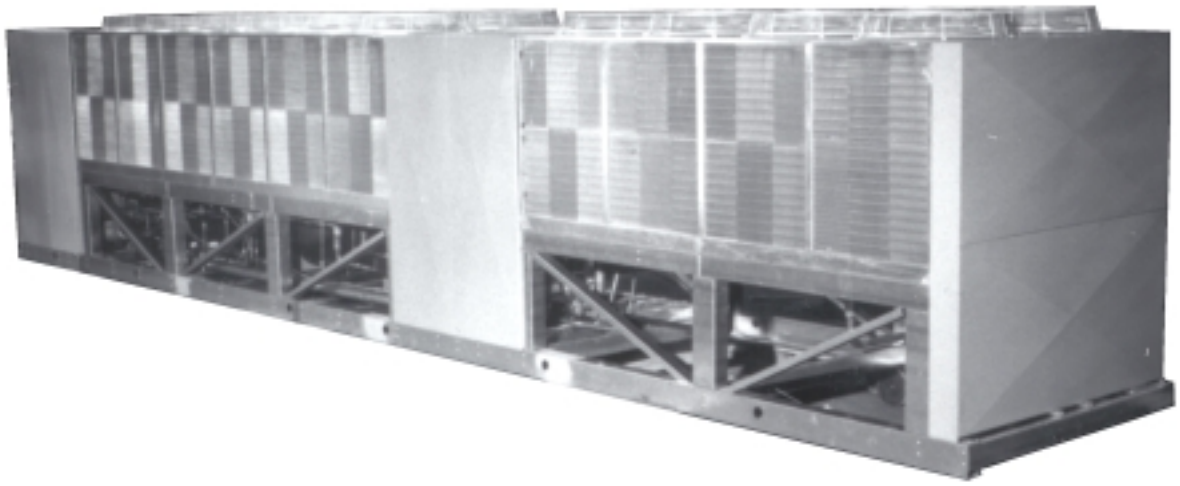
The formula for calculating an IPLV or NPLV is:

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

where: A = EER at 100% load point
B = EER at 75% load point
C = EER at 50% load point
D = EER at 25% load point

Non-Standard Part-Load Values (NPLV) also give a single number estimate for the part-load performance of a chiller but at Selected Application Rating Conditions, using the same equation as for IPLV.

Integrated Part-Load Values and Non-Standard Part-Load Values are available from your Dunham-Bush Representative and will be calculated for your specific conditions.



UNIT OPTIONS

Copper Condenser Fins (CUF)—Copper fins offer maximum corrosion protection for severe conditions.

Polycoated Condenser Fins (PCF)—Applicable for corrosion resistance in salt atmosphere conditions.

Single Point Power Source (SPPS)(SPC)—with a Single Terminal Block and Circuit Breakers for each compressor to provide single source main power connection to the unit.

Unit Mounted Compressor Disconnects (UMD3)(DS2)—for 460/3/60 or 575/3/60 Single Point Power Source units, supplied with one main power terminal block for models ACDX 270-370 and two blocks for ACDX 400-420. Circuit breakers are equipped with handles extended through the power panel door, for disconnecting each compressor circuit. For main terminal block wire ranges, refer to the Electrical Data Table on page 24.

Unit Mounted Compressor Disconnects (UMD2)(DS1)—for 460/3/60 or 575/3/60 Standard Dual Point Power Source units, supplied with two main power terminal blocks and circuit breakers with disconnect handles extended through the power panel door for each compressor. For main terminal block wire ranges, refer to the Electrical Data Table on page 24.

Ground Fault Detector (GFD)—senses "any" milli amps going to ground and shuts down the unit before compressor burnout occurs.

Three Phase Ammeter (AM3)—Single analog ammeter with a 3-phase selector switch for indication, located inside the control panel.

Three Phase Voltmeter (VM3)—Single analog voltmeter installed with a 3-phase selector switch for indication, located inside the control panel.

Operating and Safety Lights (OSL)—Provides indicator lights for control power, alarm, compressor motor overload, compressor high oil temperature and compressor high motor temperature.

Electrical Panel Door Latch Solenoids (DLS)(CPS)—Automatically disallows access to the control panel and high voltage panel when the main power is supplied to the unit. This protection can be overridden on the control panel side with a key actuated switch.

115V Convenience Outlet (CON)—Duplex outlet located inside the control panel and protected by 15 amp fusing.

Hot Gas Bypass (HGB1)—Consists of factory piped and wired hot gas bypass valve solenoid and regulating valves, on the lead circuit only, to allow the unit to operate below minimum mechanical unit operating capacity. If the unit is to be operated on a compressor lead-lag basis, HBG2 should be ordered to provide the same function as above installed on all refrigerant circuits.

Hot Gas Bypass (HGB2)—Consists of factory piped and wired hot gas bypass valve solenoid and regulating valves, on all circuits, to allow the unit to operate below minimum mechanical unit operating capacity.

Low Ambient Controls (LAC)—to 0°F (-17.8°C) minimum operating ambient with variable speed fans in conjunction with standard fan cycling head pressure control.

Modem (MOD)—allows the system to be controlled, monitored, logs retrieved, and potential problems quickly investigated in a cost effective manner from a remote computer. The modem requires a dedicated telephone line.

Entering Fluid Temperature Sensor (SEN)—and bulb well installed in cooler inlet connection to supply inlet fluid temperature information to the microcomputer.

Steel Painted Louvers (LUV)—For full unit enclosure including general mechanical security and unit aesthetics.

Aluminum Painted Grills (GRL)—similar to the louver option except manufactured of aluminum with 3/8" x 3 1/2" slots instead of louvers for security and hail protection and unit aesthetics. Same unit enclosure as louvers, but much lighter weight and easier to handle.

Fin Guard (FGT)—is a coated heavy wire fin guard with 1" x 4" openings that protects the vertical condenser surface from most physical damage.

Fin Guard Bottom (FGB)—is the same type wire guard at the FGT but is sized to fit the lower section of the unit. This option includes an end enclosure panel opposite the electric box end of the unit and provides the same basic unit mechanical security as the LUV or GRL unit enclosures.

UNIT OPTIONS (CONT.)

500 Hour Salt Spray Coating (PNT)—provides all components coated with standard grey high-grade outdoor quality coating system tested to maintain integrity under the ASTM-B-117 specification.

Compressor Sound Blanket (SBL)—is a removable attenuation blanket which provides compressor noise reduction for quiet compressor operation.

Cooler Heater Transformer (CHT)—is appropriately sized to power the 115/1/60 cooler vessel heater tape for -20°F (-28°C) cooler freeze protection. This transformer is powered from the unit's main power circuit, that must not be turned off during the winter in order to maintain the cooler freeze protection.

Suction Line Insulation (INS)—suggested for medium and low temperature applications.

Over/Under Voltage and Phase Protection Relay (UVR2)—protects against high and low voltage conditions as well as phase loss, phase reversal and phase imbalance by opening the control circuit. It is an automatic reset device.

Semi-Hermetic Compressor (SHC)—have flanged compressor housings for field serviceability. An added benefit of flanged compressors is they run quieter than non-flanged compressors.

Chiller*LINK* Communication Module (CHLK)— for communication with (BMS) Building Management Systems through BacNet or Modbus. See ChillerLink Data Acquisition Form SD202-22203.

Chilled Water Pump Control (CWPC)—provides a contact closure for pump starting prior to starting the chiller.

ACCESSORIES

Water Flow Switch (WFS)—paddle type, field adjustable, flow switch available to be tied into the unit safety circuit so that the package will not run without flow through the cooler to minimize the chance of cooler freeze-up. This is a NEMA 3R device that can be used for water or Ethylene or Propylene Glycol.

Spring Isolators (SPG)—are housed spring assemblies designed for 1" spring deflection that have a neoprene friction pad on the bottom to help prevent the passage of sound into the support structure. Loading and leveling bolts are supplied just under the top mounting plate of the isolators. Neoprene inserts prevent contact between the steel upper and lower housings. Spring isolators are more suitable than Rubber-in-Shear Isolators for critical applications.

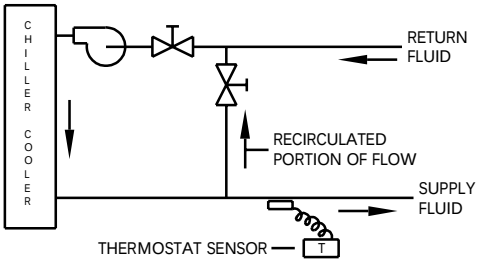
Rubber-in-shear Isolators (RIS)—are one piece molded isolators with skid resistant baseplates that are designed for easy installation.

Remote Monitor Display Terminal (RMDT)—includes a terminal for remote monitoring and enabling/disabling unit control plus reading of all microcomputer screens up to 50 feet (15.2 meters) of wire length away. (See Page 9.)

Cooler Design Data

1. ***Maximum***—(LCFT) Leaving Chilled Fluid Temperature is 50°F (10°C). The unit can start and pull down with up to 80°F (27°C) entering-water temperature. For sustained operation, it is recommended that the entering water temperature not exceed 70°F (21°C).
2. ***Minimum***—(LCFT) Leaving Chilled Fluid Temperature is 40°F (4.4°C) for all unit models except compact sizes 048 through 108 for water applications. Some unit models will require oversized coolers for water temperatures below 44°F (6.7°C). Refer to the physical Specifications section of this catalog to determine which untis will require oversized evaporators.
3. Minimum/Maximum Flow Rates and Vessel Fluid Volume—refer to Physical Specifications.
4. Pressure Drop Data—refer to Figure 16, page 16 and glycol correction factors, Tables 17A and 17B.
5. Wide Range ΔT—Low Flow Applications
   a. Multiple smaller chillers may be applied in series, each providing a portion of the design temperature range of roughly 10°F (5.5°C) each.
   b. Special cooler baffling may be provided from the factory for applications from 12.5°F to 20°F (7°C to 11°C) chiller fluid ranges.
   c. Chilled fluid may be recirculated through the cooler as shown below to allow the chiller to operate with acceptable flow rates and temperature ranges (Figure 14A).

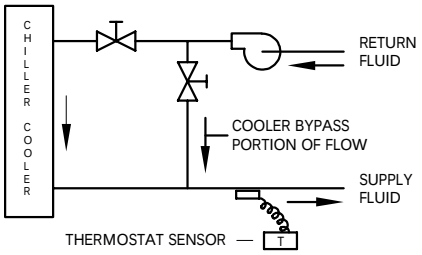
Figure 14A



The mixed fluid temperature range through the cooler for units with standard coolers, should not be less than 7.5°F (4.2°C).

6. Narrow Range ΔT - High Flow Applications
   a. Special cooler baffling is available from the factory for 5°F to 7.5°F (2.7°C to 4.2°C) ΔT applications.
   b. For Extra-Narrow Range ΔT applications a partial cooler bypass piping and valve configuration can be used as shown below. This permits a higher ΔT and lower ΔP (pressure drop) through the cooler (Figure 14B). Contact your local Dunham-Bush sales office when using this arrangement.

Figure 14B



The fluid mixes after the cooler.

Chilled Fluid Loop Volume (CFLV)

Careful consideration needs to be given to the "Chilled Fluid Loop Volume" (CFLV) or System / Inertia to maintain an acceptable leaving fluid temperature.

Small loop Volume Systems may have temperature control problems due to the small fluid volume in the system. This "System Inertia Problem" is exaggerated at low load conditions and causes chiller short cycling. The small fluid volume in the system will be pulled down to setpoint in a very short period of time, and the chiller will be shut down. The chiller's anti-recycle timer limits the number of starts to three per hour. The system loop temperature will warm up during this off-cycle and may require cooling before the anti-recycle timer has timed out. Once the anti-recycle timer has timed out, the unit will restart and the chiller will again load up possibly to 100% and pull the loop down again repeating the short cycle pattern.

The **System Loop Volume** should be sized to limit the temperature rise that can occur during the off cycle.

Air Conditioning Applications

The chilled fluid loop volume must equal or exceed 3 gallons per nominal ton of cooling (3.25 L per kW).

Process & Special Air Conditioning Applications

Where leaving fluid temperature is often more critical, the chilled fluid loop volume should be increased to 6 to 10 gallons per ton minimum (6.5 to 10.8 L per KW).

Table 15A **Minimum Chilled Fluid Loop Volume***

ACDX Model	Air Conditioning Applications		Process Applications				
	Gallons	Liters	Gallons	Liters		Gallons	Liters
270	783	2864	1566	5827	To	2610	9879
300	861	3259	1722	6518	To	2870	10863
320	921	3486	1842	6972	To	3070	11620
340	1008	3815	2016	7631	To	3360	12718
370	1071	4054	2142	8107	To	3570	13512
400	1179	4463	2358	8925	To	3930	14875
420	1236	4678	2472	9357	To	4120	15594

*Values calculated for ARI Conditions of Service (C.O.S.)

Type of Application	Gal/Ton	L/KW
Normal Air Conditioning	3	3.25
Process Cooling	6 - 10	6.5 - 10.8

Gallons = Gal/Ton x ARI Capacity in Tons
Liters = L/KW x ARI capacity in KW

For applications with other than ARI C.O.S., calculate the system loop volume based on the adjusted or corrected unit capacity.

Tanks for System Volume Enhancement

It may be necessary to install a tank in the system to provide sufficient system fluid volume, as shown below.

Figure 15A Single Loop System with Storage Tank to Increase Loop Volume

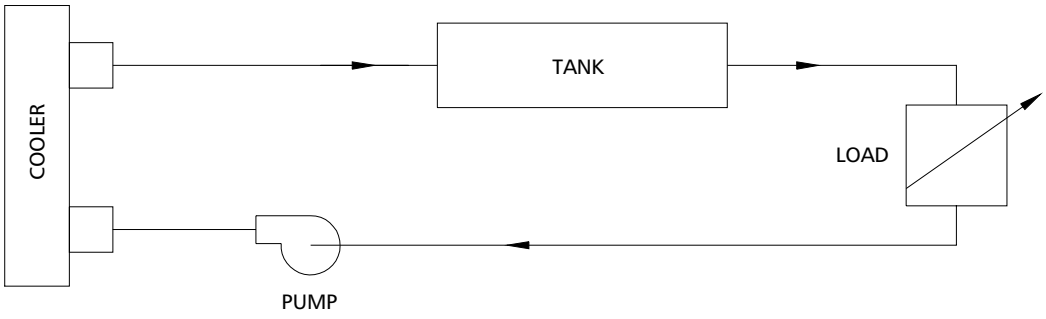
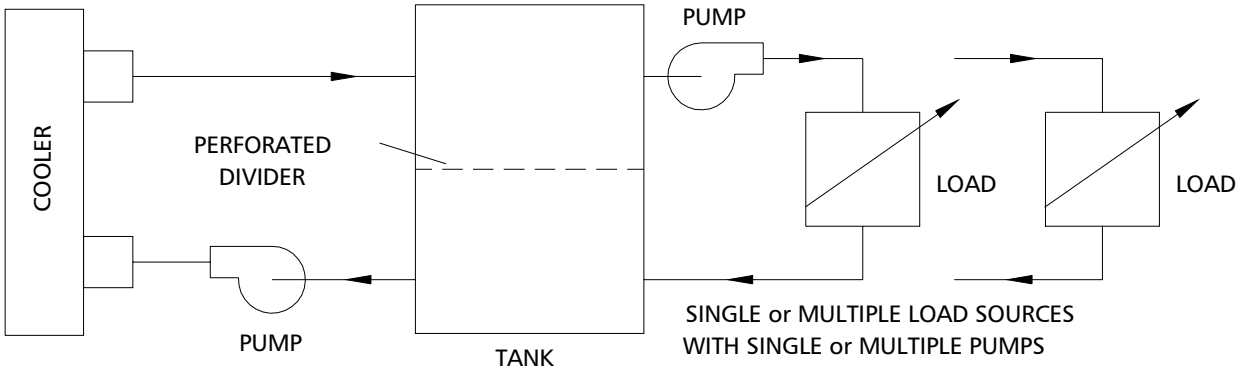


Figure 15B Primary and Secondary Loop Systems are normally used where the secondary system has variable flow and/or multiple loads. See example below.

