INSTALLATION, OPERATION AND MAINTENANCE MANUAL

50 Hz

Form No: MM0418A
- Mesa Hospital, Ankara, Turkey

DUNHAM-BUSH®

Products That Perform...By people Who Care

AIR COOLED ROTARY SCREW CHILLERS

MODEL:
ACXi 165-5SP-LN

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SCHEMATIC DIAGRAM, GRAPH AND TABLE

1.0 INTRODUCTION

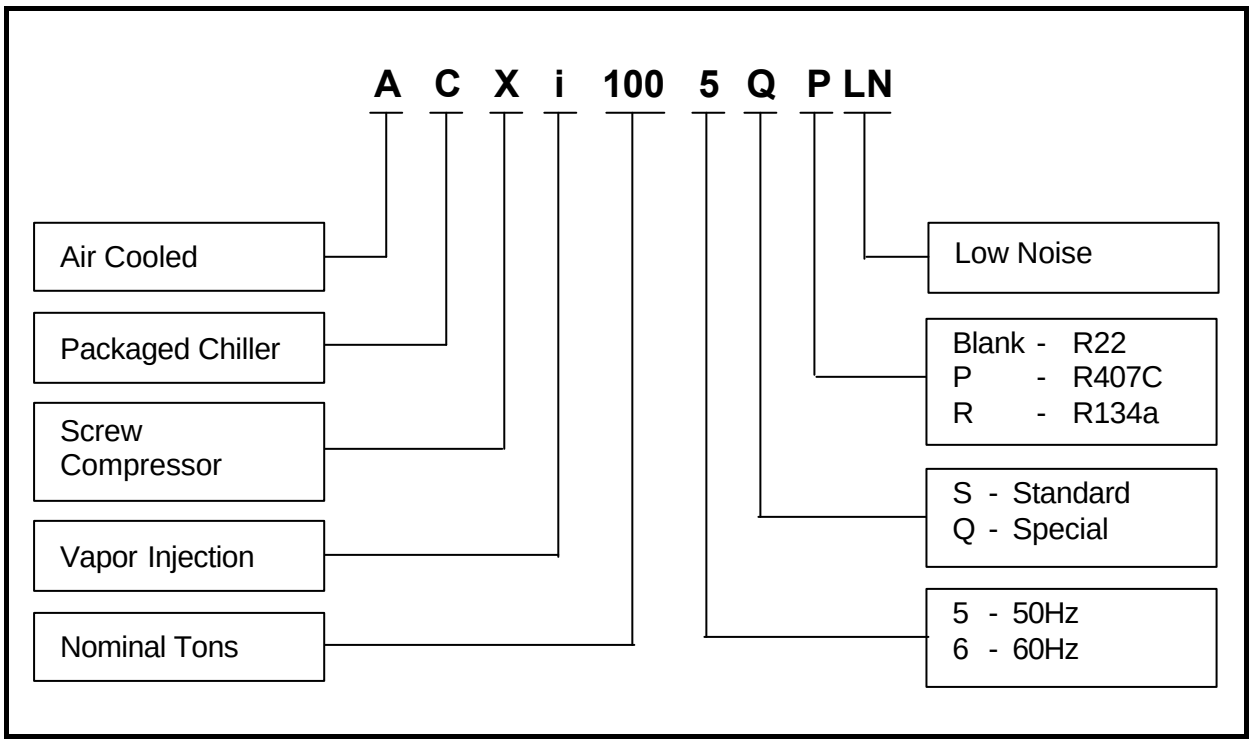
This manual is prepared to provide all the necessary information for installation, operation and maintenance of the latest generation of the Dunham-Bush medium screw compressor air-cooled packaged chillers.

To use this manual effectively, you must first identify your unit model from the unit nameplate.

Your Dunham-Bush chiller has been manufactured under a careful quality control system. If the package is installed, operated and maintained with care and attention to the instructions contained herein, it will give many years of satisfactory service.

It is assumed those who use of this manual and those who install, operate and maintain this equipment are experienced and qualified air conditioning equipment personnel.

1.1 PRODUCT IDENTIFICATION



1.0 INTRODUCTION

TABLE 1.1 PHYSICAL SPECIFICATIONS

Model		ACXi 165-5SP-LN
Compressor		
Model (Qty.)		MSC 1210(1), 1212 (1)
RPM		2950
Oil Charge	Liter (Qty)	37.3(1), 33.5 (2)
% Unit Capacity Reduction (Min.)		100 – 25%
Evaporator		
Model		EXD16112J07DFRO
Water Connections	(inch / mm)	6 / 152
Nom. Water Flow (GPM) / PD (ft.wg.)		402.4 / 19.8
Min. / Max. Water Flow	(GPM)	197.5 / 481.6
Min. / Max. Water Flow PD (ft.wg.)		6.1 / 30.0
Air Cooled Condenser		
Coil Rows Deep / FA (Sq.Ft)		3 / 141.2, 3 / 141.2
No. Of Fans		6, 6
Fan Diameter	(inch / mm)	31.5 / 800.0, 31.5 / 800.0
Motor HP	(Each)	0.5, 0.5
Min. Ambient Temperature °F @ Min. Load		65 °F
General		
Unit Length	(inch / mm)	322 1/2 / 8191
Unit Width	(inch / mm)	88 / 2235
Unit Height	(inch / mm)	96 / 2438
Shipping Weight	(lb / kg)	15915 / 7219
Operating Weight	(lb / kg)	16333 / 7409
Operating Charge R407c	(lb / kg)	437 / 198

2.0 INSTALLATION

2.1 GENERAL

Packaged chillers are designed to cool water or other non-corrosive liquids. Water is circulated through the direct expansion evaporator where it is cooled to the desired temperature then circulated to cooling coils for air conditioning, or to other types of heat exchangers for process cooling.

Care should be taken to see that the equipment is properly installed and adjusted. An installer or operator should first become familiar with the information contained in this manual.

2.1.1 APPLICATION PRECAUTIONS

The following instructions are intended to help assure proper and successful application of your water chilling machine.

2.1.2 CHILLED WATER FLOW

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

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

2.2 INSPECTION

When the equipment is delivered, it is important that the following inspection be completed in the presence of the carrier's representative.

1.) Check all crates and cartons received against the Bill of Lading/Shipping Papers to be sure they agree.

2.) Check the model number and the electrical characteristics on the nameplate to determine if they are correct.

3.) Check for freight damage, shortages or other discrepancies and note them on the delivery receipt before signing.

In the event that any damage is found, a damage claim should immediately be filed by the purchaser against the delivering carrier as all shipments are F.O.B. Factory.

2.3 RIGGING

2.3.1 GENERAL

Each unit has been carefully tested and crafted at the factory where every precaution is taken to assure that the unit reaches you in perfect condition. It is very important that the riggers and movers should use the same care and precaution in moving the equipment into place. Make sure that chains, cables. or other moving equipment are placed so as to avoid damage to the unit or piping. The refrigerant piping must not be used as a ladder or as a hand hold. Do not attach a chain hoist sling to the piping or equipment. Move the unit in an upright position and let it down gently from trucks or rollers.