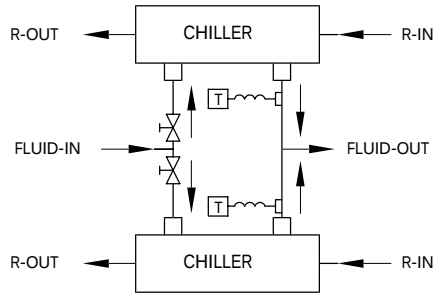


APPLICATION DATA (CONT.)

Multiple Chillers Per Chilled Water System

1. Where the load is greater than one **ACDX-B** can supply or where standby capacity is required or the load profile dictates, multiple chillers may be piped in parallel. Units of equal size help to ensure fluid flow balance, but balancing valves ensure balanced flows even with dissimilar chillers. Temperature controller sensors may or may not need to be moved to the common fluid piping depending on the specific application.
2. Parallel Chiller Applications (Figure 16A). Both units operate simultaneously modulating with load variations. Each unit operates independently sensing its own leaving water temperature. The set point of each thermostat is set to maintain the desired loading scheme.

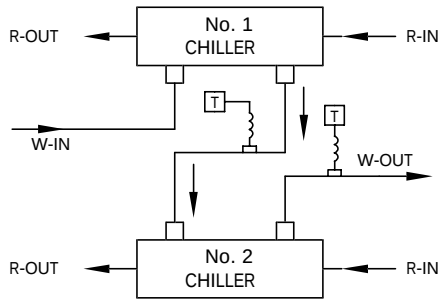
Figure 16A



3. Series Chiller Applications (Figure 16B)

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

Figure 16B



Oversizing Chillers

Oversizing of chillers more than 5-10% is not recommended. Oversizing causes energy inefficiency and shortened compressor life due to excessive compressor cycling. Larger future load requirements may cause temporary oversizing of equipment which will require careful unit selection. It may be better to properly size for the present load and add another unit later for future expansion. It is also recommended using multiple units where operation at minimum load is critical. Fully loaded equipment operates better and more efficiently than large equipment running at or near minimum capacity.

Hot gas bypass should not be a means to allow oversizing of chillers. Hot gas bypass should only be used where the equipment is sized properly for full load but the load turn down is less than the minimum unloading available.

Water (Fluid) Strainers

It is recommended that 40-mesh strainers be installed in the fluid piping as close to the unit cooler as possible.

Low Ambient Operation/Freeze Protection

If unit is required to operate below 20°F (-7°C), optional head pressure control is required. Though heater tape is provided on vessel, all water piping must also be protected by heater tape. Glycol is recommended for added protection. If wind in area is over 5 mph (8 kph), a wind barrier is recommended.

Desuperheaters

A hot gas desuperheater can be factory mounted or supplied for field installation. Tees in refrigerant lines with shut off valves can be supplied for field installed desuperheaters. Consult factory for further details.

GLYCOL CORRECTION FACTORS

Glycol Freeze Protection

If the chiller or fluid piping may be exposed to temperatures below freezing, glycol protection is recommended. The recommended protection is 15°F (8.3°C) below the minimum ambient temperature. Use only glycol solutions approved for heat exchanger duty. The use of automotive anti-freeze is not recommended because they have short-lived inhibitors and fouling of the coolers will occur. If the equipment is exposed to freezing temperature and not being used, the vessels and piping should be drained.

Cooler heaters are provided for protection down to -20°F (-29°C) minimum ambient but piping must be protected. A separate 115V service is required for this protection.

If the equipment is being used for operating conditions below the water rated vessel capability, glycol should be used to prevent freeze damage. The freeze protection level should be 20°F (11°C) lower than the leaving brine temperature. The use of glycol causes a performance derate as shown below in Table 17A for ethylene glycol and Table 17B for propylene glycol and needs to be included in the unit selection procedure.

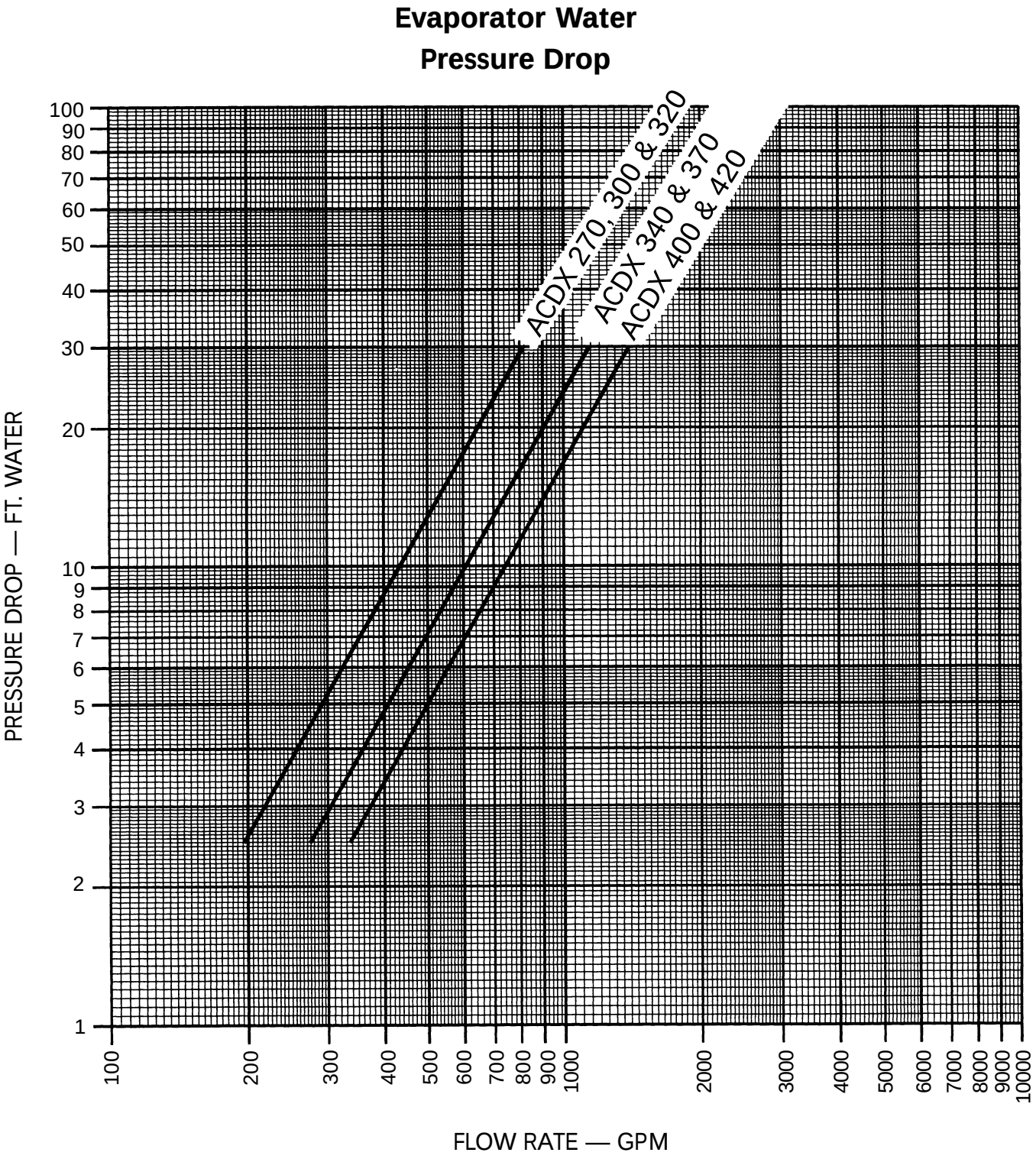
Table 17A **Ethylene Glycol**

% E.G.	FREEZE POINT		C1 CAPACITY FACTOR	K1 kW FACTOR	G1 FLOW RATE	P1 P.D. FACTOR
	°F	°C				
10	26.2	-3.2	0.997	0.999	1.032	1.081
15	22.4	-5.3	0.994	0.997	1.040	1.115
20	17.8	-7.9	0.991	0.996	1.050	1.151
25	12.6	-10.8	0.989	0.995	1.062	1.190
30	6.7	-14.1	0.986	0.994	1.075	1.234
35	0.0	-17.8	0.982	0.992	1.089	1.284
40	-8.0	-25.8	0.978	0.990	1.105	1.340
45	-17.5	-27.5	0.974	0.988	1.124	1.402
50	-28.9	-33.8	0.969	0.986	1.144	1.472

Table 17B **Propylene Glycol**

% P.G.	FREEZE POINT		C2 CAPACITY FACTOR	K2 kW FACTOR	G2 FLOW RATE	P2 P.D. FACTOR
	°F	°C				
10	26.1	-3.3	0.994	0.997	1.009	1.049
15	22.8	-5.1	0.990	0.996	1.012	1.070
20	19.1	-7.2	0.986	0.994	1.016	1.097
25	14.5	-9.7	0.981	0.992	1.022	1.129
30	8.9	-12.8	0.974	0.989	1.029	1.167
35	2.1	-16.6	0.967	0.986	1.036	1.211
40	-6.4	-21.3	0.960	0.982	1.047	1.261
45	-16.6	-27.0	0.954	0.980	1.061	1.316
50	-28.9	-33.8	0.946	0.976	1.076	1.382

Cooler Pressure Drop Data: .....



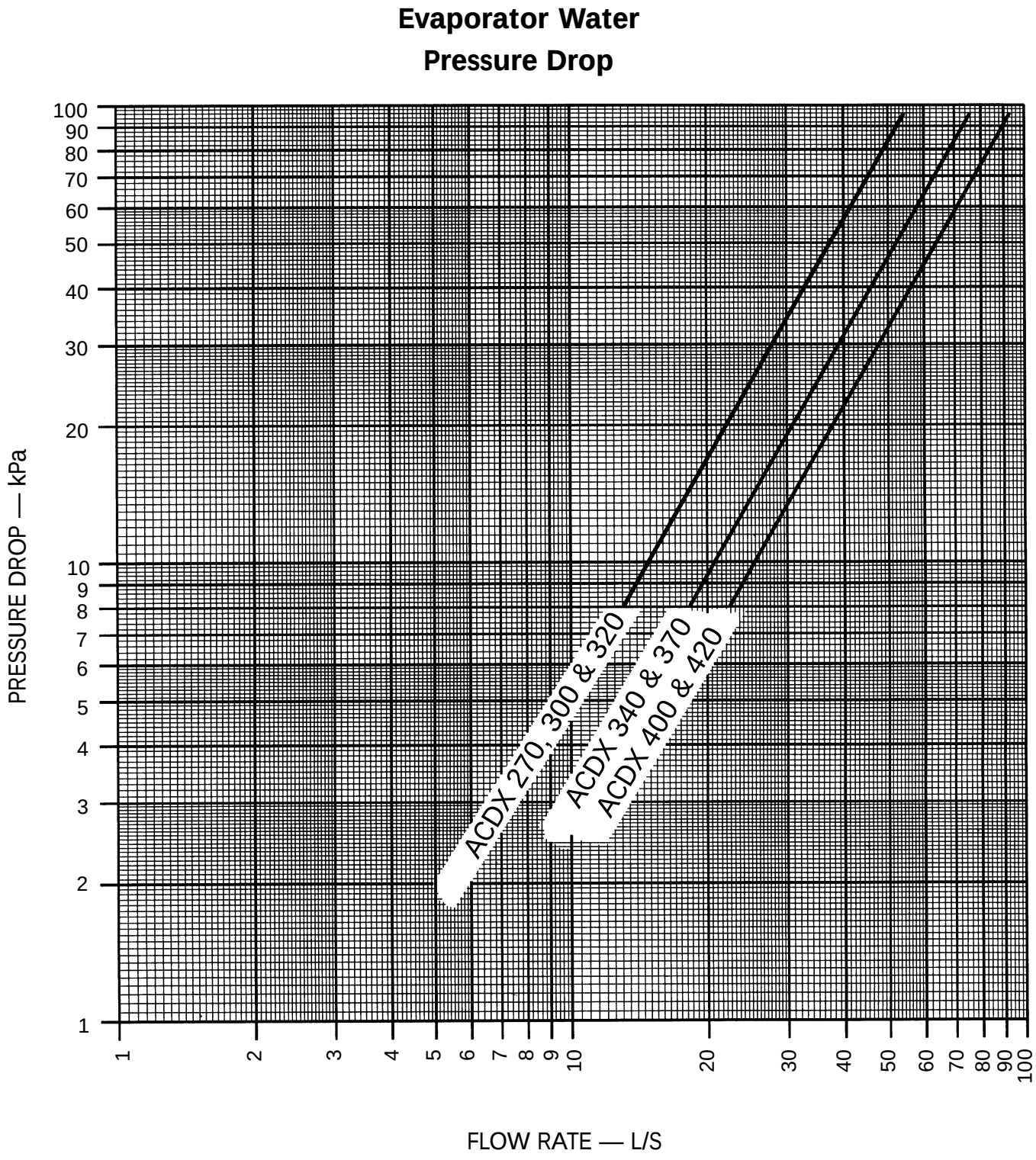
Legend:

ACDX 270, 300, 320 — Curve #1

ACDX 340, 370 — Curve #2

ACDX 400, 420 — Curve #3

Cooler Pressure Drop Data: .....



Legend:

ACDX 270, 300, 320 — Curve #1

ACDX 340, 370 — Curve #2

ACDX 400, 420 — Curve #3

SELECTION PROCEDURE: ENGLISH I.P. UNITS

Design Requirements

The following design requirements must be known in order to select a packaged chiller.

*1. Required cooling capacity in tons or kWo
2. Evaporator outlet water temperature °F or °C
*3. GPM or L/S of chilled water to be circulated
*4. Chilled water cooling range (water in °F or °C - water outlet °F or °C)
5. Design ambient temperature °F or °C. Minimum starting/operating ambient temperature °F or °C.
6. Electrical power characteristics
7. Special codes (state, city or local) with which unit must comply

*Any 2 out of 3 must be known

Example 1 (English I.P. Units)

Select an air cooled packaged chiller for the following conditions:

325 tons at 54°F entering, 44°F leaving chilled water.