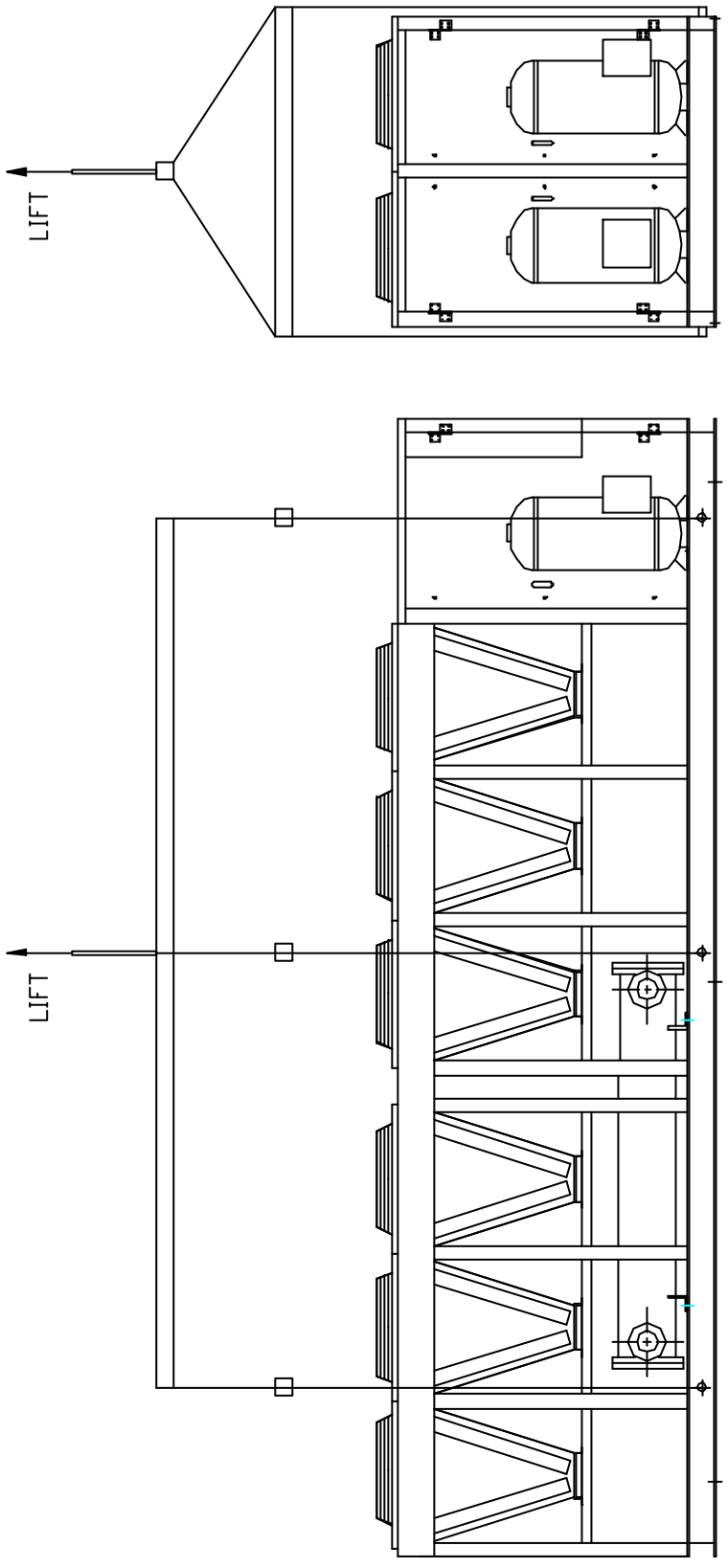
2.3.2 RIGGING AND MOVING

Any unit mounted on skids may be moved with a forklift, but care must be taken not to damage the unit with forks. The skids should not be removed until the unit is at its final location.

The ACXI model is to be rigged through the holes in the base side rails. In all cases, spreader bars must be used between rigging lines to prevent coil or fan deck damage. The unit must be lifted using **All Rigging Points.** Refer to Rigging Instructions on Figure 2.3.2.

All models can be pushed or pulled (with chains) from the control box end only. Truck forks must be kept level and not tilted back. Do not raise the end of the unit more than 2" off the floor.

FIGURE 2.3.2 ACXi 165-5SP-LN TYPICAL RIGGING



2.4 SPACE REQUIREMENTS AND CLEARANCE

2.4.1 GENERAL

The dimensional data and clearances that follow are useful for determining space requirements. The unit should be placed to make the clearance noted available for servicing properly. Failure to allow these clearances will cause serious trouble and result in higher costs for operation, maintenance and repair.

2.4.2 ACXi

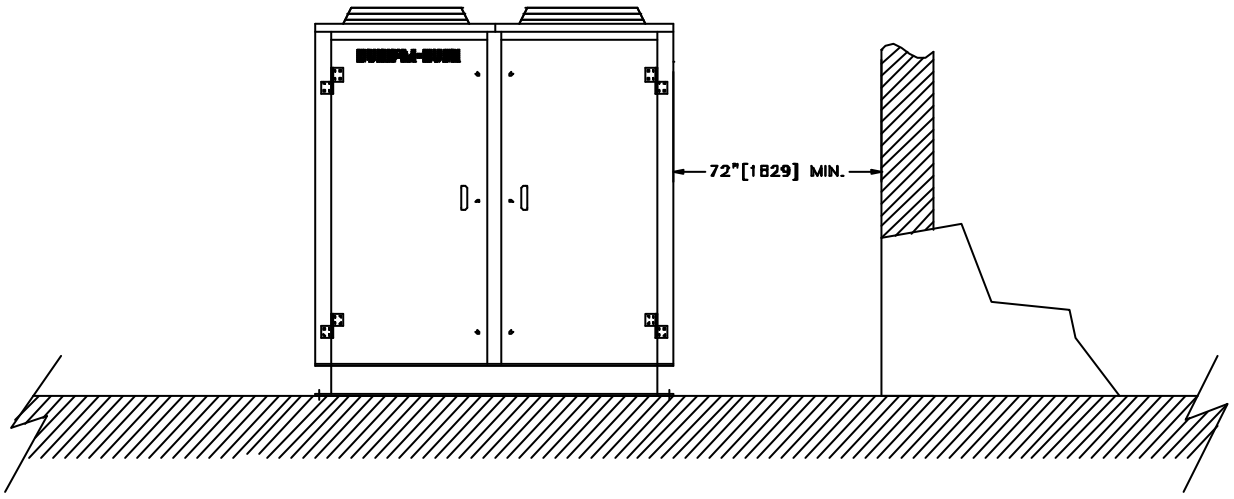
The dimensional data are shown in Figure 2.4.2 and space requirements are shown in Figure 2.4.1. The most important consideration which must be taken into account when deciding upon location of air cooled equipment, is provision for a supply of ambient air to the condenser, and removal of heated air from the condenser area. Where this essential requirement is not provided, it will result in higher condensing temperatures, which cause poor operation, higher power consumption and possibly, eventual failure of equipment. Units must not be located in the vicinity of steam, hot air or fume exhausts.

Another consideration which must be taken into account is that the unit should be mounted away from noise sensitive spaces and must have adequate support to avoid vibration and noise transmission into the building. Units should be mounted over corridors, utility areas, rest rooms or other auxiliary areas where sound levels are not an important factor. Sound and structural consultants should be retained for recommendations on critical installations.

FIGURE 2.4.1 ACXI 165-5SP-LN SPACE REQUIREMENTS

WALLS OR OBSTRUCTIONS

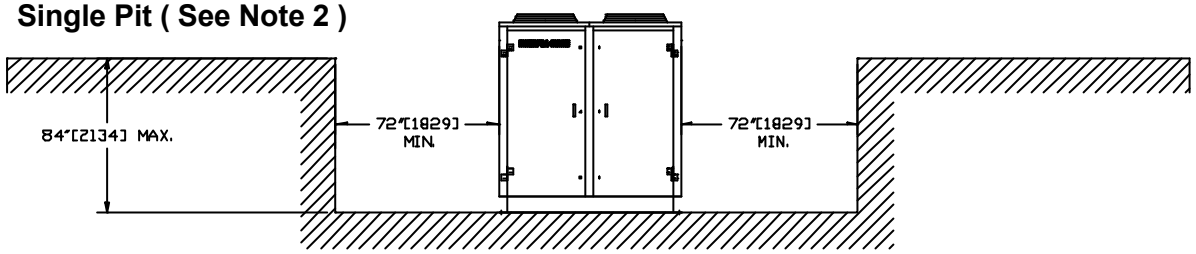
The unit should be located so that air may circulate freely and not be recirculated. For proper air flow and access all sides of the unit must be a minimum of four feet away from any wall or obstruction. It is preferred that this distance be increased whenever possible. Care should be taken to see that ample room is left for maintenance work through access doors and panels. Overhead obstructions are not permitted. When the unit is in an area where it is enclosed by three walls the unit must be installed as indicated for units in a pit.



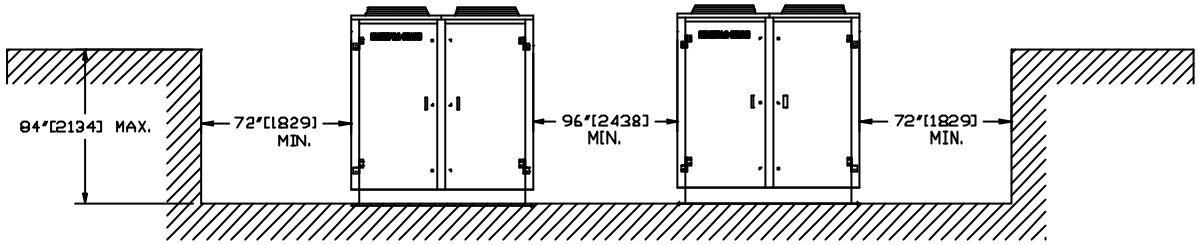
2.0 INSTALLATION

FIGURE 2.4.1 ACXi 165-5SP-LN SPACE REQUIREMENTS

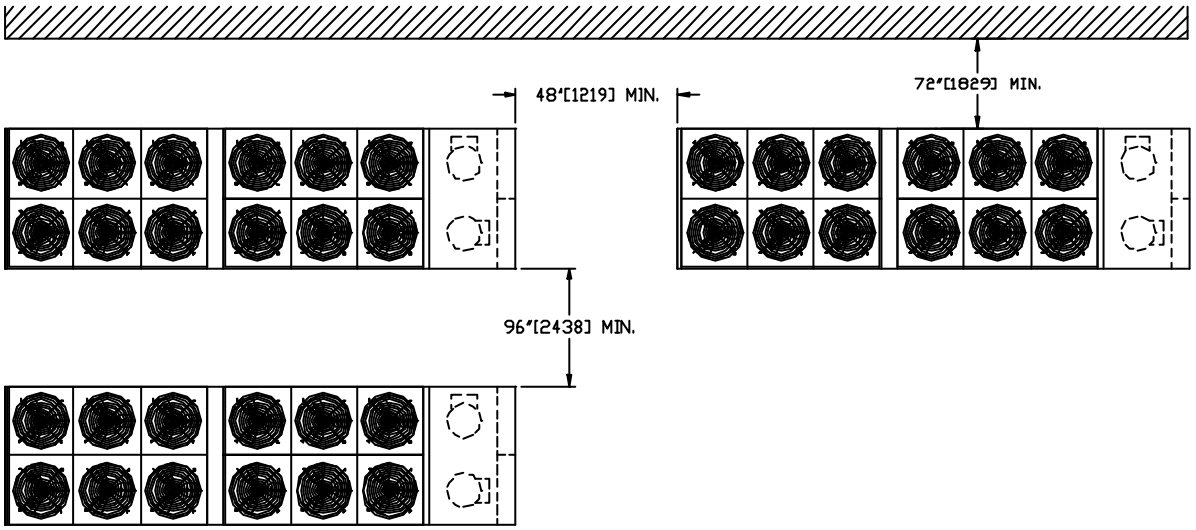
Single Pit (See Note 2)



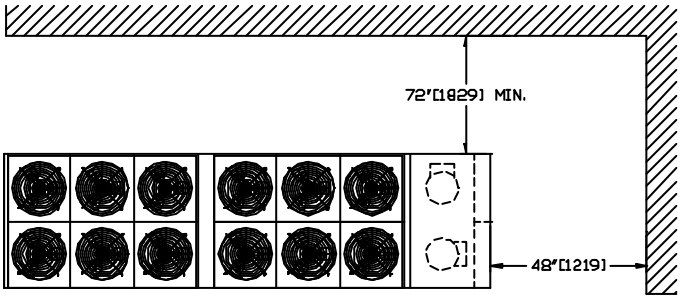
Double Pit (See Note 2)



Multi Pit



Corner Wall

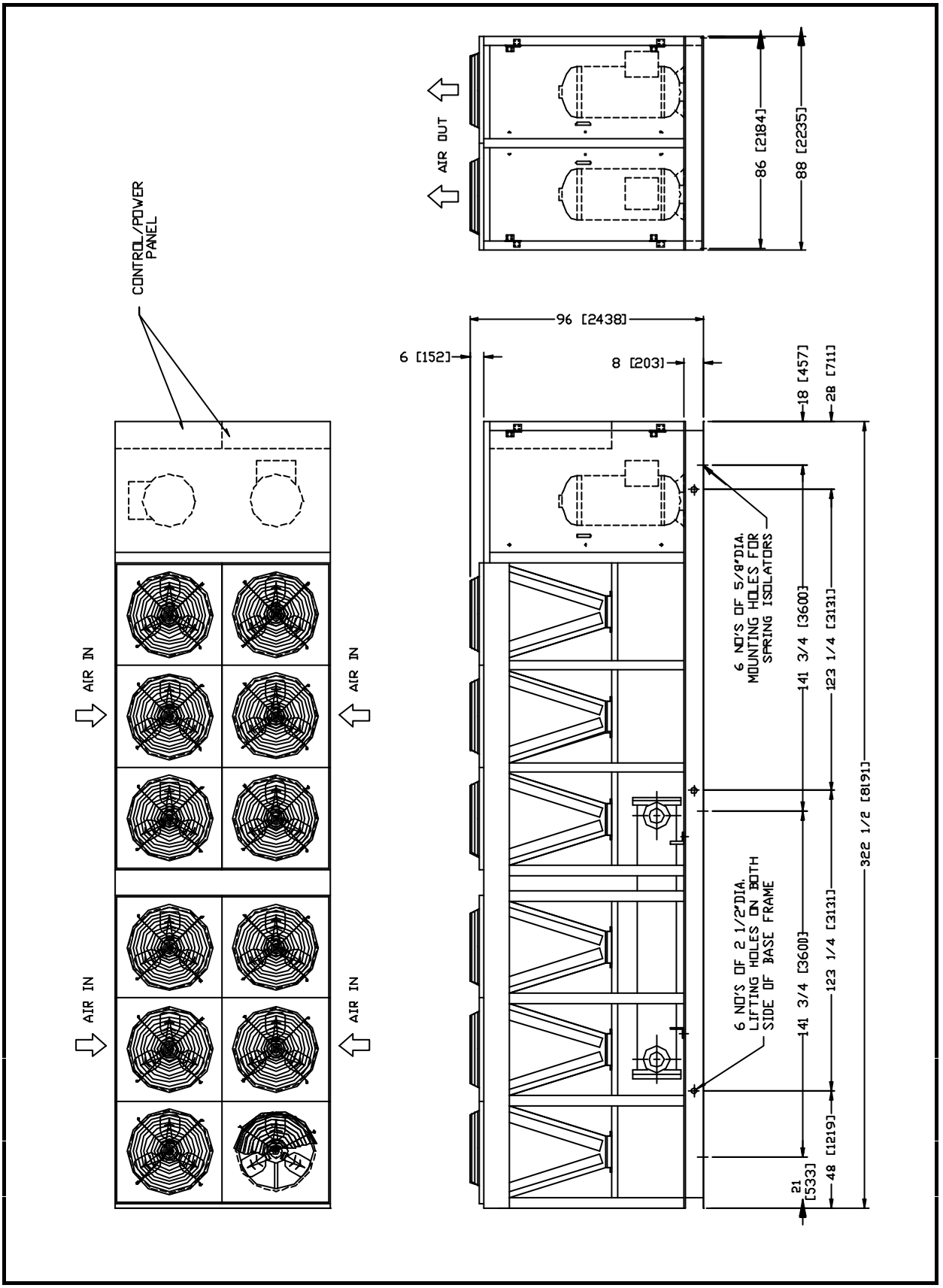


Notes

1.) All Dimensions Are Minimal, Unless Otherwise Noted.

2.) Pit Installations Are Not 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 Or Fan Motor Temperature Trips. Dunham-Bush Will Not Be Responsible For Ducting Fans To A Higher Level To Alleviate The Above Mentioned Conditions.

FIGURE 2.4.2 ACXi 165-5SP-LN DIMENSIONAL DATA



NOTE: ALL DIMENSIONS ARE IN INCHES [MM].

2.0 INSTALLATION

2.5 FOUNDATION

Refer to index for unit dimensions and load points. Foundations must be level for proper operation and functioning of controls and provision must be made for supporting the individual load points as shown in the unit dimensions. Roof mounted units must be supported on adequate steel structure. If units are located on the ground level, a concrete base is recommended.

2.6 VIBRATION ISOLATION

Under certain critical conditions. it may be necessary to install vibration isolators under the base of the packaged chiller.

Rubber-in-shear or spring vibration isolators are offered as optional items. When spring isolators are used, flexible connections must be installed in the water piping system and in the refrigerant lines of split systems. Note: These flexible connectors must be suitable for the fluid and pressures involved.

All piping which is external to the packaged chiller must be supported by spring mounted hangers and any piping which goes through the wall, ceiling or floor should be properly sheathed to prevent transmission of piping vibration to the structure.

When spring isolators are used, electrical service to the unit must also be flexibly connected by means of a 36" section of flexible conduit.

2.7 PIPING CONNECTIONS

Refer to the dimensional drawings for water piping connection locations. After the unit has been leveled and isolators (if any) installed & adjusted, connect evaporator water piping, keeping in mind that the evaporator tubes may require cleaning or replacement at some future date, and removable sections of piping will be required to permit evaporator head removal.

Piping must be supported to avoid excess stress on the evaporator heads. Cut piping holes in the removable access panel at the end of the unit. Opening the hole to the left hand side of the panel so that it can still be removed after piping is in place. Holes can also be cut down through the floor of the unit providing no cross-members are cut out. Install air vent points to permit complete air purging of the chilled water circuit. Install drain valves in similar low points to facilitate complete water system drainage. Install temperature & pressure indicators in the water piping at the unit to monitor water flow. Install shut-off valves to isolate the unit from the piping system during unit servicing. Note: Due to possible high pressures resulting from rising temperatures, do not close shut-off valves with cold water in the evaporator.

It is important that the chilled water system be cleaned before startup to avoid collecting debris in the evaporator. After filling the system with water (or a glycol solution), start pump, bleed off trapped air, and check for proper flow rate by measuring water pressure drop across evaporator.