Design ambient is 95°F. Minimum operating ambient is +0°F. Altitude is 2000 feet.

Chilled fouling factor .0005. Electrical characteristics 460/3/60 with single power connection.

Step 1 - Unit Selection

For 2000 feet elevation divide the required tonnage by the altitude correction factor from Table 20A.

$$\frac{325 \text{ tons}}{.99} = 328.3 \text{ Tons}$$

For .0005 fouling factor divide the required tonnage at 2000 feet by the fouling correction factor from Table 20B.

$$\frac{328.3 \text{ Tons}}{.981} = 334.6 \text{ Tons}$$

Entering the table on page 22 we see that an ACDX340 for water at sea level will do 336 tons, drawing 412 compressor kW. For the conditions specified, the unit will do:

Capacity = 336 x .99 x .981 = 326.3 Tons
Compressor kW = 412 x 1.01 = 416 kW

Step 2 - Evaporator GPM and Pressure Drop

$$GPM = \frac{\text{Original Tons x 24}}{\text{Cooling Range}} = \frac{325 \times 24}{10} = 780 \text{ GPM}$$

Referring to page 18 for the evaporator pressure drop, we see a 15 ft. P.D. for 780 GPM.

Step 3 - Chilled Water Pump Selection

To the pressure drop calculated in Step 2, add the pressure drop through the chilled water loop piping, valves and equipment.

Step 4 - Head Pressure Control Selection

To select the proper head pressure control for an ACDX340, use the Physical Data Table found on page 24. Note that the standard ambient with fan cycling is 20°F. Since requirement is for 10°F, the optional variable speed fan must be used.

Step 5 - Electrical Wire and Disconnect Sizing

Using the Electrical Data found on page 25 for an ACDX340 operating on 460/3/60 service with single power connection, we find the following:

Unit Full Load Amps: 637
Unit Minimum Circuit Ampacity: 690
Unit Maximum Fuse Size : 900

Table 20A

Elevation Above Sea Level		Correction Factor	
Feet	Meters	Capacity	Row
0	0	1.00	
2000	600	.99	1.01
4000	1200	.98	1.02
6000	1800	.97	1.03

Table 20B

Fouling Factor		Capacity	kW
(hr-ft. - °F/BTU)	(M^2 °C kW^{-1})	Factor	Factor
.0001	.018	1.000	1.000
.00025	.044	.993	.998
.00050	.088	.981	.994
.00100	.176	.958	.986

SELECTION PROCEDURE: S.I. UNITS

Example 2 (S.I. Units)
Select an air cooled packaged chiller for the following conditions:

900 kWo at 13°C entering 7°C leaving chilled water. Design ambient is 35°C. Minimum operating ambient is 10°C. Altitude is 600 meters. Chiller fouling factor 0.018. Electrical characteristics 575/3/60 with two power connections required. Brine loop to be 40% Ethylene Glycol by weight.

Step 1 - Unit Selection
For 600 meter elevation divide the required tonnage by the altitude correction factor from Table 20A.

$$\frac{900}{.99} = 909 \text{ kWo}$$

To correct for evaporator fouling, consult Table 20B. In this example the fouling factor is 0.018 which has a capacity factor and kW factor of 1.00, so no correction is necessary.

To correct for 40% E.G., consult Table 17A for a correction factor °C and make the following adjustment.

$$\frac{909}{.978} = 929 \text{ kWo}$$

Entering the table on page 23, we see that an ACDX300 for water at sea level will do 1016 kWo drawing 341 kWi for compressor. The unit will do:

Capacity = 1016 x .99 x .978 = 983.7 kWo
Compressor kW = 341 x .99 = 337.6 kWi

Step 2 - Evaporator L/S and Pressure Drop

$$L/S = \frac{\text{Original kWo}}{4.187 \times \text{Range}} = \frac{900}{4.187 \times 6} = 35.8$$

Correcting for glycol from Table 17A:

L/S = 35.8 x 1.10 = 39.4 (E.G.) L/S

Referring to page 19 for the evaporator pressure drop, we see a 54 kPa for 39.4 L/S of water. Correcting for glycol from Table 17A:

P.D.(E.G.) = 54 x 1.340 = 72.3 kPa

Step 3 - Chilled Water Pump Selection
To the pressure drop calculated in Step 2 add the pressure drop through the chilled water loop piping valve, etc.

Step 4 - Head Pressure Control
Refer to Physical Data for ACDX300. Since standard fan cycling is good to 7°C and requirement is for 10°C, no additional control is required.

Step 5 - Electrical Wire and Disconnect Sizing
Using the Electrical Data found on page 25 for an ACDX300 operating on 575/3/60 service with separate power connections, we find:

Unit Full Load Amps: 407	
Unit Minimum Circuit Ampacity:	229 Circuit #1
	272 Circuit #2
Unit Maximum Fuse Size:	350 Circuit #1
	450 Circuit #2

Application Data

Low Ambient Operation/Freeze Protection
If unit is required below 20°F/-7°C, optional head pressure control is required. Though a heater tape is provided on vessel, all water piping must also be protected by heat tape. Glycol is recommended for added protection. If wind in area is over 5 mph/8 kph, a wind barrier is recommended.

Water Circuit
Constant water flow required with a minimum of 3 gallons/ 3.3 liters water loop volume per ton/kWo increasing up to 10 gallons/11 liters for process, low load applications with small temperature ranges and/or vastly fluctuating load conditions.

PEFORMANCE DATA: 60 HZ I.P. UNITS

LWT	Model	Ambient Air Temperature °F															
		85				95				105				115			
°F	ACDX	Tons	kW	EER	NPLV	Tons	kW	EER	NPLV	Tons	kW	EER	NPLV	Tons	kW	EER	NPLV
42	270	268	280	10.6	13.7	255	310	9.2	13.0	240	343	7.9	12.4	183	288	7.0	11.9
	300	293	303	10.6	13.2	280	336	9.2	12.5	265	372	8.0	11.8	210	326	7.1	12.1
	320	313	340	10.2	13.1	299	377	8.9	12.5	282	416	7.6	11.9	209	329	7.0	11.5
	340	340	366	10.2	11.5	326	407	8.9	11.6	309	452	7.6	11.1	256	429	6.6	10.2
	370	363	392	10.2	13.4	347	436	8.9	12.3	328	484	7.6	11.8	258	426	6.7	11.2
	400	401	411	10.7	13.5	383	457	9.3	13.7	362	506	8.0	13.1	288	451	7.1	11.5
	420	420	448	10.4	14.1	402	497	9.0	13.5	379	550	7.7	12.9	287	454	7.0	11.4
44	270	274	284	10.7	13.8	261	314	9.3	13.1	245	346	7.9	12.6	185	286	7.2	12.0
	300	300	307	10.8	13.4	287	340	9.4	12.6	271	376	8.1	11.9	212	322	7.3	12.3
	320	321	344	10.4	13.2	307	381	9.0	12.6	288	418	7.8	12.1	211	322	7.2	11.7
	340	350	371	10.4	12.2	336	412	9.0	11.8	318	457	7.8	11.3	259	423	6.8	10.3
	370	373	398	10.3	13.5	357	442	9.0	12.9	337	489	7.7	11.9	260	418	6.9	11.3
	400	411	417	10.8	13.6	393	463	9.4	13.8	370	511	8.1	13.2	290	447	7.2	11.6
	420	432	455	10.5	14.2	412	503	9.1	13.6	389	556	7.9	13.1	290	449	7.2	11.5
45	270	277	286	10.7	13.8	264	316	9.3	13.2	248	348	8.0	12.6	185	283	7.2	12.1
	300	304	309	10.8	13.4	291	342	9.4	12.7	272	374	8.1	12.0	212	319	7.3	12.3
	320	326	347	10.4	13.3	311	383	9.1	12.7	289	416	7.8	12.2	211	318	7.3	11.8
	340	355	374	10.4	12.4	341	415	9.1	11.9	323	460	7.8	11.5	260	419	6.9	10.4
	370	378	401	10.4	13.5	361	444	9.1	13.0	341	492	7.8	12.5	260	414	7.0	11.3
	400	417	420	10.9	13.6	397	465	9.5	13.9	374	514	8.1	13.3	291	443	7.3	11.6
	420	437	458	10.6	14.3	417	506	9.2	13.7	392	558	7.9	13.1	291	444	7.2	11.5
46	270	281	288	10.8	13.9	266	318	9.4	13.2	250	350	8.0	12.7	186	280	7.3	12.1
	300	308	311	10.9	13.5	294	344	9.5	12.8	275	375	8.2	12.1	213	316	7.4	12.4
	320	330	349	10.5	13.3	315	385	9.2	12.8	291	415	7.9	12.3	214	319	7.4	11.8
	340	361	377	10.5	12.5	346	417	9.2	12.0	327	463	7.9	11.6	261	416	7.0	10.5
	370	383	404	10.5	13.6	366	447	9.1	13.1	345	495	7.8	12.6	263	414	7.0	11.4
	400	422	424	11.0	14.6	402	468	9.5	13.9	378	517	8.2	13.3	291	439	7.3	11.7
	420	443	461	10.7	14.3	423	510	9.3	13.7	395	557	8.0	13.2	291	439	7.3	11.6
48	270	287	292	10.9	14.0	273	321	9.5	13.4	255	354	8.1	12.8	186	274	7.5	12.3
	300	316	315	11.1	13.6	302	348	9.6	12.9	278	373	8.3	12.2	215	312	7.6	12.5
	320	339	354	10.7	13.5	323	390	9.3	12.9	292	408	8.1	12.5	215	312	7.6	12.0
	340	--	--	--	--	356	423	9.3	12.2	336	468	8.0	11.8	264	409	7.1	10.7
	370	394	410	10.6	13.7	375	453	9.2	13.2	353	501	7.9	13.3	264	405	7.2	11.5
	400	433	430	11.1	14.7	412	474	9.7	14.1	387	522	8.3	13.5	294	434	7.5	11.8
	420	455	468	10.8	14.5	433	516	9.4	13.9	401	558	8.1	13.4	295	434	7.5	11.7
50	270	295	296	11.1	14.1	279	325	9.6	13.5	258	352	8.2	13.0	189	272	7.7	12.4
	300	325	320	11.2	13.8	309	352	9.8	13.1	283	372	8.5	12.3	216	306	7.8	12.7
	320	--	--	--	--	331	395	9.4	13.1	293	400	8.2	12.8	216	304	7.8	12.1
	340	--	--	--	--	366	428	9.5	12.5	345	474	8.1	12.0	266	401	7.3	10.9
	370	404	416	10.8	13.9	385	459	9.4	14.0	362	506	8.0	13.4	266	397	7.4	11.6
	400	445	436	11.3	14.8	423	480	9.8	14.2	393	522	8.4	13.7	296	426	7.7	12.0
	420	--	--	--	--	445	522	9.5	14.1	404	552	8.2	13.6	296	424	7.7	11.8

NOTES:
1. Interpolation between ratings is permissible but extrapolation is NOT.
2. kW is for compressor only. Fan power is shown in PHYSICAL DATA .
3. EER is for entire unit.
4. ARI Standard rating point and IPLV. All other points are non-standard part load ratings.
5. For 50 Hz operation, consult factory.
6. Contact factory for optimized 50 Hz capacity.

PEFORMANCE DATA: 60 HZ S.I. UNITS .....

LWT	Model	Ambient Air Temperature °C											
		29.4			35			40.5			46		
°C	ACDX	kWo	kWi	COP	kWo	kWi	COP	kWo	kWi	COP	kWo	kWi	COP
5.5	270	940	280	3.1	895	310	2.7	844	342	2.3	650	292	2.1
	300	1028	302	3.1	982	336	2.7	929	371	2.3	744	330	2.1
	320	1098	339	3.0	1048	376	2.6	990	416	2.2	742	333	2.1
	340	1192	365	3.0	1145	406	2.6	1085	451	2.2	909	433	1.9
	370	1273	392	3.0	1219	436	2.6	1154	483	2.2	916	431	2.0
	400	1409	411	3.1	1346	457	2.7	1273	505	2.4	1021	456	2.1
	420	1476	447	3.1	1410	497	2.6	1333	549	2.3	1015	457	2.1
6	270	950	281	3.1	904	312	2.7	852	344	2.3	650	289	2.1
	300	1040	304	3.1	994	338	2.7	940	373	2.4	745	327	2.1
	320	1111	341	3.0	1061	378	2.6	1003	418	2.3	744	329	2.1
	340	1209	368	3.0	1160	409	2.6	1099	453	2.3	912	430	2.0
	370	1289	394	3.0	1234	438	2.6	1167	485	2.3	918	426	2.0
	400	1425	413	3.2	1361	459	2.7	1285	507	2.4	1021	452	2.1
	420	1494	450	3.1	1427	499	2.7	1348	552	2.3	1016	452	2.1
7	270	970	285	3.1	922	315	2.7	867	347	2.3	656	287	2.1
	300	1064	308	3.2	1016	341	2.8	957	375	2.4	750	322	2.2
	320	1138	345	3.1	1087	382	2.7	1020	419	2.3	747	322	2.1
	340	1242	372	3.1	1191	413	2.7	1128	458	2.3	919	423	2.0
	370	1322	399	3.1	1263	443	2.7	1193	490	2.3	921	418	2.0
	400	1457	419	3.2	1390	464	2.8	1311	512	2.4	1028	447	2.1
	420	1530	456	3.1	1459	505	2.7	1377	557	2.3	1029	449	2.1
8	270	991	288	3.2	941	318	2.8	883	350	2.4	656	280	2.2
	300	1089	312	3.2	1039	345	2.8	970	375	2.4	757	319	2.2
	320	1166	350	3.1	1113	386	2.7	1029	416	2.3	758	319	2.2
	340	1276	377	3.1	1223	418	2.7	1156	463	2.3	925	416	2.1
	370	1354	405	3.1	1293	448	2.7	1219	495	2.3	930	414	2.1
	400	1491	424	3.2	1420	469	2.8	1337	517	2.4	1036	443	2.2
	420	1567	462	3.1	1493	511	2.7	1396	558	2.3	1037	443	2.2
9	270	1013	292	3.2	960	322	2.8	900	354	2.4	664	278	2.2
	300	1115	316	3.3	1063	348	2.8	981	373	2.5	759	312	2.2
	320	--	--	--	1138	390	2.7	1030	408	2.4	759	311	2.2
	340	--	--	--	1254	423	2.7	1185	468	2.4	931	408	2.1
	370	1387	410	3.1	1323	453	2.7	1246	501	2.3	932	405	2.1
	400	1526	430	3.3	1451	474	2.8	1365	522	2.4	1039	434	2.2
	420	1605	468	3.2	1527	516	2.8	1415	558	2.4	1039	433	2.2
10	270	1036	295	3.3	981	325	2.8	906	351	2.4	666	272	2.3
	300	1141	319	3.3	1087	352	2.9	995	372	2.5	765	308	2.3
	320	--	--	--	1165	395	2.8	1038	404	2.4	769	309	2.3
	340	--	--	--	1286	428	2.8	1214	474	2.4	936	401	2.2
	370	1422	415	3.2	1354	458	2.8	1273	506	2.4	942	400	2.2
	400	1565	435	3.3	1486	480	2.9	1382	522	2.5	1047	427	2.3
	420	--	--	--	1564	522	2.8	1427	553	2.4	1047	426	2.3

NOTES:
1. Interpolation between ratings is permissible but extrapolation is NOT.
2. kWi is for compressor only. Fan power is shown in PHYSICAL DATA .
3. COP is for entire unit.
4. For 50 Hz operation, consult factory.
5. Contact factory for optimized 50 Hz capacity.

PHYSICAL DATA

Description		MODELS ACDX						
		270	300	320	340	370	400	420
Compressor Model	Circuit #1	1215	1215	1218	1212	1215	1215	1215
	Circuit #2	1215	1218	1218	1212	1215	1215	1215
	Circuit #3				1215	1212	1215	1218
Capacity Control Infinite To		15%	15%	15%	10%	10%	10%	10%
Low Ambient Operation	Fan Cycling (°F/°C)	20/-7	20/-7	20/-7	20/-7	20/-7	20/-7	20/-7
	Opt. Var. Fan (°F/°C)	0/-18	0/-18	0/-18	0/-18	0/-18	0/-18	0/-18
Condenser Fans	Quantity	14	16	16	20	20	22	22
	Diameter (in.)/(mm)	30/762	30/762	30/762	30/762	30/762	30/762	30/762
	Motor HP	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	Total KW	23.8	27.2	27.2	34.0	34.0	37.4	37.4
Evaporator	No. Circuits	2	2	2	3	3	3	3
	Dia. & Length (in.)	20x122	20x122	20x122	22x149	22x149	24x149	24x149
	Dia. & Length (mm)	508x3099	508x3099	508x3099	559x3785	559x3785	610x3785	610x3785
	Volume (gal.)/Liters	70/318	70/318	70/318	112/509	112/509	131/595	131/595
	Min. Flow (GPM)/(L/S))	298/19	298/19	298/19	298/19	298/19	424/27	424/27
	Max. Flow (GPM)/(L/S)	816/52	816/52	816/52	816/52	816/52	1462/92	1462/92
Approx. Operating Wt. (lbs.)		16032	16840	16840	22520	22686	24718	24718
Approx. Operating Wt. (kg)		7272	7638	7638	10216	10290	11213	11213
Approx. Shipping Wt. (lbs.)		15465	16273	16273	21564	21724	23586	23586
Approx. Shipping Wt. (kg)		7021	7388	7388	9790	9963	10708	10708
Operating Charge R-22 (lbs)/(kg)		497/226	547/248	585/266	643/292	684/311	748/340	786/357

FIELD WIRING ELECTRICAL DATA

Model	Unit	Unit	Standard Dual Power Source						Optional Single Power Source		
			Circuit #1		Terminal Block	Circuit #2		Terminal Block			
ACDX	Volts/Hz	FLA	MCA-1	MFS-1	( )# of wires/pole	MCA-2	MFS-2	( )# of wires/pole	MCA	MFS	Terminal Block Wire Range
270	460/60-400/50	464	285	450	(1) #6 to 400 mcm	285	450	(1) #6 to 400 mcm	517	700	(2)-1/0 to 600 mcm
	575/60	367	226	350	(1) #6 to 400 mcm	226	350	(1) #6 to 400 mcm	410	500	(2)-1/0 to 600 mcm
300	460/60-400/50	514	288	450	(1) #6 to 400 mcm	343	500	(1) #4 to 500 mcm	578	800	(2)-1/0 to 600 mcm
	575/60	407	229	350	(1) #6 to 400 mcm	272	450	(1) #6 to 400 mcm	458	600	(2)-1/0 to 600 mcm
320	460/60-400/50	558	343	500	(1) #4 to 500 mcm	343	500	(1) #4 to 500 mcm	622	800	(2)-1/0 to 600 mcm
	575/60	441	273	450	(1) #6 to 400 mcm	272	450	(1) #6 to 400 mcm	493	600	(2)-1/0 to 600 mcm
340	460/60-400/50	637	448	600	(2)-1/0 to 600 mcm	288	450	(1) #6 to 400 mcm	690	900	(2)-1/0 to 600 mcm
	575/60	499	350	500	(1) #4 to 500 mcm	228	350	(1) #6 to 400 mcm	542	700	(2)-1/0 to 600 mcm
370	460/60-400/50	662	517	700	(2)-1/0 to 600 mcm	243	400	(1) #6 to 400 mcm	715	900	(2)-1/0 to 600 mcm
	575/60	524	410	500	(2)-1/0 to 600 mcm	193	300	(1) #6 to 400 mcm	567	700	(2)-1/0 to 600 mcm
400	460/60-400/50	726	537	700	(2)-1/0 to 600 mcm	299	500	(1) #6 to 400 mcm	781	1000	*
	575/60	580	430	600	(2)-1/0 to 600 mcm	240	400	(1) #6 to 400 mcm	624	800	(2)-1/0 to 600 mcm
420	460/60-400/50	743	517	700	(2)-1/0 to 600 mcm	343	500	(1) #4 to 500 mcm	807	1000	*
	575/60	588	410	500	(2)-1/0 to 600 mcm	272	450	(1) #6 to 400 mcm	640	800	(2)-1/0 to 600 mcm

NOTES: (1) MCA - Minimum Circuit Ampacity per NEC440-33
(2) MFS - Maximum Fuse Size per NEC440-22
(3) Copper conductors only.
(4) Units are not available for 200/230/240V operation.

* - (2) - 1/0 to 600 mcm & (1) - #6 to 400 mcm

UNIT ELECTRICAL DATA: 60 HZ / 3 PH

ACDX Model		Nom. Volts	Electrical Data: Unit RLA	Std. Dual Power Circuit #1 MCA	Std. Dual Power Circuit #1 MFS	Std. Dual Power Circuit #2 MCA	Std. Dual Power Circuit #2 MFS	Optional Single Power MCA	Optional Single Power MFS	Compressor: Qty / Model	Compressor: RLA each	Compressor: LRA each	Compressor: Step In-rush	Condenser Fan Motors: Std. 1140 RPM Fan Motors Qty	HP	Total kW	FLA Each	Compressor: Oil Sump Htr. Total Watts	Total Amps
270	AU	400/50	464	285	450	285	450	517	700	(2) 1215	211	1330	520	14	1.5	20.3	3.0	800	6.6
	AR	460/60	464	285	450	285	450	517	700	(2) 1215	211	1330	520	14	1.5	20.3	3.0	800	6.6
	AS	575/60	367	226	350	226	350	410	500	(2) 1215	169	1064	416	14	1.5	20.3	2.1	800	6.6
300	AU	400/50	514	288	450	343	500	578	800	(1) 1215 (1) 1218	211 255	1330 1485	520 600	16	1.5	23.2	3.0	800	6.6
	AR	460/60	514	288	450	343	500	578	800	(1) 1215 (1) 1218	211 255	1330 1485	500 600	16	1.5	23.2	3.0	800	6.6
	AS	575/60	407	229	350	272	450	458	600	(1) 1215 (1) 1218	169 204	1064 1188	416 480	16	1.5	23.2	2.1	800	6.6
320	AU	400/50	558	343	500	343	500	622	800	(2) 1218	255	1485	600	16	1.5	23.2	3.0	800	6.6
	AR	460/60	558	343	500	343	500	622	800	(2) 1218	255	1485	600	16	1.5	23.2	3.0	800	6.6
	AS	575/60	441	272	450	272	450	493	600	(2) 1218	204	1188	480	16	1.5	23.2	2.1	800	6.6
340	AU	400/50	637	448	600	288	450	690	900	(2) 1212 (1) 1215	183 211	1050 1330	448 520	20	1.5	29.0	3.0	1200	9.9
	AR	460/60	637	448	600	288	450	690	900	(2) 1212 (1) 1215	183 211	1050 1030	448 520	20	1.5	29.0	3.0	1200	9.9
	AS	575/60	499	350	500	228	350	542	700	(2) 1212 (1) 1215	144 169	840 1064	359 416	20	1.5	29.0	2.1	1200	9.9
370	AU	400/50	662	517	700	243	400	715	900	(2) 1215 (1) 1212	211 180	1330 1050	520 448	20	1.5	29.0	3.0	1200	9.9
	AR	460/60	662	517	700	243	400	715	900	(2) 1215 (1) 1212	211 180	1330 1050	520 448	20	1.5	29.0	3.0	1200	9.9
	AS	575/60	524	410	500	193	300	567	700	(2) 1215 (1) 1212	169 144	1064 840	416 359	20	1.5	29.0	2.1	1200	9.9
400	AU	400/50	726	537	700	299	500	781	1000	(3) 1215	220	1330	520	22	1.5	31.9	3.0	1200	9.9
	AR	460/60	726	537	700	299	500	781	1000	(3) 1215	220	1330	520	22	1.5	31.9	3.0	1200	9.9
	AS	575/60	580	430	600	240	400	625	800	(3) 1215	178	1064	416	22	1.5	31.9	2.1	1200	9.9
420	AU	400/50	743	517	700	343	500	807	1000	(2) 1215 (1) 1218	211 255	1330 1485	520 600	22	1.5	31.9	3.0	1200	9.9
	AR	460/60	743	517	700	343	500	807	1000	(2) 1215 (1) 1218	211 255	1330 1485	520 600	22	1.5	31.9	3.0	1200	9.9
	AS	575/60	588	410	500	272	450	640	800	(2) 1215 (1) 1218	169 204	1064 1188	416 480	22	1.5	31.9	2.1	1200	9.9

Notes:
1. ACDX units have separate 115VAC cooler heater circuit. Total 1680 Watts - 14.7 Amps
2. Refer to compressor nameplate for complete model number.
3. Low Ambient Option Units have (2) 1 HP single phase fan motors at 2.4 amps each.
4. Copper Conductors ONLY.
5. Units for 200/230/240 voltage power, are not available.

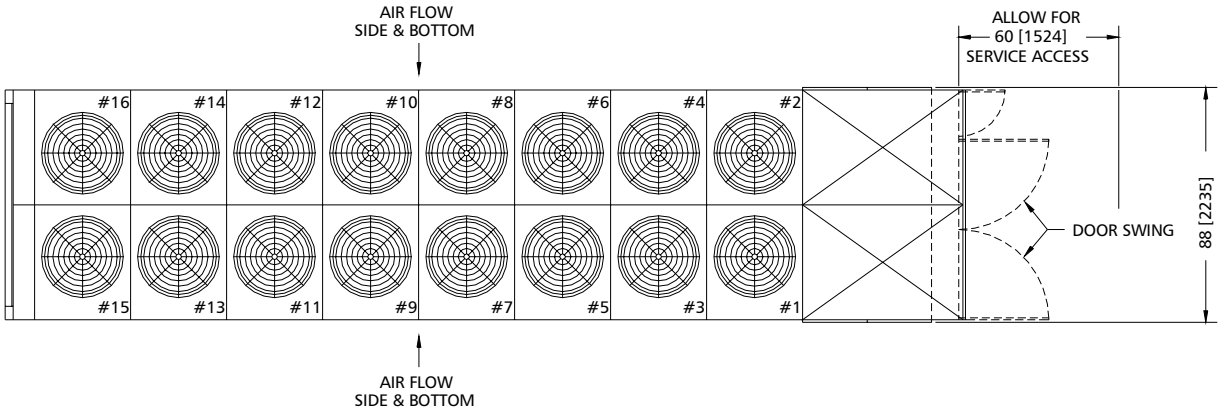
RLA	Rated Load Amps at ARI Conditions of Service
MCA	Minimum Corcuit Ampacity
MFS	Maximum Fuse Size, protective device
LRA	Locked Rotor Amps

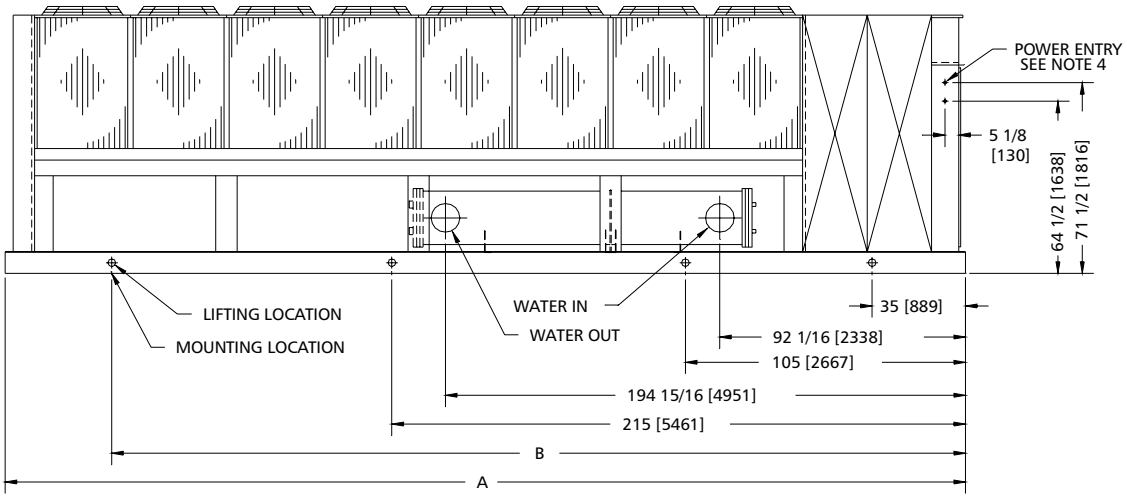
General Electrical Notes:

1. Main power must be supplied from a dual or single source field-supplied fused disconnect(s) using dual element time delay fuses.
2. The Power Supply must be three phase.
3. The maximum incoming wire size is 500MCM. On units having a MCA greater than 500 MCM wire, the factory-supplied field power terminal block will accept two parallel field wires per pole.
4. Standard compressor starting is by incremental starting method.
5. Cooler heater power (115VAC) must be field-supplied from a separate field-mounted fused disconnect (15 amp max. fuse size).
6. Crankcase heaters are wired in the control circuit. **The main power, field fused disconnect, (and local safety switch if used) must be closed (ON) at all times for heater operation.**
7. The compressor crankcase heaters must be energized for 24 hours before the unit is initially started, or after a prolonged period with the power disconnected from the oil sump heaters.
8. All field wiring must be done in accordance with all applicable local and national codes.
9. Minimum and maximum unit supply voltages are shown in the following tabular data.