NOTE: WATER QUALITY - ACXi

Evaporators used in these packages are made of steel, copper and brass and are suitable for operation with well-maintained water systems. However, if the water used in evaporator is corrosive, high in mineral content or entrained solids, the water can cause reduced performance and even failure of heat exchangers. Therefore, it may be necessary to obtain the services of a water treatment consultant and to provide and maintain water treatment. This is particularly important with glycol systems.

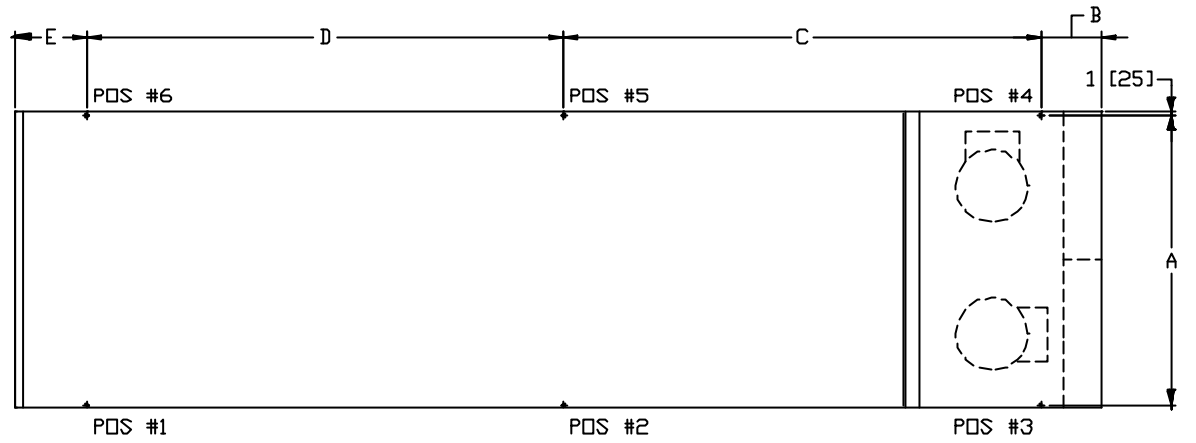
2.8 ELECTRICAL WIRING

In connecting power wiring to the unit, the following precautions should be taken:

1.) All field wiring is to be in accordance with the National Electric Code and must comply with state and local codes. See Electrical Data for minimum circuit ampacity and fuse size.

2.0 INSTALLATION

FIGURE 2.5A ACXi 165-5SP-LN ISOLATOR LOCATION



Unit Model	Isolator Weights				
	Dimensions - Inches				
	A Dim.	B Dim.	C Dim.	D Dim.	E Dim.
ACXi 165-5SP-LN	86	18	141 3/4	141 3/4	21

FIGURE 2.5B ACXI 165-5SP-LN ISOLATOR POINT LOAD DATA

Unit Model	Point Load - LBS						Total Operating
	Pos. #1	Pos. #2	Pos. #3	Pos. #4	Pos. #5	Pos. #6	Weight (LBS)
ACXi 165-5SP-LN	2413	2666	2920	3039	2778	2517	16333

2.) Check unit wiring for damage and all terminal connections for tightness. Unit terminal blocks are to be connected with copper conductors only, sized per ampacity listed on unit data plate.

3.) Connections to unit should match the unit nameplate in volts, phase, and Hertz. Voltage must not vary beyond ±10% of nameplate value and voltage imbalance between phases must not exceed 2% at any time during operation of the unit.

4.) Phase sequence to connectors L1, L2 and L3 shall be in that order. Check with Amprobe phase sequence adapter PSA-1 or equivalent.

2.9 CONTROLS

2.9.1 CONNECTIONS

Controls which are to be field installed should be connected in accordance with the appropriate wiring diagram accompanying the unit. The following connections should be made where applicable:

1.) Connect a set of normally open auxiliary contacts from chilled water pump contactor into unit controls as shown on unit wiring diagram.

2.) Install a chilled water flow switch (paddle type recommended) (or differential pressure switch) in straight length of chilled water piping to avoid turbulence. Connect in same electrical circuit as (1.)

2.9.2 SETTINGS

All controls are factory set, however operating control settings are not always applicable under all operating conditions. For recommended control settings, see wiring diagram accompanying unit. Safety controls must be set to factory recommendations.

2.10 REQUEST FOR START-UP REPRESENTATIVE

After the installation has been completed and checked, Form 9180 must be filled out and sent to the Dunham-Bush Service Department for authorized start-up representative to perform the initial start-up of the Dunham-Bush packaged chiller. The purchaser will have competent service and operating personnel in attendance to assist in the work involved, and also to be trained in the service and maintenance of this unit. (During the warranty period, the manufacturer is responsible for parts only upon proof of defective workmanship or manufacture).

Following receipt of the signed Form 9180, a representative will be sent to the customer. He will inspect the installation to determine whether it meets Dunham-Bush, Inc. requirements; perform the initial start-up of the installation; determine whether it is in satisfactory operating condition; and instruct the specified customer personnel in its operation and maintenance for the length of time specified in the purchase contract.

NOTE: Sump oil heaters should be energized for a minimum of 24 hours and the oil sump temperature must be at a minimum of 100°F (38°C) prior to arrival of start-up representative. This will ensure that the oil is warm enough to vaporize any dissolved refrigerant and that the oil is within the normal operating temperature range.

WARNING: The compressor (s) should be started initially ONLY under the direct supervision of an Authorized Dunham-Bush, Inc., Start-Up Representative.

3.0 OPERATION

3.1 GENERAL

The unit should be started up only by a refrigeration technician who is familiar with accepted operation practices for refrigeration systems.

Use small screw unit start-up report to record all temperature, pressure, electrical readings and control settings. A copy must be forwarded to Dunham-Bush, Inc., before the warranty will be honored.

3.2 UNIT PIPING

Each unit has a separate refrigerant circuit for each compressor. See figure 3.2 for typical unit piping schematic.

3.3 SYSTEM WATER FLOW RATE

The quantity of chilled water being circulated can be measured quite accurately (±5%) by determining the water pressure drop through the evaporator and reading GPM from the evaporator pressure drop curve, Figure 3.3. Connect reliable pressure gauges to valves installed in evaporator entering and leaving water vent connections and read pressure difference with chilled water pump in operation. An alternative method of determining GPM is to measure pressure difference from pump inlet to outlet and read GPM from pump curve.

3.4 STANDARD AMBIENT UNIT OPERATION (65°F MINIMUM AMBIENT) INCLUDING OVERNIGHT SHUT-DOWN AND MORNING RESTART

Caution: These units may equipped with manifold installed manual discharge valve that must be opened before attempting to start.

Important: Do not use chilled water pump operation via the flow switch or Aux. chilled water pump contacts to start & stop this unit. These are safety controls, not operational controls.

3.4.1 AIR COOLED PACKAGE CHILLER START-UP

The unit is ready for start-up when the following procedures have been completed.

1. Water piping for the evaporator is installed and tested.
2. Electrical connections are made and properly fused.
3. Unit has been leak tested. leaks corrected, and charge completed.
4. ***Compressor crankcase heater(s) has been energized for a minimum of 24 hours.***
5. Calibrated refrigerant gages have been connected to the suction and discharge.
6. Turn on the chilled water pump, check direction of rotation and adjust the water flow through the evaporator to the specified flow rate. Bleed off all entrained air.
7. Manually energize the fan starters and check the fan rotation. Fans should pull air through the condenser coil and discharge vertically upwards.
8. Check all refrigerant valves to be sure they are open.
9. Proceed to System Start-up.

Compressor #1 will start in about 15 minutes & proceed to load up if leaving water temperature is above setpoint. Compressor #2 will follows as the demand dictates.

3.5 SYSTEM START UP

1. Before starting the compressor(s), check all three phases of supply voltage, of all legs of the motor. They must be within ±10% of the nameplate voltage. Check to be sure compressor is not running backwards.