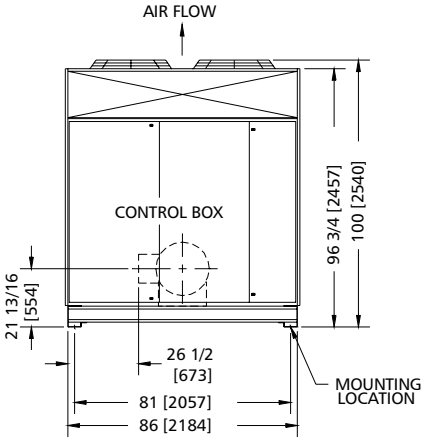
Supply Voltage		
Nominal	**Minimum**	**Maximum**
400/3/50	360V	440V
460/3/60	414V	506V
575/3/60	518V	632V

DIMENSIONAL DATA: ACDX 270-320





DIM. DATA TABLE				CHILLER INFORMATION	
MODEL ACDX	NO# OF FANS	DIM. A	DIM. B	MODEL EVAP.	WATER CONNECTION
270	14	324	284	EXD20122	10 VICTAULIC
METRIC DIM.		8230	7214		254 VICTAULIC
300	16	360	320	EXD20122	10 VICTAULIC
METRIC DIM.		9144	8128		254 VICTAULIC
320	16	360	320	EXD20122	10 VICTAULIC
METRIC DIM.		9144	8128		254 VICTAULIC



NOTES:
1 - ALL DIMENSIONS ARE IN INCHES AND MILLIMETERS.
2 - VENT & DRAIN CONNECTIONS PROVIDED ON COOLER.
3 - ALLOW 60 [1524] CLEARANCE AT CONTROL PANEL END OF UNIT FOR SERVICE.
4 - USE MINIMUM 36 [914] FLEXIBLE CONDUIT TO CONTROL BOX TO ISOLATE UNIT.
5 - WATER PIPNG TO BE SUPPORTED TO MINIMIZE LOAD ON UNIT.
6 - ALL DIMENSIONS AND SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.
7 - WATER CONNECTION SIZES SHOWN ARE NOMINAL BORE INCH SIZE WITH MILLIMETER EQUIVALENT.

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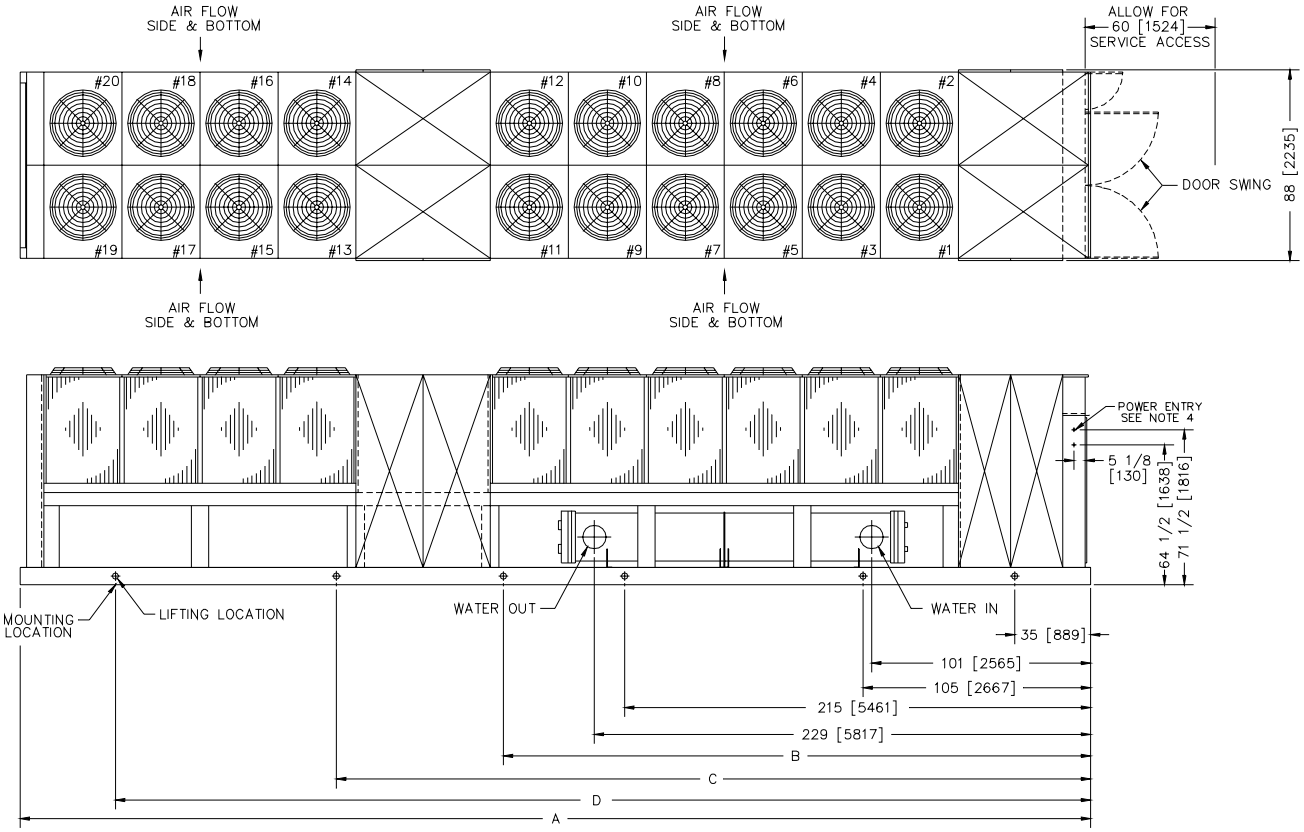
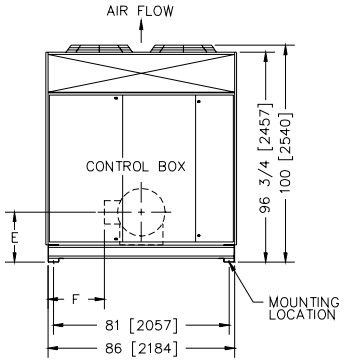
DIMENSIONAL DATA: ACDX 340-420



DIMENSIONAL DATA TABLE								CHILLER INFORMATION	
MODEL ACDX	NO# OF FANS	DIM. A	DIM. B	DIM. C	DIM. D	DIM. E	DIM. F	MODEL EVAP.	WATER CONNECTION
340	20	494	271	348	450	22 13/16	26	EXT22149	10 VICTAULIC
METRIC DIM.		12,548	6883	8839	11,430	579	660		254 VICTAULIC
370	20	494	307	384	460	22 13/16	26	EXT22149	10 VICTAULIC
METRIC DIM.		12,548	7798	9754	11,684	579	660		254 VICTAULIC
400	22	530	307	384	480	23 13/16	25	EXT24149	10 VICTAULIC
METRIC DIM.		13,462	7798	9754	12,192	605	635		254 VICTAULIC
420	22	530	307	384	480	23 13/16	25	EXT24149	10 VICTAULIC
METRIC DIM.		13,462	7798	9754	12,192	605	635		254 VICTAULIC



NOTES:
1 – ALL DIMENSIONS ARE IN INCHES AND MILLIMETERS.
2 – VENT & DRAIN CONNECTIONS PROVIDED ON COOLER.
3 – ALLOW 60 [1524] CLEARANCE AT CONTROL PANEL END OF UNIT FOR SERVICE.
4 – USE MINIMUM 36 [914] FLEXIBLE CONDUIT TO CONTROL BOX TO ISOLATE UNIT.
5 – WATER PIPNG TO BE SUPPORTED TO MINIMIZE LOAD ON UNIT.
6 – ALL DIMENSIONS AND SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.
7 – WATER CONNECTION SIZES SHOWN ARE NOMINAL BORE INCH SIZE WITH MILLIMETER EQUIVALENT.

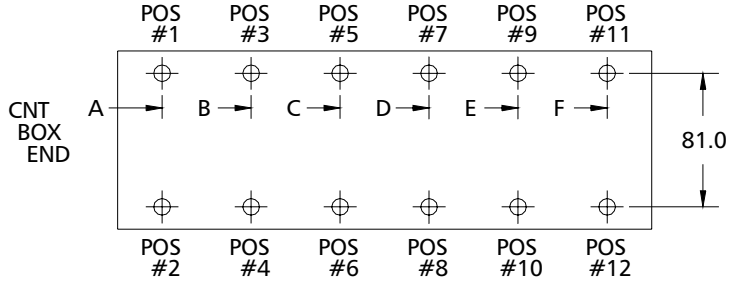
WEIGHT DISTRIBUTION & ISOLATOR LOCATION

UNIT MODEL ACDX	ISOLATOR LOCATIONS DIMENSIONS - INCHES					
	A DIM	B DIM	C DIM	D DIM	E DIM	F DIM
270	35.0	105.0	215.0	284.0		
300	35.0	105.0	215.0	320.0		
320	35.0	105.0	215.0	320.0		
340	35.0	105.0	215.0	271.0	348.0	450.0
370	35.0	105.0	215.0	307.0	384.0	460.0
400	35.0	105.0	215.0	307.0	384.0	480.0
420	35.0	105.0	215.0	307.0	384.0	480.0

UNIT MODEL ACDX	ISOLATOR WEIGHTS LOAD-LBS.												TOTAL OPERATING WGT.(LBS.)
	POS #1	POS #2	POS #3	POS #4	POS #5	POS #6	POS #7	POS #8	POS #9	POS #10	POS #11	POS #12	
270	2013	2013	2867	2867	2052	2052	1084	1084					16,032
300	2013	2013	2865	2865	2313	2313	1229	1229					16,840
320	2013	2013	2865	2865	2313	2313	1229	1229					16,840
340	1770	1770	2883	2883	2726	2726	1005	1299	1226	1520	1356	1356	22,520
370	2015	2015	2881	2881	3045	3045	1189	1325	1026	1162	1051	1051	22,686
400	2017	2017	3059	3059	3223	3223	1247	1541	1138	1432	1381	1381	24,718
420	2017	2017	3059	3059	3223	3223	1247	1541	1138	1432	1381	1381	24,718

UNIT MODEL ACDX	ISOLATOR LOCATIONS DIMENSIONS - MILLIMETERS					
	A DIM	B DIM	C DIM	D DIM	E DIM	F DIM
270	889	2667	5461	7214		
300	889	2667	5461	8128		
320	889	2667	5461	8128		
340	889	2667	5461	6883	8839	11,430
370	889	2667	5461	7798	9754	11,684
400	889	2667	5461	7798	9754	12,192
420	889	2667	5461	7798	9754	12,192

UNIT MODEL ACDX	ISOLATOR WEIGHTS LOAD - KILOGRAMS												TOTAL OPERATING WGT.(KG.)
	POS #1	POS #2	POS #3	POS #4	POS #5	POS #6	POS #7	POS #8	POS #9	POS #10	POS #11	POS #12	
270	913	913	1300	1300	931	931	492	492					7272
300	913	913	1300	1300	1049	1049	557	557					7638
320	913	913	1300	1300	1049	1049	557	557					7638
340	803	803	1308	1308	1237	1237	456	589	556	689	615	615	10,216
370	914	914	1307	1307	1381	1381	539	601	465	527	477	477	10,290
400	915	915	1388	1388	1462	1462	566	699	516	650	626	626	11,213
420	915	915	1388	1388	1462	1462	566	699	516	650	626	626	11,213



ISOLATOR BOLT HOLE DIMENSIONS ARE .688

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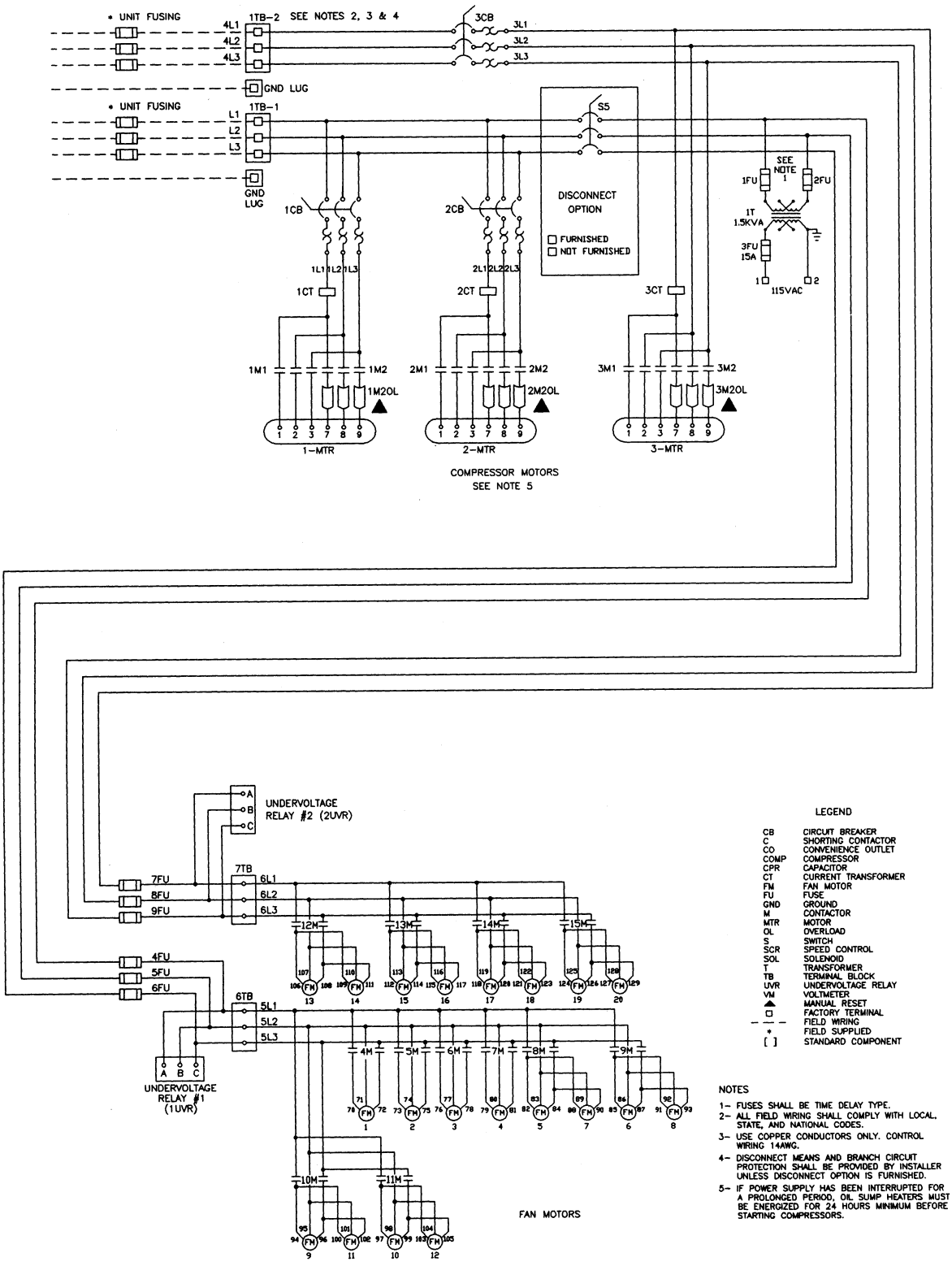
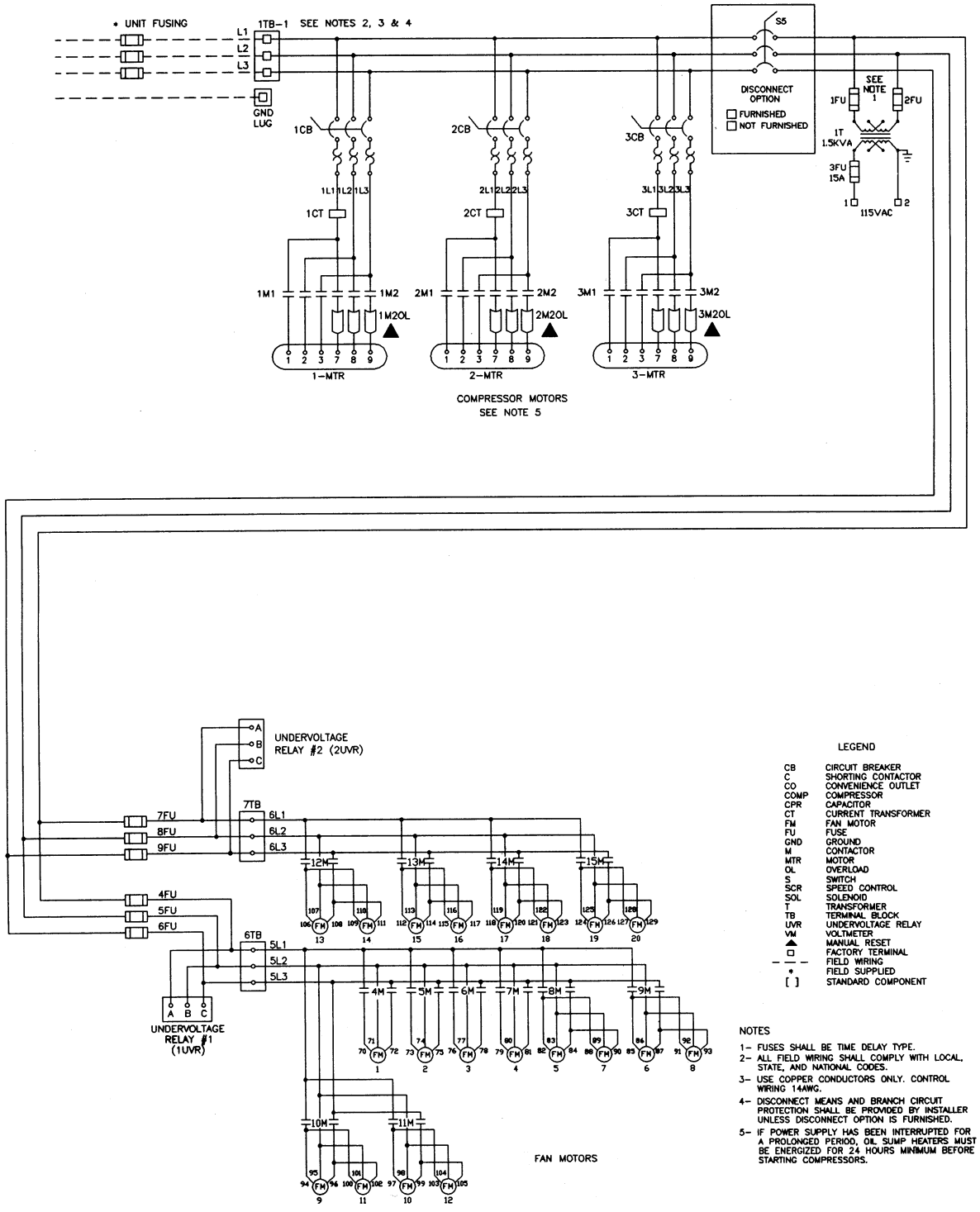
TYPICAL STANDARD DUAL SOURCE POWER WIRING



TYPICAL OPTIONAL SINGLE SOURCE POWER WIRING



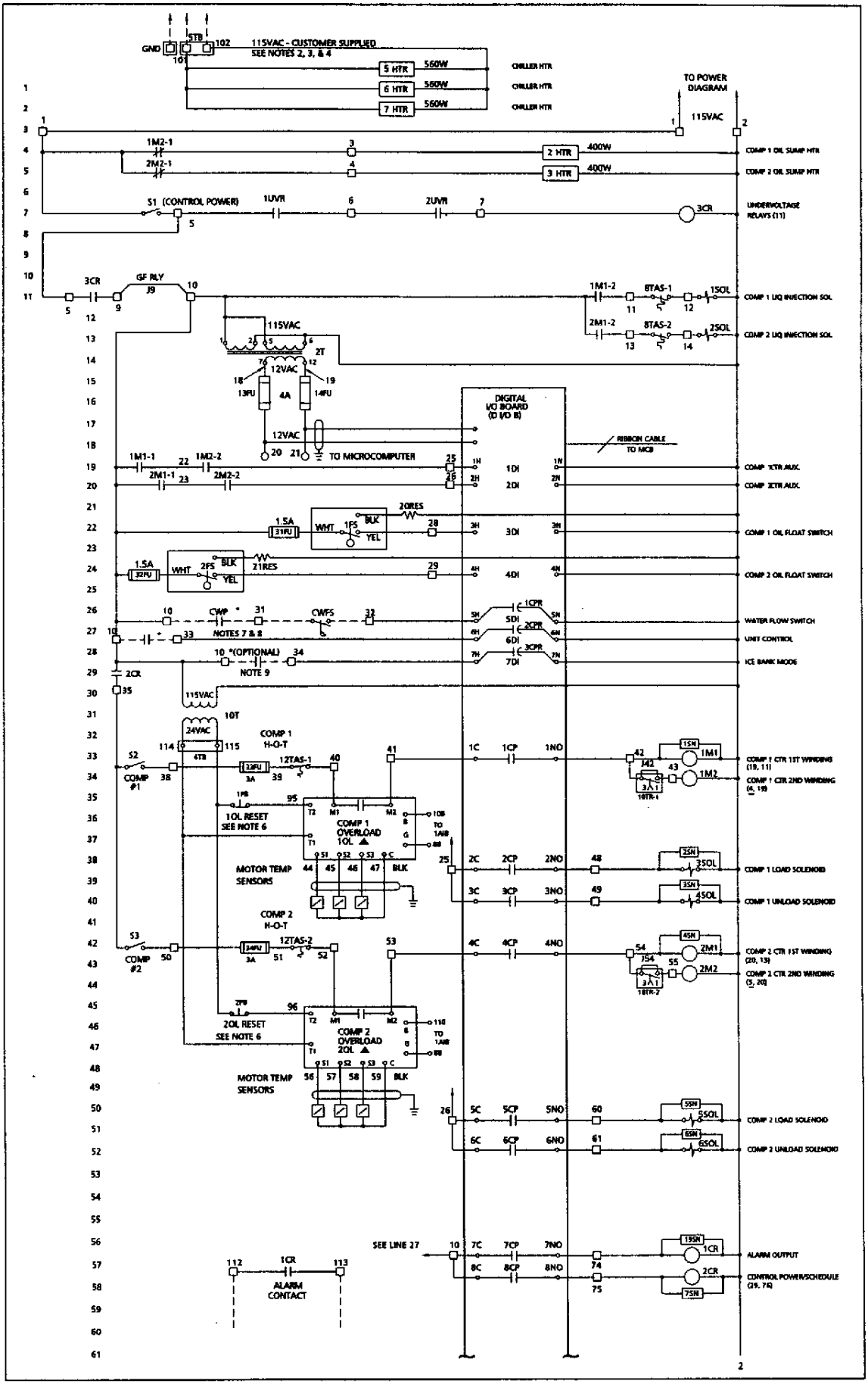
LEGEND

CB	CIRCUIT BREAKER
C	SHORTING CONTACTOR
CO	CONVENIENCE OUTLET
COMP	COMPRESSOR
CPR	CAPACITOR
CT	CURRENT TRANSFORMER
FM	FAN MOTOR
FU	FUSE
GND	GROUND
M	CONTACTOR
MTR	MOTOR
OL	OVERLOAD
S	SWITCH
SCR	SPEED CONTROL
SOL	SOLENOID
T	TRANSFORMER
TB	TERMINAL BLOCK
UVR	UNDERVOLTAGE RELAY
VM	VOLTMETER
▲	MANUAL RESET
□	FACTORY TERMINAL
– – –	FIELD WIRING
*	FIELD SUPPLIED
[ ]	STANDARD COMPONENT

NOTES

1- FUSES SHALL BE TIME DELAY TYPE.
2- ALL FIELD WIRING SHALL COMPLY WITH LOCAL, STATE, AND NATIONAL CODES.
3- USE COPPER CONDUCTORS ONLY. CONTROL WIRING 14AWG.
4- DISCONNECT MEANS AND BRANCH CIRCUIT PROTECTION SHALL BE PROVIDED BY INSTALLER UNLESS DISCONNECT OPTION IS FURNISHED.
5- IF POWER SUPPLY HAS BEEN INTERRUPTED FOR A PROLONGED PERIOD, OIL SUMP HEATERS MUST BE ENERGIZED FOR 24 HOURS MINIMUM BEFORE STARTING COMPRESSORS.

TYPICAL CONTROL WIRING: ACDX 270-320



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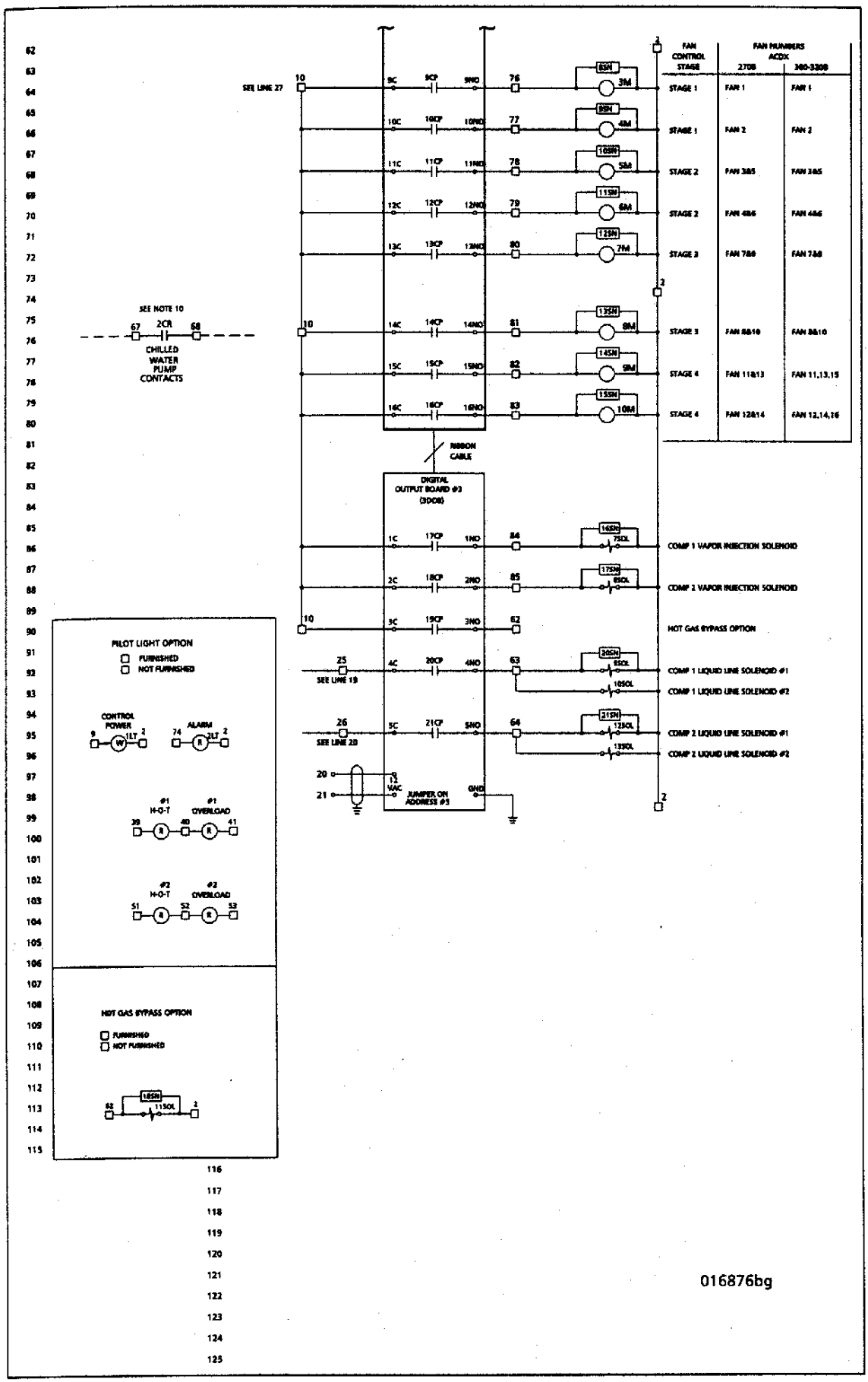
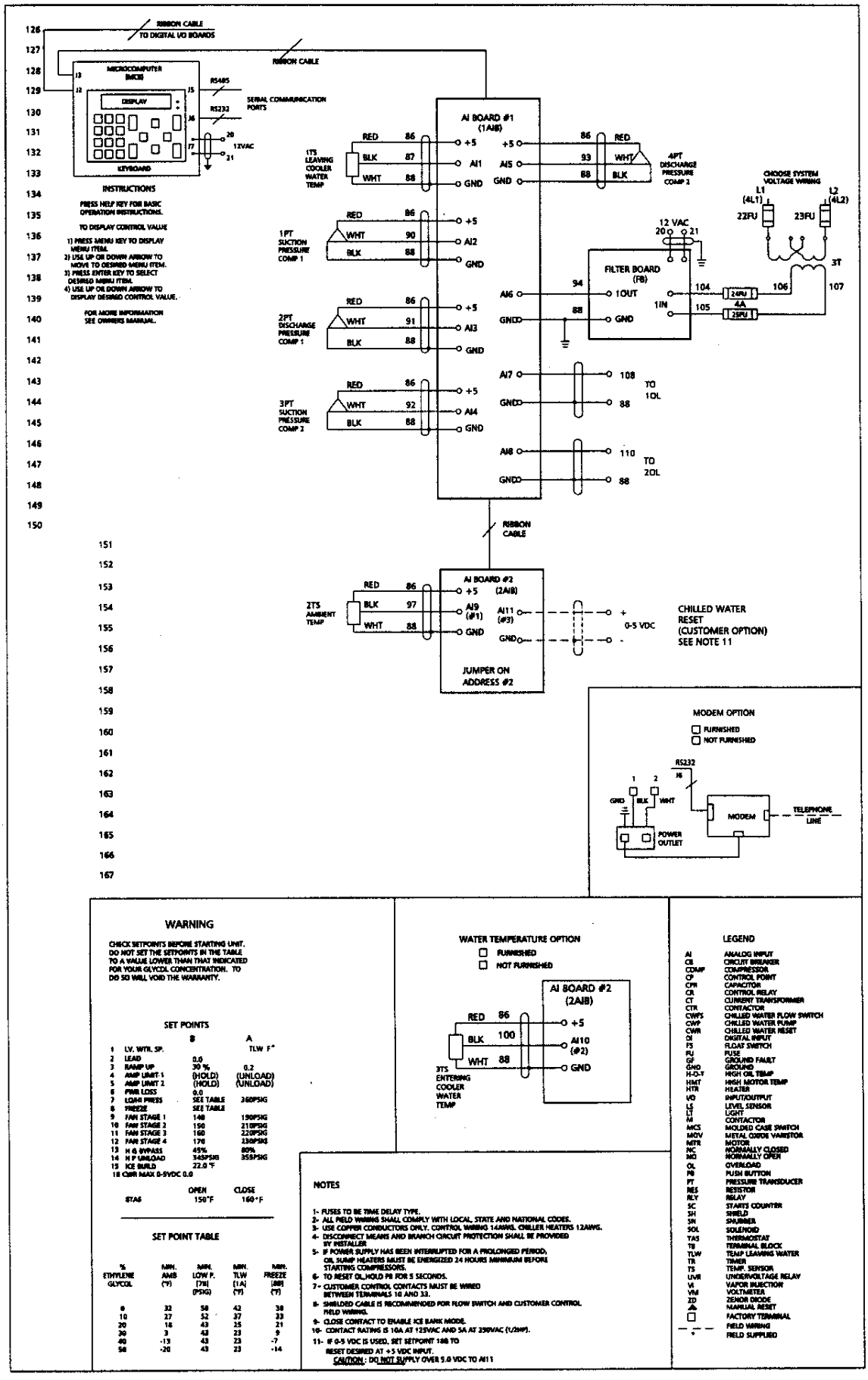
TYPICAL CONTROL WIRING: ACDX 270-320 (CONT.)