3.0 OPERATION

FIGURE 3.2 ACXi 165-5SP-LN TYPICAL SCHEMATIC PIPING

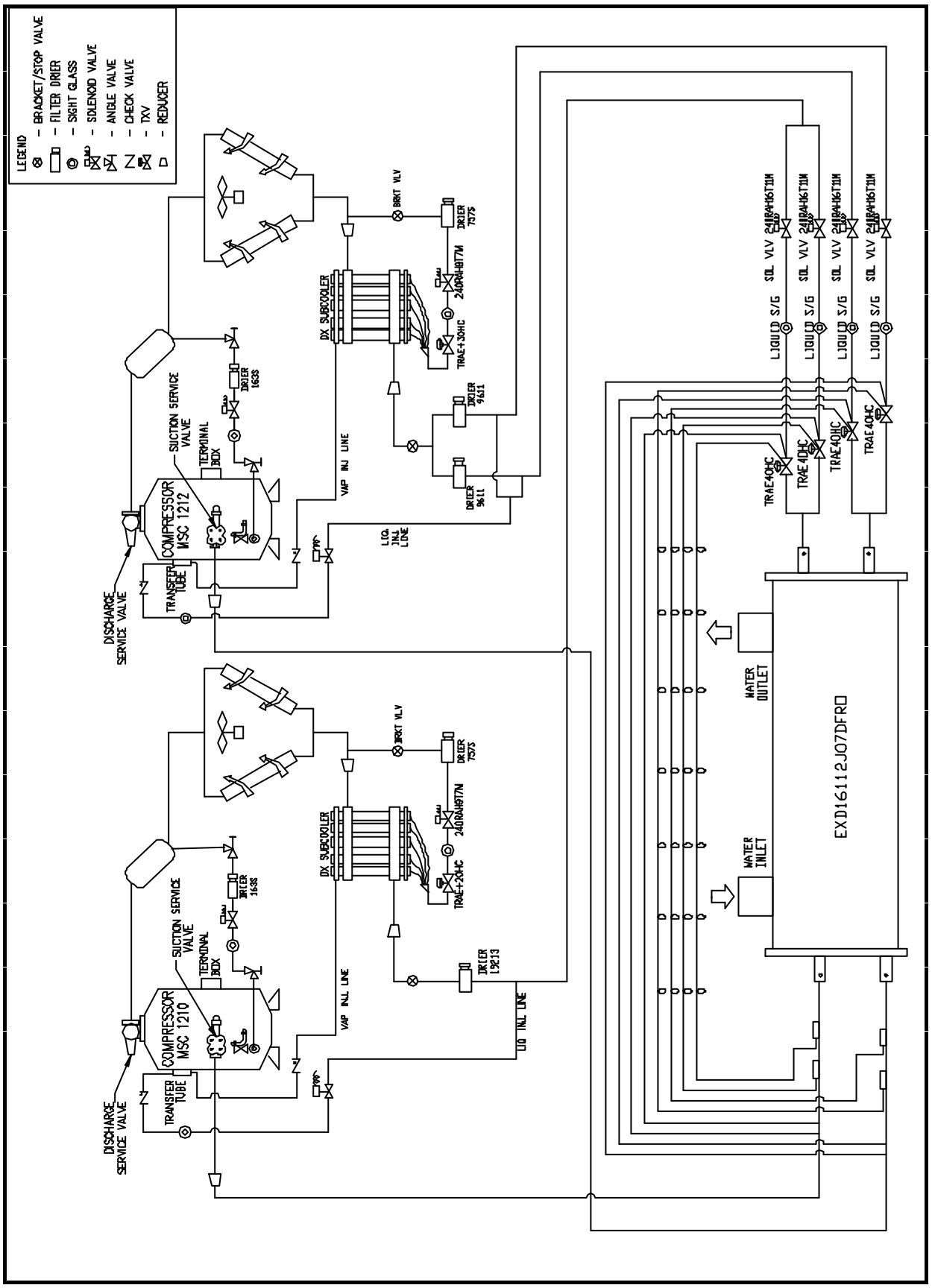
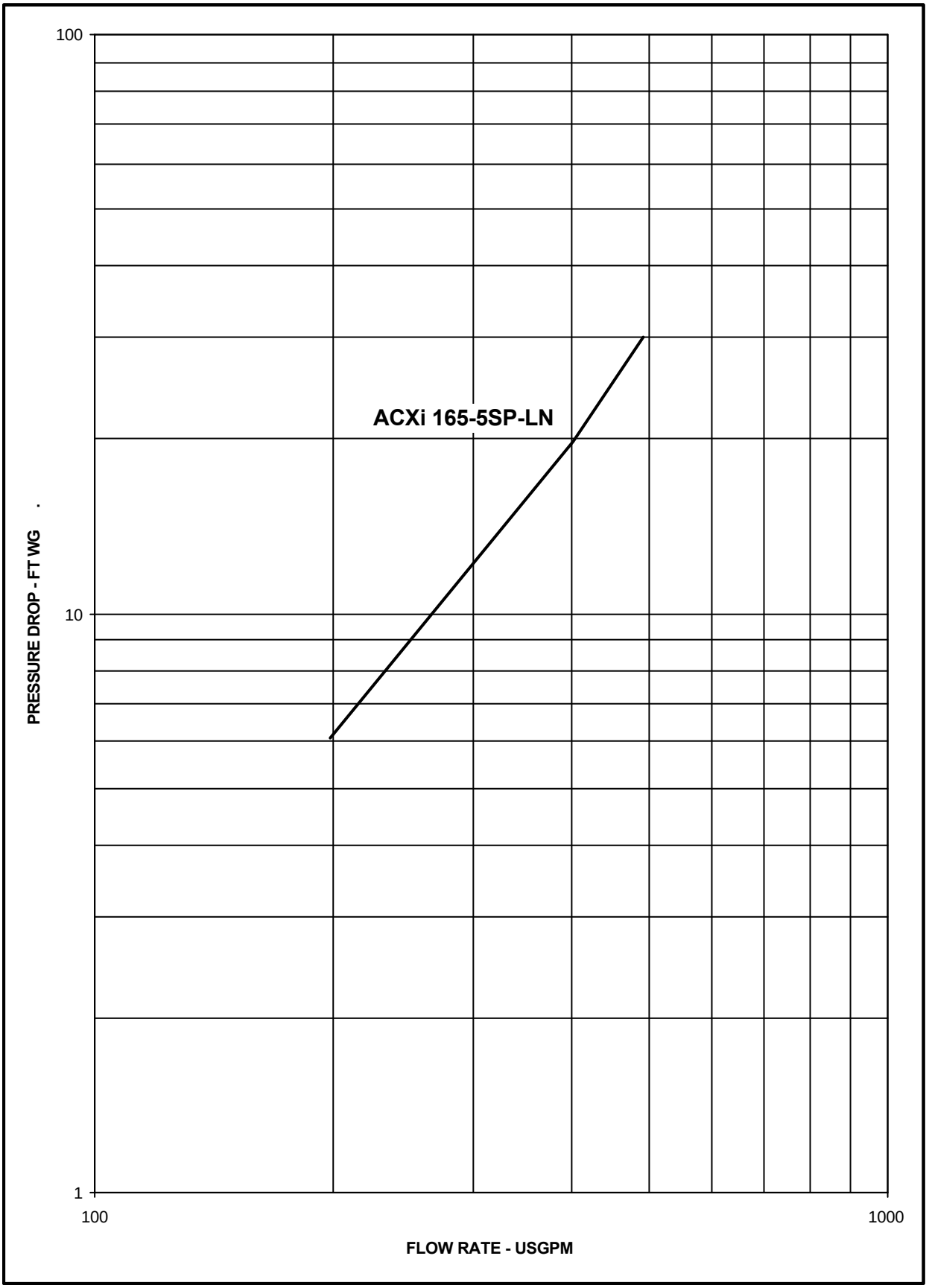


FIGURE 3.3 EVAPORATOR WATER PRESSURE DROP



2. Start compressor(s), check the gages and note if the pressures are within the prescribed limits.
3. Check the refrigerant sight glass at the TX Valve to be sure it is free of bubbles. If not, charge as required to clean sight glass.
4. Stage unit down until all compressors are off and check the compressor crankcase sight glass for oil level. It should be 1/2 to 3/4 of the compressor sight glass.
5. Restart the compressor. After an hour of operation, the expansion valve superheat setting should be checked, it should be between 9° and 12°F at full load design conditions. In some instances, it will be necessary to lower the superheat setting to ensure proper distribution. Turn the TX valve adjustment stem clockwise to increase the superheat setting and counterclockwise to decrease the setting. Be sure and allow ample time between each adjustment for the system to rebalance.
6. The electrical control settings should be checked and if necessary, reset to those settings indicated on the wiring diagram. Safety controls are factory set and must be maintained at settings indicated on the wiring diagram.
7. The temperatures of the chilled water both in and out, should be checked to insure the unit is operating within the desired temperatures.

3.6 SHUT-DOWN (OVERNIGHT OR WEEKEND)

To shut-down in the unit with compressors on or off, turn each individual compressor switch. Do not close any valve. The chilled water pump may then be turn off. If it is possible that the overnight ambient will drop below 65°F, it is preferable to leave the chilled water pump on. Finally, do not open the main unit disconnect. Main power is required to keep the sump heaters.

3.7 SEASONAL SHUT-DOWN PROCEDURE

Standard Ambient Units

1. Follow standard overnight shut-down procedure
2. Turn off chilled water pump
3. Close manual discharge valve
4. Close liquid valve on sealpot
5. If ambient temperature during the extended shut-down period will not get below freezing, the chilled water system may be left filled, If the ambient temperature will be below freezing, drain all water thoroughly, removing all vent & drain plugs from both heads of the evaporator, and blow out tubes will compressed air to avoid serious stagnant water corrosion.
6. Finally, it is recommended that an oil sample be taken from each compressor & submitted for lab analysis. Dunham-Bush offers this service in its "Oil Kare" program. This analysis should be done at the end of each operating season or every 6 months if the unit is used year round.