TYPICAL CONTROL WIRING: ACDX 270-320 (CONT.)



TYPICAL SEQUENCE OF OPERATION

(Ref. Typical Wiring Diagrams on pages 31, 32 and 33)

The following sequence of operation for two compressor unit is typical of all ACDX Models. Refer to the wiring diagram furnished with the unit for specific information.

( ) Control Identification Symbol
[ ] Circuit Line Number

Important Note!
With all the control circuit switches (S1-S3) in the "off" position, Terminals #1 and #2 must have 115 volts supplied for a minimum of 24 hours to energize the compressor crankcase heaters (HTR).

Preliminary Sequence—Close the main power disconnect switch. Verify proper voltage. Check to see that the indicating light on the under voltage relay (UVR) is lit. **This light must be on to indicate proper phase rotation for the compressors.** If the light is not on, disconnect the main power and reverse any two phase legs at the Main Incoming Power Terminal Block. (WARNING! DO NOT REVERSE THE LEADS ON THE PHASE LOSS MONITOR FOR THIS WILL ALLOW THE COMPRESSORS TO RUN BACKWARDS, CAUSING SEVERE DAMAGE, & WILL VOID THE COMPRESSOR WARRANTY!) Check phase sequence using a meter before compressor start.

The crankcase heater relay contacts (1M2-1) and (2M2-1) are closed and are supplying power to the compressor crankcase heaters. Power must also be supplied to the chiller heaters by the separate customer supplied 115 VAC supply. Terminal block 5TB.

Control power is turned on by the Control Power Switch (S1). The ground fault relay (GF RLY), if supplied, must be turned on to activate the computer.

Start up the chilled water pump. The water flow is confirmed when the water flow switch completes the electrical circuit across Terminals #31 and #32 and when chilled water pump auxiliary (CWP) closes between #10 and #31.

Check to make sure unit control contacts between terminals #10 and #33 close when the unit needs to operate.

Set the desired leaving water temperature (e.g. 44°F - 6.66°C) in the microcomputer setpoint 1A. See microcomputer controller section.

Place the two compressor control circuit switches (S2-S3) in the "On" position, thus energizing the balance of the control circuit. All safety controls must be satisfied and the microcomputer has been RESET. The system may be in a 'Time-in' mode for up to fifteen minutes before the first compressor will start.

Stage I Starting

In summary, the following conditions must be met to start a compressor:

- system voltage above undervoltage relay (UVR) setting
- chilled water pump running
- chilled water flow switch made
- compressor circuit breakers on
- customer unit control contact closed
- control switch and compressor switches on
- reset pressed on microcomputer **keypad**
- power has been on the microcomputer for 15 minutes
- all safety conditions satisfied
- leaving chilled water temperature 20°F (1°C) or more above setpoint
- schedule in microcomputer set for unit operation

A compressor is started by first energizing 1M1 followed by 1M2 after 1 second if step start is activated. Otherwise, both contactors energize together. Anti-recycle time of 15 minutes is initiated within the computer at start.

The liquid line valve will stay closed until the suction pressure drops to the low pressure cut-out. The valve will then open and start pulsing every 3 seconds to maintain desired suction superheat. As condenser pressure rises, the microcomputer will stage on the fans according to the fan setpoints.

Stage 1 Modulation
When the compressor starts, the microcomputer monitors amperage by means of 1CT, voltage using 3T, leaving water temperature using 1TS, and condensing pressure. These inputs are used to control the loading and staging of the compressor. The compressors loading is controlled by pulsing signals to the load and unload solenoids.

Stages 2 and 3 Starting
If the safety conditions are satisfied for the #2 compressor, at least 1 minute has elapsed since #1 compressor has reached full load, and leaving water temperature remains above the deadband; 2M1 and 2M2 will be activated by the microcomputer, 2M2 will close after 1 second delay, if step start is desired). #2 compressor also has a 15 minute anti-recycle timer built into the microcomputer. Loading of the #2 compressor is controlled the same as compressor #1 Compressor #3 operates in a similar manner.

For each compressor, the liquid line valve will stay closed until suction pressure falls to the low pressure cut-out. The valve will then open and pulse to maintain chiller superheat.

The fans will also be staged on to maintain proper condenser pressure.

Shutdown Sequence

Stage 2 and 3 Shutdown
When leaving water temperature falls below setpoint minus deadband, the compressors begin to unload. When the operating compressor capacities fall below a predetermined setpoint, the last compressor is shut down. The corresponding liquid line valve closes and the fans turn off. When a compressor turns off, the remaining compressors load up to maintain the leaving water temperature.

Stage 1 Shutdown
If the leaving water temperature is still lower than the setpoint, compressor 1 unloads fully and then turns off. Circuit #1 liquid line valve turns off and the fans turn off.

GUIDE SPECIFICATIONS

Part 1: General

1.01 Work Included

A. Provide a complete Air Cooled Packaged Chiller utilizing rotary screw compressors suitable for outdoor installation and be controlled by a Full Function Microcomputer Controller. Contractor shall furnish and install chiller(s) as shown and scheduled on the drawings. Units shall be installed in accordance with this specification.

B. Chillers shall be selected for use with water / (___% ethylene or propylene glycol).

1.02 Quality Assurance

A. Unit construction shall be designed to conform to ANSI / ASHRAE 15 latest version safety standards, NEC (USA), and ASME Section VIII (USA) applicable codes.

B. Unit shall have ETL (USA) and cETL (Canadian) approval (60Hz)

C. The unit shall comply with all local codes.

D. Unit efficiency shall meet or exceed the latest version of ASHRAE Standard 90.1.

E. The unit shall be rated in accordance with ARI Standard 550/590 latest version.

F. The unit shall be fully tested at the factory with all options mounted and wired.

1.03 Design Base

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

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

1.04 Related Work Specified Elsewhere

A. General Provisions: Section 15XXX

B. General Completion and Startup: Section 15XXX

C. Equipment & Pipe Identification: Section 15XXX

D. Tests: Section 15XXX

E. Vibration Isolation: Section 15XXX

F. Chilled Water System: Section 15XXX

1.05 Submittals

A. Submit shop drawings on each piece of equipment specified in accordance with Specifications Section 51010, General Provisions.

B. Furnish three (3) sets of Operations and Maintenance Data.

1.06 Delivery and Handling

A. The unit shall be delivered to the job site completely assembled and charged with refrigerant and oil by the manufacturer.

B. Delivery and handling shall comply with the manufacturer's instruction for rigging and handling.

C. The unit controls shall be capable of withstanding 150°F (66°C) - storage temperature in the control panel for an indefinite period of time

1.07 Start-Up

A. The contractor shall provide labor to accomplish the check, test and startup procedure as recommended by the unit manufacturer.

B. The startup serviceman shall provide and complete the manufacturers check, test and start forms. One copy shall be sent to the engineer and one copy to the manufacturer's factory.

C. The unit manufacturer shall provide a factory-trained serviceman to supervise the original startup of the units for final operation.

1.08 Warranty

A. The equipment supplier shall provide a warranty on the entire refrigeration system exclusive of refrigerant for a period of one (1) year from date of start-up or 18 months from date of shipment, whichever occurs first. Compressors shall have, as standard, an additional one (1) year warranty, **2 years total.**

B. (Provide an optional extended three - (3) year warranty on the compressors only, 5 years total).

C. The start-up date shall be certified by the Mechanical Contractor, and provided to the Manufacturer, Engineer and Owner.

D. (During the warranty period, the equipment supplier shall furnish the services of an authorized service agency for all labor associated with parts replacement or repair, and start-up of the refrigeration equipment at the beginning of each cooling season. The equipment supplier shall also furnish the services of an authorized service agent for one maintenance visit during winter months of operation, the Owner shall designate such time.)

1.09 Maintenance

Maintenance of the chillers shall be the responsibility of the owner and performed in accordance with the manufacturer's instructions.

Part 2: Products

2.01 Air Cooled Rotary Screw Water Chillers

2.02 Acceptable Manufacturers

A. Dunham-Bush, Inc.

B. (Approved equal)

2.03 General

A. Furnish and install as shown on the plans, an air-cooled, twin rotor, screw compressor water chiller with infinite capacity control. Units shall be Dunham-Bush Model ACDX or equal.

B. The units are to be completely factory assembled and wired in a single package complete with Twin Rotor Screw compressor, cooler, condenser, starting controls, safety controls and operating controls. The unit is to be given a complete factory operating and control sequence test under load conditions with fluid hooked up, and is to be shipped with full operating charge of refrigerant and oil.

C. The units shall be built in accordance with all applicable national and local codes including the ANSI safety code; the National Electrical Code and applicable ASME Code for Unfired Pressure Vessels.

D. The unit shall meet or exceed the latest ASHRAE standard 90.1 Energy Efficiency Code.

E. The unit shall be furnished for operation on 460 volt, three phase, 60 Hertz power supply and have a unit EER rating of no less than _____.

2.04 Performance

The units shall be furnished as shown on capacity schedules and drawings. Unit performance shall be rated in accordance with ARI Standard 550/590, latest revision.

2.05 Construction

The unit will be designed for maximum corrosion protection being of heavy gauge, G90 approved galvanized steel construction. The base shall be manufactured of formed, 8 gauge, galvanized steel channel. Frame members and legs are constructed of 12 gauge, galvanized steel. The unit control center, end enclosure panels and fan decking shall be constructed of 16 gauge galvanized steel and be finished with a baked power high grade outdoor quality coating system which exceeds 500 hour salt spray requirements when tested in accordance with the ASTM-B-117 specifications. The overall dimensions shall not exceed ____ inches (millimeters) in length, _____ inches (millimeters) in width and _____ inches (millimeters) in height.

2.06 Cooler

The cooler shall be direct expansion, shell and tube type. The shell shall be fabricated from carbon steel, with inner finned copper tubes roller expanded. Water control baffles shall be cold-rolled steel. The heads shall be removable and constructed of carbon steel. Coolers shall be designed, constructed and inspected to comply with latest edition ASME code for unfired pressure vessels. Shell side (water) design working pressure shall be minimum 200 PSIG and tube side (refrigerant) design working pressure shall be minimum 250 PSIG. The cooler is to be circuited so that no more than one compressor is connected to an independent refrigerant circuit.

A thermostatically controlled electric resistance heater cable shall be wrapped around the shell to prevent freezing down to -20°F ambient temperature. The cooler shell be insulated with ¾" thick closed-cell urethane insulation with a .28 K factor at 75°F mean temperature.

2.07 Condenser

The condenser coil is to be constructed of copper tubes and die formed aluminum (copper) (poly-coat) fins having self-spacing collars. Fins shall be mechanically bonded to the tubes. Condenser divider baffles shall fully separate each condenser fan section to control the airflow to maintain proper head pressure control.

2.08 Fans

The fans shall be heavy duty, aluminum blade, direct drive propeller type. Motors shall be three phase (single phase, variable speed motor used on the lead fan of each refrigerant circuit for optional low ambient) with internal overloads and are to be permanently lubricated. Belt driven designs are not acceptable due to excessive maintenance requirements.

2.09 Compressor

A. Provide a positive displacement, twin rotor, screw compressor with infinite capacity control. All compressors shall be direct driven with a 3500 RPM integral discharge gas-cooled hermetic (semi-hermetic) motor.

B. Each compressor shall include an integral oil separation system, oil sump, oil sight glass and oil filter. The oil temperature shall be controlled during operation to maintain proper oil temperature throughout the lubrication system. Integral lubrication system utilizing compressor pressure differentiation.

C. Each compressor shall be fitted with a crankcase heater to maintain oil temperature during shutdown period.

D. Each compressor shall have a suction check valve, suction filter and a discharge check valve. In addition, each compressor shall be furnished with a suction service valve permitting isolation of the complete refrigerant charge in the condenser.

E. The compressor capacity control shall be obtained by an electrically initiated, hydraulically actuated, slide valve to provide infinite capacity control.

F. The compressor shall have a standard **Two Year Warranty**.

G. Rotors shall be of the latest asymmetrical profiles of Dunham-Bush design to assure operation at the highest efficiencies. They shall be precision machined from AISI 1141 Bar stock and case hardened.

H. Each rotor shall be fitted with a set of anti-friction tapered roller bearings which are capable of carrying both radial and thrust loads. All housings shall be manufactured of high grade, low porosity, cast iron.

I. Motor winding protection module shall be used in conjunction with sensors embedded in the compressor motor windings and shall be designed to prevent the motor from operating at unsafe limits. The overloads for the motor shall be solid state and three compressor models (340, 370, 400, 420) shall have branch short circuit protection as standard via circuit breakers for each compressor.

2.10 Capacity Control

A. An infinitely variable capacity control system that is capable of matching the demand requirement of the system.

B. A microcomputer-based controller shall modulate the compressor slide valves in response to supply water temperature and maintain water temperature within 3/4° F of set point. This system is to provide precise and stable control of supply water temperature over the complete range of operating conditions. It shall be capable of a system capacity control range of 100% to __% at specified conditions. (Provide hot gas bypass to provide capacity control to approximately 50% of the minimum unit slide valve unloading capability).

2.11 Refrigerant Circuit

A. The unit shall be provided with fully independent refrigerant circuits per compressor.

B. Units shall be provided with a multi-circuited direct expansion cooler and air cooled condenser.

C. The packaged chiller shall use a positive pressure refrigerant that will not require a purge system.

D. Each refrigerant circuit shall include dual thermal expansion valves, sight glass, moisture indicator, solenoid valve, replaceable core filter-drier, liquid line shut off valves, high pressure relief valves, charging and gauge connections, suction service valve and discharge check valve.

E. Each refrigerant circuit shall be supplied with an economizer cycle utilizing a separate shell and tube subcooler with its filter drier solenoid vale, sight glass, moisture indicator and thermal expansion valve to generate flash gas for vapor injection into compressor after rotors close off to suction to increase overall unit efficiency.