   The power supply to the unit may be de-energized to conserve energy. Just remember that all heaters will now be inactive, and the evaporator could freeze-up if not properly drained.

3.8 SEASONAL START-UP PROCEDURE

1. Check fan drives for wear, rust, propeller clearance, etc. and make necessary repairs & adjustments. Grease main fan shaft bearings with a good grade of EP ball bearing grease.
2. Check & clean condenser fin surface if necessary. Use a warm water soap solution, being careful not to bend fins. Comb out bent fin areas.
3. Check all power supply connections at all points, and all control terminal screws for tightness.
4. Energize main power to unit & leave on for at least 24 hours in order for compressor to thoroughly warm up.
5. Start chilled water pump and verify correct flow-rate glycol % if required. Bleed-off system air if necessary.
6. Open main discharge valve in discharge header.
7. Open liquid valve on sealpot.

8. Turn control circuit power switch on, and all individual compressor circuit switches. Press computer keyboard reset key (RST). Compressors should start after start-up clock times out and will come on in sequence to satisfy the existing load.

3.9 SAFETY RELIEF VALVES

Each pressure vessel is protected by a safety relief valve as required by ASME Code. Each compressor is protected by a relief valve which is vented to atmosphere. Never install any kind of shut-off valve in a safety relief vent line.

3.10 REFRIGERATION CYCLE -MULTIPLE COMPRESSOR ACXi

Following is the normal sequence of operation for a unit installed in a typical air conditioning system. Refer to Figure 3.2, the typical piping schematic for multiple compressor ACXi unit. Each vertical screw compressor discharges hot, high pressure gas into a hot gas manifold and is then split and routed into the left-hand and right-hand side, condenser where it condenses, rejecting heat to the outdoor air drawn through the coil by fans. The liquid refrigerant from the condenser is drain out from bottom of the condenser coil through liquid stop valve into a liquid subcooler.

The refrigerant flows through the liquid subcooler, dropping its temperature causing it to flash. Liquid is cooled from the liquid subcooler, drains to liquid line filters drier and sight glass, liquid solenoid before through DX evaporator main expansion valve which is at an intermediate pressure between condenser and evaporator.

Refrigerant flows into the DX evaporator, where it boils, cooling the water flowing outside evaporator tubes. Vapor from the boiling refrigerant flows up the suction pipes through shut-off valves, suction check valves and suction filters (inside compressor) into compressors where it is compressed and starts the cycle again.

Vapor flows from the top of the liquid subcooler into the compressors at the vapor injection ports, which feed it into the compressors part way through the compression process. Check valve will prevent backflow at shutdown.

3.11 FAN CYCLING

On start-up, all fan will remain off (some units may have base fans which run together with compressor). As the head pressure builds up, next fan stage will start. Subsequently fan stage will start if the head pressure continues to rise. Refer wiring circuit diagram for number of fan stage.

3.12 LIQUID INJECTION

Each compressor is fitted with a liquid injection system designed to feed refrigerant liquid into the compressor to provide additional motor cooling as required. The liquid injection control TXV will modulate to hold the compressor discharge gas temperature below 170ºF, the maximum discharge operating temperature of these compressors.

3.13 HYDRAULIC CAPACITY CONTROL SYSTEM

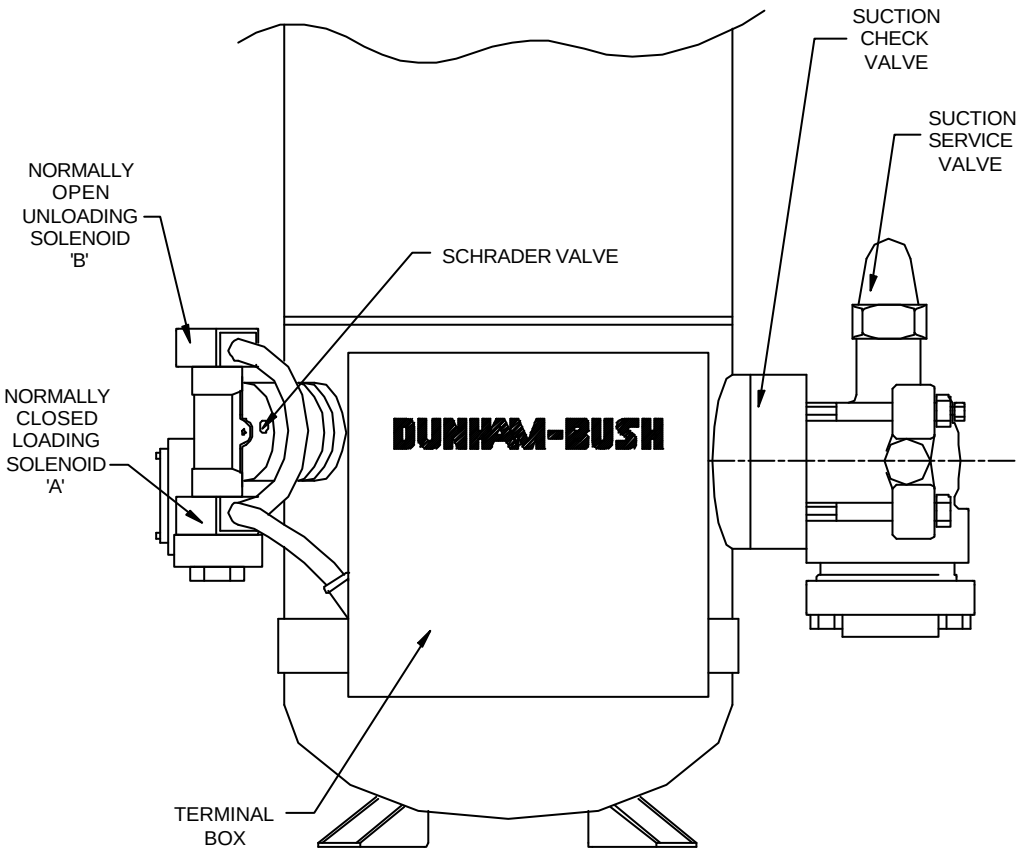
Each compressor has a hydraulic control system to supply the proper force necessary to actuate the capacity control slide valve, thereby regulating compressor loading for maximum unit capacity. It is composed of a normally closed solenoid valve (A), a normally open solenoid valve (B), an internal pressure regulating valve. With valves A and B both energized (A open, B closed) during normal compressor operation, high pressure oil is directed to the slide valve. This pressure acts on the surface of the slide valve piston creating a force which is sufficient to overcome the opposing spring force and to move the valve in the direction of increasing capacity.

When the compressor is given a "hold" command, valve A is de-energized (closed) and slide valve movement is halted. The internal pressure regulating valve allows oil to bleed from the slide valve chamber during the hold condition. If valve B is then de-energized (open), the high pressure oil acting on the slide valve will be vented to suction, and the pressure in the slide valve chamber will be reduced. The slide valve spring will now move the slide valve back toward the minimum capacity position.

Under standard conditions, the compressor will load in 60 seconds and unload in 55 seconds.

	SLIDE VALVE POSITION		
	UNLOADING	**LOADING**	**HOLD**
SOLENOID VALVE A (NORMALLY CLOSED)	CLOSED (DE-ENERGIZED)	OPEN (ENERGIZED)	CLOSED (DE-ENERGIZED)
SOLENOID VALVE B (NORMALLY OPENED)	OPEN (DE-ENERGIZED)	CLOSED (ENERGIZED)	CLOSED (ENERGIZED)

FIGURE 3.13 COMPRESSOR CAPACITY CONTROL DETAIL



4.0 ELECTRICAL

4.1 ELECTRICAL DATA

ACXI Unit Data				Compressor				Fan Motors		
Model ACXi	Electrical Spec. V- PH- Hz	Min Circuit Ampacity (A)	Max Branch Fuse Size (A)	Qty.	Model	RLA Each (A)	LRA Each (A)	Qty.	Hp Each (A)	FLA Each (A)
165-5SP-LN	400 - 3- 50	440A	600A	1 1	MSC 1210 MSC 1212	163 202	995 1050	12	0.5	2.0

4.2 WIRING DIAGRAM

Figure 4.2 are typical wiring diagrams for a 2 compressor unit. This may not be an accurate representation of your unit. It is best to use the wiring diagram mounted in the package control panel. A copy of that diagram is furnished with the unit owner's manual.

4.3 TYPICAL OPERATION

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

- Phase Control Relay (PCR) 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 2°F or more above setpoint

A compressor is started by first energizing 1M1 followed by 1M2. Anti-recycle time of 15 minutes is initiated within the computer at start.