2.12 Control Center

A. Control Center shall be fully enclosed in baked powder coated steel, control panel with hinged access doors. Dual compartments, separating the safety and operating controls from the power controls, are to be provided. A 115 volt control power transformer shall be supplied.

1. Separate terminal blocks for main power, and 115 VAC chiller heater power
2. Compressor starting contactors for across the line or delta/delta incremental start.
3. Solid state motor protection module providing phase loss, current unbalance, phase reversal, current sensing and thermal overload protection
4. Complete labeling of all control components
5. Numbering of wires and terminal strips for easier wire tracing
6. Terminals for customer digital input to enable/disable unit
7. Dry contacts for cooler water pump control
8. Dry contacts for unit alarm
9. Condenser fan control contactors
10. Fused fan circuits
11. Condenser pressure sensing fan cycling control for start-up and operation down to 20°F. ambient
12. (Convenience outlet powered through the control transformer)
13. (Cooler heater transformer)
14. (Over/under voltage relay)
15. (Operation and safety lights visible from unit exterior including: power on; alarm; compressor overload, high oil temperature, high motor temperature)
16. (Control panel door latch solenoid to prevent door opening before turning off power to the unit)

17. (Analog ammeter with 3-phase selector switch)
18. (Analog voltmeter with 3-phase selector switch)
19. (Entering chilled water temperature sensor)

B. Control Center's individual Microcomputer shall provide compressor staging based on leaving water temperature and maintain equal loading of multiple compressors throughout the full range of operation. It shall have a two-line 80 character alphanumeric Liquid Crystal display utilizing an easy-to-understand menu driven software. It shall be proactive in control and accommodate system anomalies such as high condensing pressure, low suction pressure, and high compressor amp draw by controlling loading to keep the unit running but at reduced capacity until the fault is fixed. Battery backed-up real time clock and memory with over 10 years life and automatic recharge of lithium ion battery that requires no service.

C. Microcomputer: individual chiller controller shall provide for:

1. **Unit control:**
   a. Staging of compressors
   b. Loading and unloading of compressors based on leaving water temperature
   c. Activating condenser fan relays for fan cycling head pressure control
   d. Seven-day time clock with schedules for machine control
   e. Proactive control to unload the compressors based on high pressure, low pressure, and high amp draw too reduce nuisance trips
   f. (Control of hot gas bypass circuit)
   g. Dry contacts for chilled water pump control
   h. Terminals for customer enable/disable of unit
   i. Dry contacts for unit alarm
2. **Unit Protection:**
   a. Low pressure protection
   b. High pressure protection
   c. Automatic re-start from power outage
   d. Cooler freeze protection
   e. Compressor current limiting
   f. Anti-recycling protection
   g. Sensor error
   h. Motor high temperature protection
   i. Low oil level
   j. Dry contacts for chilled water pump control
   k. Over current protection
   l. Phase loss, phase reversal and phase imbalance
   m. Ramp control for timed unit loading when the return water temperature is 5°F above leaving water set point
3. **Microcomputer** - **Readouts** shall provide the following:
   a. Compressor run time and cycles
   b. Leaving liquid temperature
   c. (Entering liquid temperature)
   d. Compressor ampere draw
   e. Suction pressure each compressor
   f. Discharge pressure each compressor
   g. Unit control contacts
   h. Water flow switch
   i. Chilled water reset
   j. Digital Outputs
   k. Compressor control status
   l. Unloader control status
   m. Liquid line solenoid control status
   n. Condenser fan control status
   o. Alarm control status
   p. Control power status
   q. Ambient temperature
   r. Chilled water pump control
   s. Utility demand limit

4. **Microcomputer** - **Set-points** shall provide the following:
   a. High discharge pressure
   b. Low suction pressure
   c. Freeze protection temperature
   d. Leaving water temperature
   e. Condenser fan control
   f. Low suction unload
   g. High discharge unload
   h. High & low compressor amperes
   i. Chilled water reset
   j. Demand limit reset
   k. Low ambient lock-out
5. **Microcomputer - Alarm History** shall provide the following:
   a. The 8 most recent alarms can be displayed
   b. Low suction pressure of all circuits
   c. High discharge pressure of all circuits
   d. Freeze protection cutout
   e. No run
   f. No stop
   g. Loss of water flow
   h. Power failure
   i. Temperature sensor error
   j. Hi/Low pressure error
   k. Low oil level
6. **Microcomputer Remote Monitoring Capabilities:**
   a. **Telephone Modem (option):**
      The microcomputer is complete with an RS232 communications port and all hardware and software necessary to remotely monitor and control the packaged chiller through the optional phone modem. This option requires a dedicated phone line.
   b. **Remote Monitor Display Terminal (RMDT option):**
      The Remote Monitor Display Terminal is supplied with a 14" monitor, two (2) RS232 serial ports, 6 foot 115 volt power cord and an enhanced PC keyboard. The RMDT can be hard wired up to 50 feet away from the chiller for remote monitoring and operating of the one or multiple units. This option allows remote start-stop, chilled water set-point changes, and reading of all microcomputer screens including operating condition, faults, and fault history.
   c. **BMS - Building Management System Terminal:**
      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 communications protocol. Dunham-Bush has an open communications protocol policy with most BMS companies.
   d. **(Chiller*LINK* {CHLK option}):**
      The Chiller*LINK* shall be supplied for communication from the Chiller (or Chiller Network) to the BMS (Building Management System) through BACnet or MODBUS communicating systems)

2.13 Starting Equipment:

A. Unit mounted Compressor starting contactors for across the line or delta/delta closed transition incremental start.

B. Solid state motor protection module providing phase loss, current imbalance, phase reversal, current sensing and thermal overload protection.

C. (Non-fused disconnect switches with through-the-door interlocking handles.

D. (Compressor circuit breakers on Models 270, 300, 320). Standard on three compressor models.

2.14 Additional Equipment

A. (Copper Fin/Copper Tube condenser coil)

B. (Silicone polyester Poly-Coat condenser fin coating for maximum salt spray and corrosion resistance)

C. (Single Power Connection

D. (Cooler heater transformer)

E. (Convenience Outlet 115 volt AC powered dual 3 prong ground fault receptacle powered by control transformer and fused for 15 amps)

F. (Hot gas bypass valve to permit operation down to 50% of unit minimum mechanical unloading capability on lead compressor)

G. (Low ambient control to 0°F (-17.8°C) minimum starting ambient)

H. (Ground Fault Detector)

I. (Semi-Hermetic Compressors)

J. (Compressor sound blanket)

K. (Over and under voltage protection relay protects against high and low incoming voltage conditions as well as single phasing, phase reversal and phase imbalance)

L. (Circuit Breakers to provide branch circuit protection on Models ACDX 270, 300, 320)

M. (Fully Painted Unit meets the requirements for outdoor unit application of 500 Hour Salt Spray Paint tested in accordance with ASTM-B-117)

N. (Steel Painted Louvers for complete unit enclosure for general mechanical security and unit aesthetics)

O. (Aluminum Painted Grills similar to louvers except manufactured of aluminum with 3/8" x 3 1/2" slots instead of louvers for hail damage protection and unit aesthetics)

P. (Fin Guards Top only (1" x 4" wire mesh) for vertical side condenser coil protection)

Q. (Fin Guards Bottom only (1" x 4" wire mesh) for general unit mechanical security for the lower portion of the unit)

R. (Flow Switch shipped loose for field mounting and wiring)

S. (Vibration isolators shipped loose: spring or rubber-in-shear)

Part 3: Execution

3.01 Installation Work By Mechanical Contractor

A. Install on a flat surface level within 1/8 inch and of sufficient strength to support concentrated loading. Place vibration isolators under the unit.

B. Assemble and install all components furnished loose by manufacturer as recommended by the manufacturer's literature.

C. Complete all water and electrical connections so unit water circuits and electrical circuits are serviceable.

D. Provide and install valves in water piping upstream and downstream of the cooler water connections to provide means of isolating evaporator for maintenance and to balance and trim system.

E. Provide soft sound and vibration eliminator connections to the cooler water inlet and outlet as well as electrical connections to the unit.

F. Interlock chillers through a flow switch in the chilled water line to the chilled water pump to ensure the unit can operate only when water flow is established.

G. Furnish and install taps for thermometers and pressure gauges in water piping adjacent to inlet and outlet connections of the cooler.

H. Provide and install drain valves with capped hose ends to each cooler shell.

I. Install vent cocks to each cooler shell.

J. Provide a separate 115 volt electrical service to power the cooler heater for winter freeze protection. (provide chiller heater transformer)

3.03 Work By Temperature Control Contractor

A. Furnish interlock wiring per manufacturer's recommendations and install loose control components furnished by chiller manufacturer.

3.04 Work By Electrical Contractor

A. Furnish power wiring to chiller control panel and obtain required code approval.

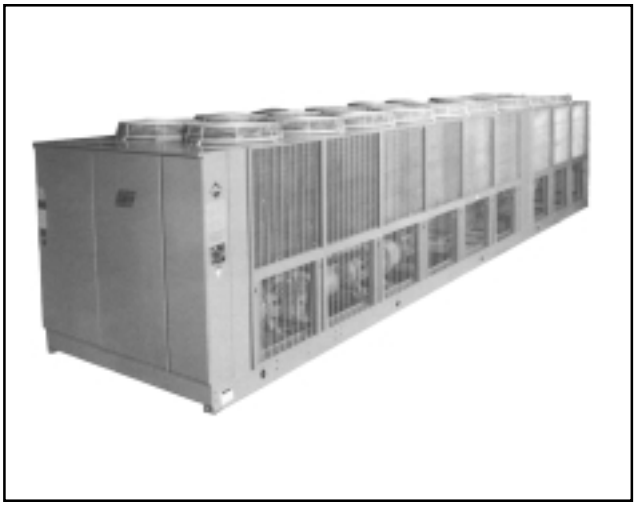
B. Furnish and install approved disconnect switch.

END OF SECTION

Specification subject to change without notice

ACDX 040-255
Air-Cooled Chiller with Horizontal Rotary Screw Compressor and Direct Expansion Cooler
40 to 255 Tons

DUNHAM-BUSH®



ACDX 048-208B
Air-Cooled Chiller with DB 110MM Vertical Screw Compressor and Direct Expansion Cooler
48 to 208 Tons

DUNHAM-BUSH®

ACDRB Air-Cooled Chiller with Reciprocating Compressor
21 to 203 Tons

DUNHAM-BUSH®

ACDX CONDENSER CLEARANCE DRAWING

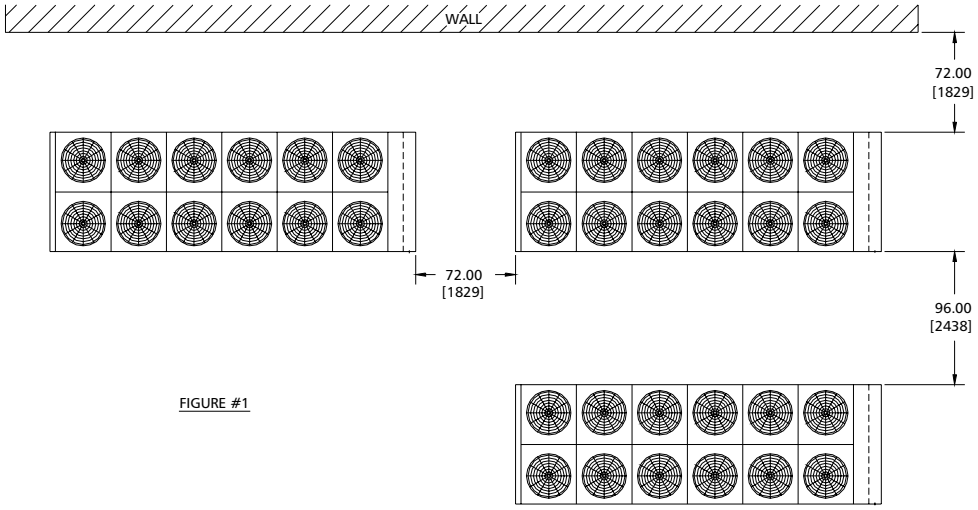


FIGURE #1

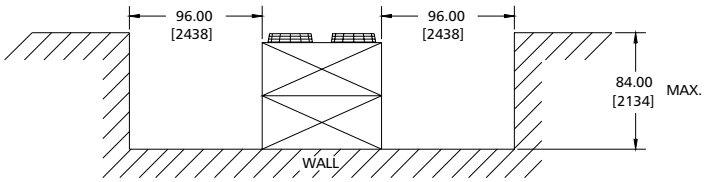


FIGURE #2
SINGLE PIT
(SEE NOTE 3)

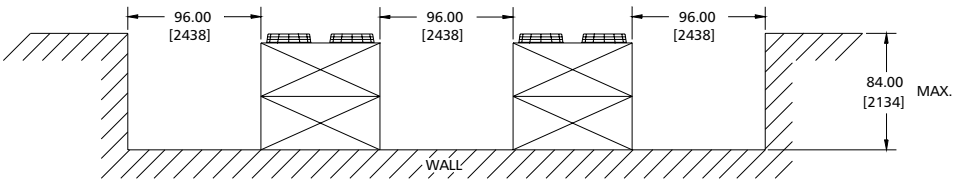


FIGURE #3
DOUBLE PIT
(SEE NOTE 3)

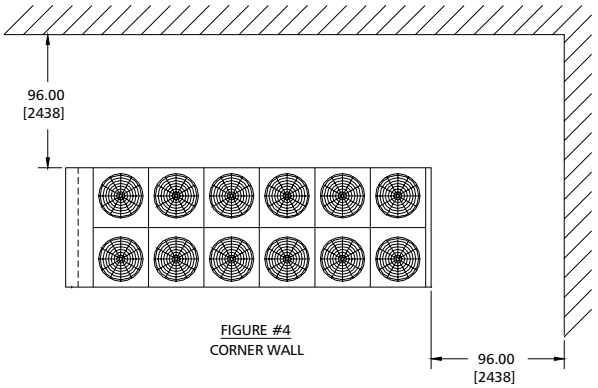


FIGURE #4
CORNER WALL

NOTE:
1) SCALE: 1/2" = 1" (INCHES) - 12.7MM = 25.4MM (MILLIMETERS)
2) ALL DIMENSIONS ARE MINIMAL, UNLESS OTHERWISE NOTED.
3) PIT INSTALLATIONS ARE NOT RECOMMENDED. RE-CIRCULATION OF HOT CONDENSER AIR IN COMBINATION WITH SURFACE AIR TURBULENCE CANNOT BE PREDICTED. HOT AIR RE-CIRCULATION WILL SEVERELY AFFECT UNIT EFFICIENCY (EER) AND CAN CAUSE HIGH PRESSURE TRIPS OR FAN MOTOR TEMPERATURE TRIPS. DUNHAM-BUSH WILL NOT BE REPSONSIBLE FOR DUCTING FANS TO A HIGHER LEVEL TO ALLEVIATE THE ABOVE MENTIONED CONDITIONS.

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