When the compressor starts, the microcomputer monitors amperage by means of 1CT, voltage using 3T, leaving water temperature using TS, and condensing pressure. These inputs are used to control the loading and staging of the compressor. The compressor's loading is controlled by pulsing signals to the load and unload solenoids.

If the safety conditions are satisfied for the #2 compressor, at least 1 minute has elapsed since starting #1 compressor, and leaving water temperature remains above the deadband; 2M1 and 2M2 will be activated by the micro-computer, #2 compressor also has a 15 minute antirecycle timer built into the microcomputer. Loading of the #2 compressor is controlled the same as compressor #1.

To shut down the unit automatically, the customer control contacts must be opened. To shut down the unit manually, simply shut off the compressor switches. This will cause a no-run alarm that must be reset to restart the compressor.

4.0 ELECTRICAL

FIGURE 4.2 ACXi 165-5SP-LN WIRING SCHEMATIC

DUNHAM-BUSH

ELECTRICAL WIRING DIAGRAM

MODEL : ACXi 165 - 5SP - LN

POWER SUPPLY : 400V-3PH-50Hz

UNITS

MODEL	: ACXi 165 - 5SP - LN
PROJECT NAME	: MESA HOSPITAL, ANKARA - TURKEY
F.O NO.	: 10992
DWG. NO.	: 834037-677 REV : 02
INSTALLER	: -

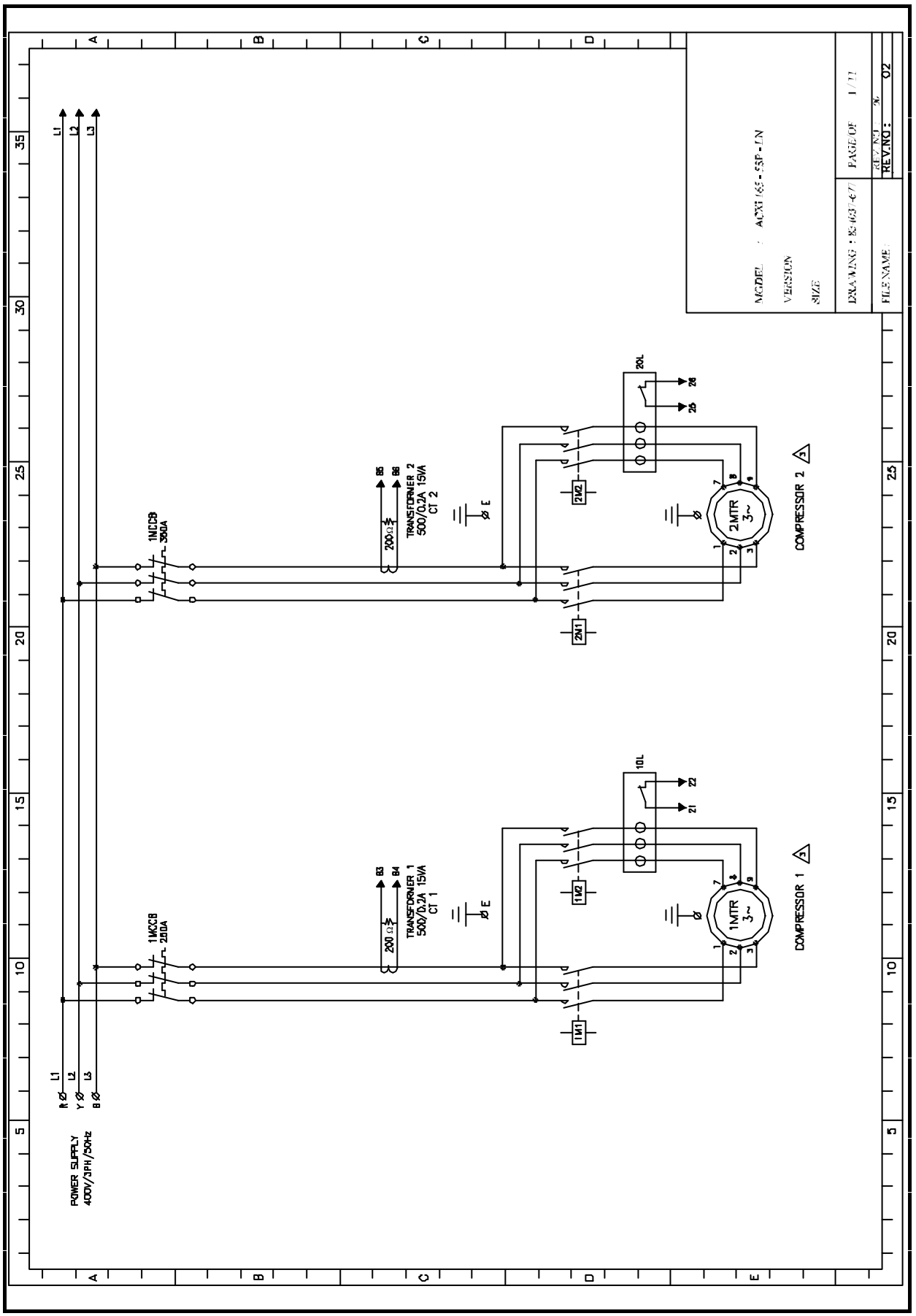
DRAWING :	834037-677	PAGES :	1 ÷ 11
REV. NO.	DATE	CHECKED	APPROV.
00	05.07.2004		

INDEX :

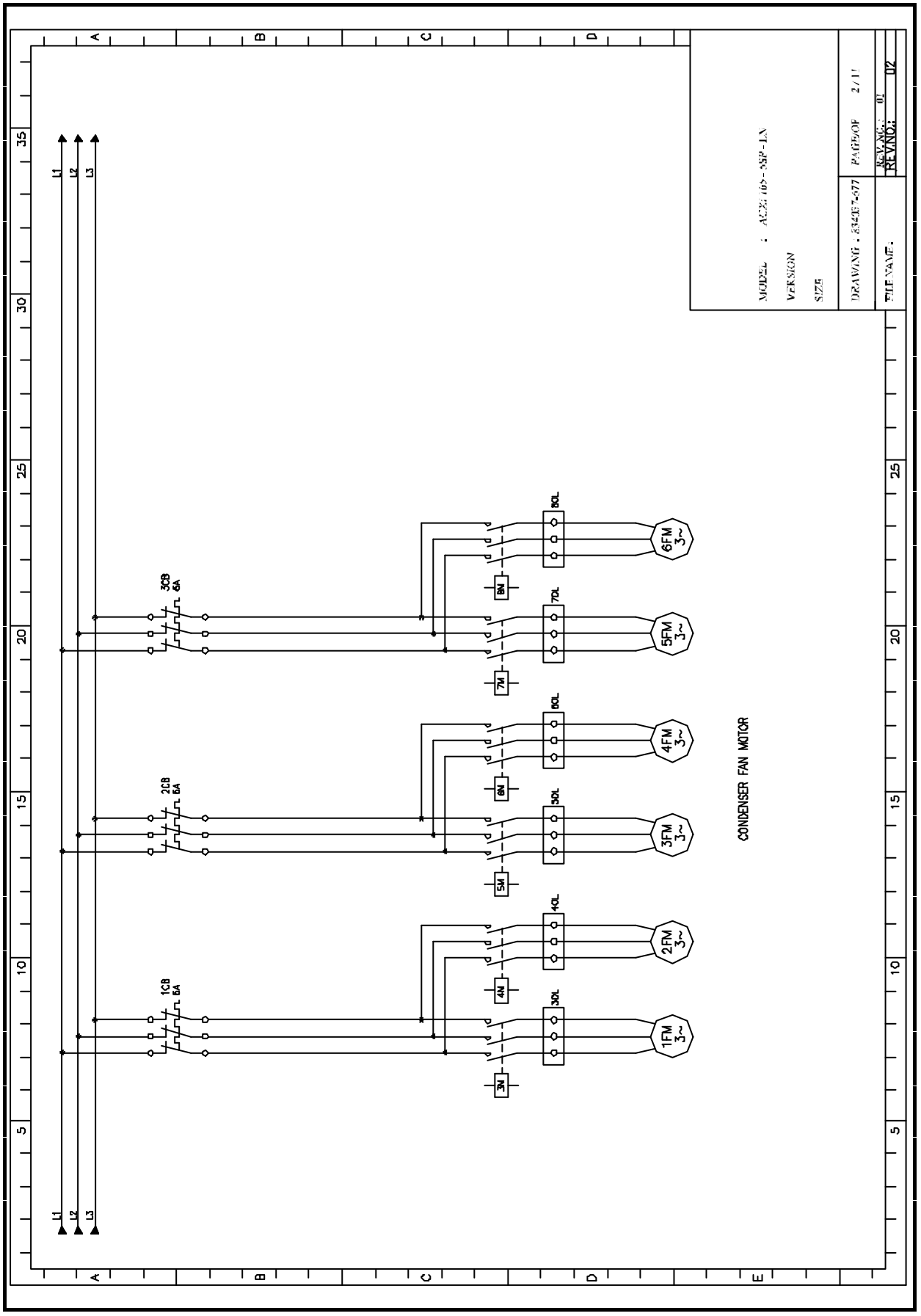
REV. NO.	DESCRIPTION
01	ADD 3ZD & 4ZD AT DISCHARGE PRESS A1 BOARD #1.
02.	CHANGE 400VAC TO 415VAC (PAGE 4/11) CHANGE 10 CB 6A TO 10CB 10A(PAGE 5/11) CHANGE NUMBERING 13SOL & 14SOL TO 15SOL & 16SOL (PAGE 6/11) CHANGE COMP 1 2ND CONTACTOR NUMBERING FROM 22 TO 22B(PAGE 7/11)

PAGES	DESCRIPTION
1	INTRODUCTION
1 - 2 - 3	POWER WIRING DIAGRAM
4 - 5 - 6 - 7 - 8	FUNCTIONAL WIRING DIAGRAM
9	LEGEND
10	NOTES
11	CONTROL DATA SHEET

4.0 ELECTRICAL



4.0 ELECTRICAL



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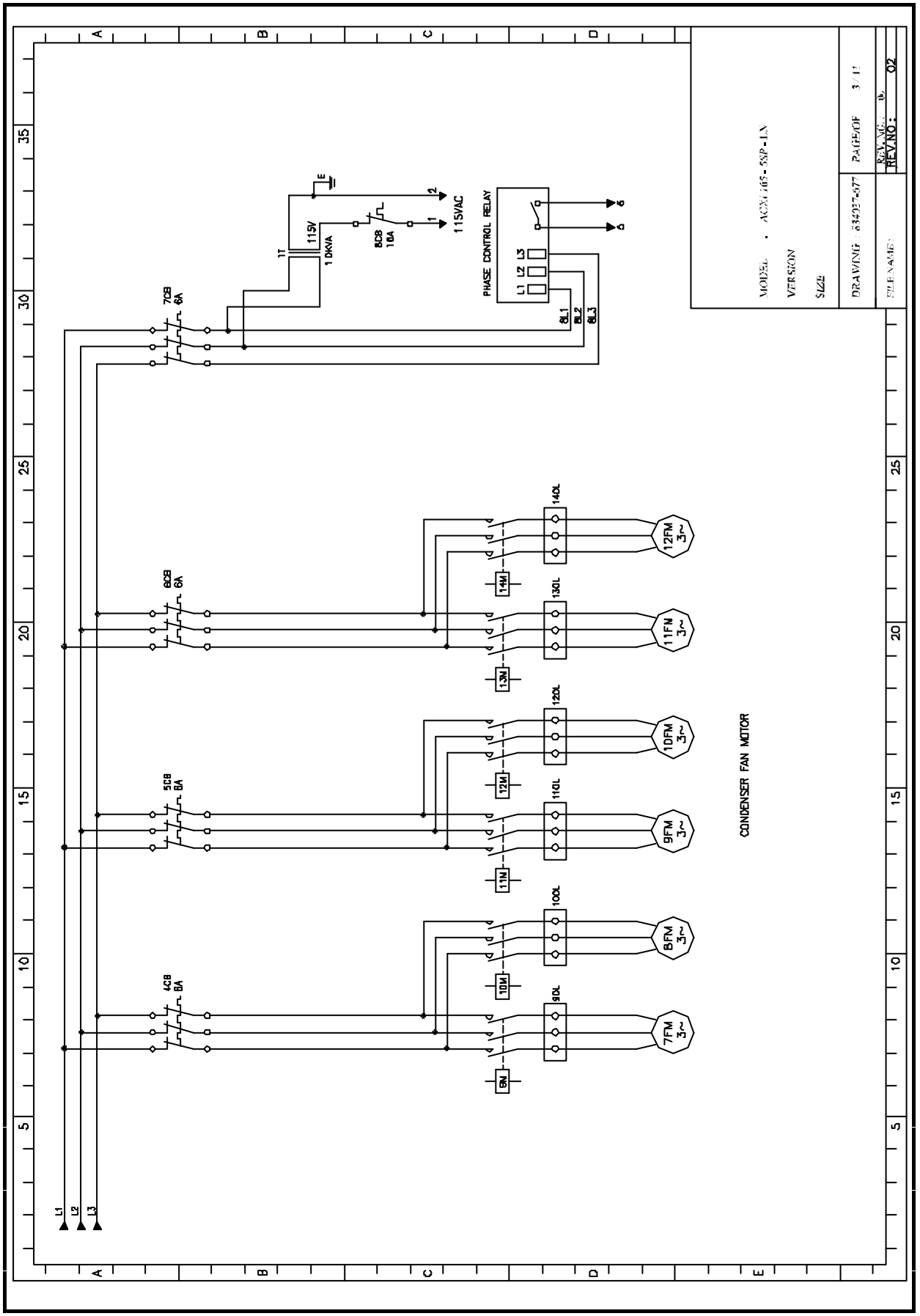

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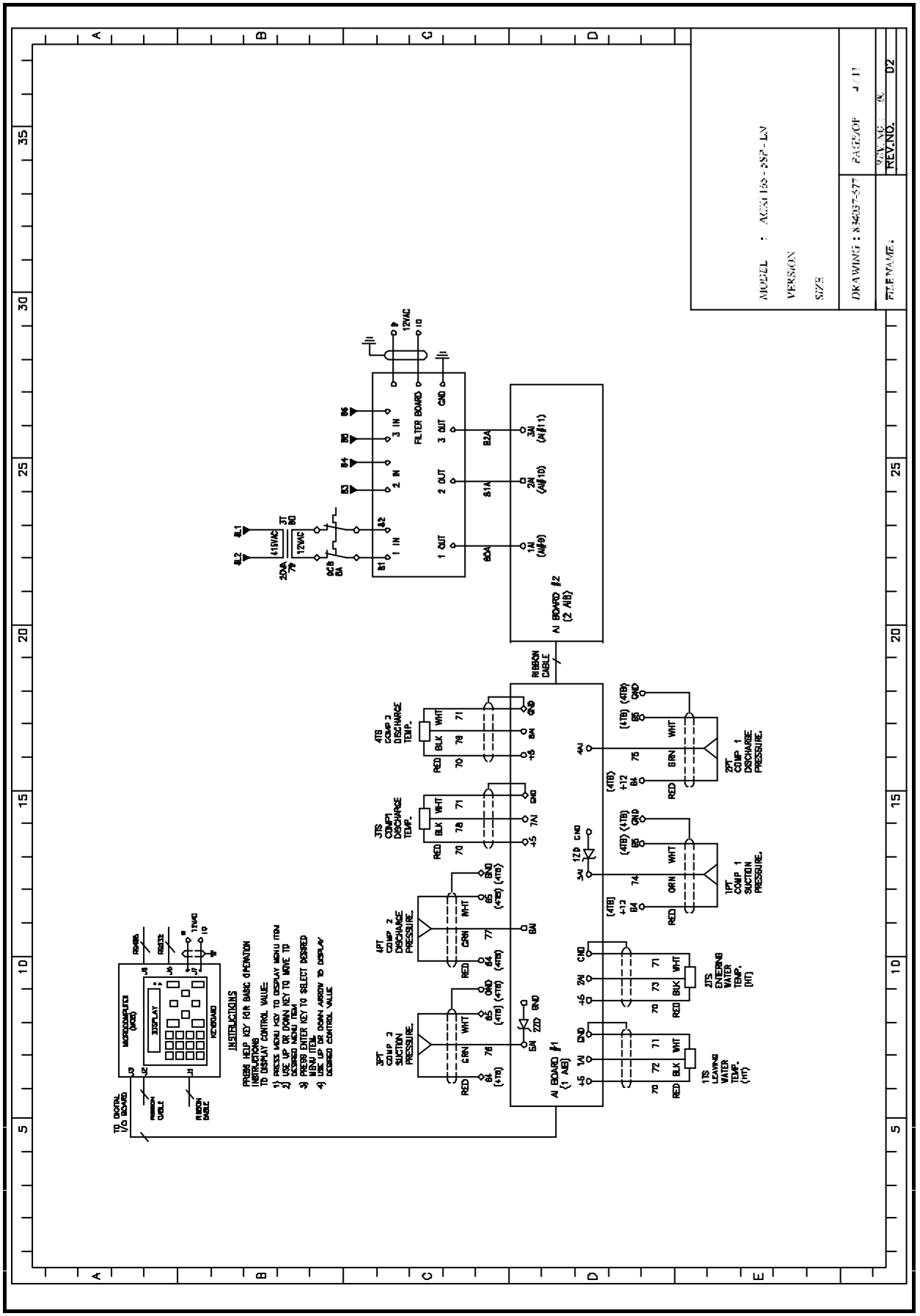

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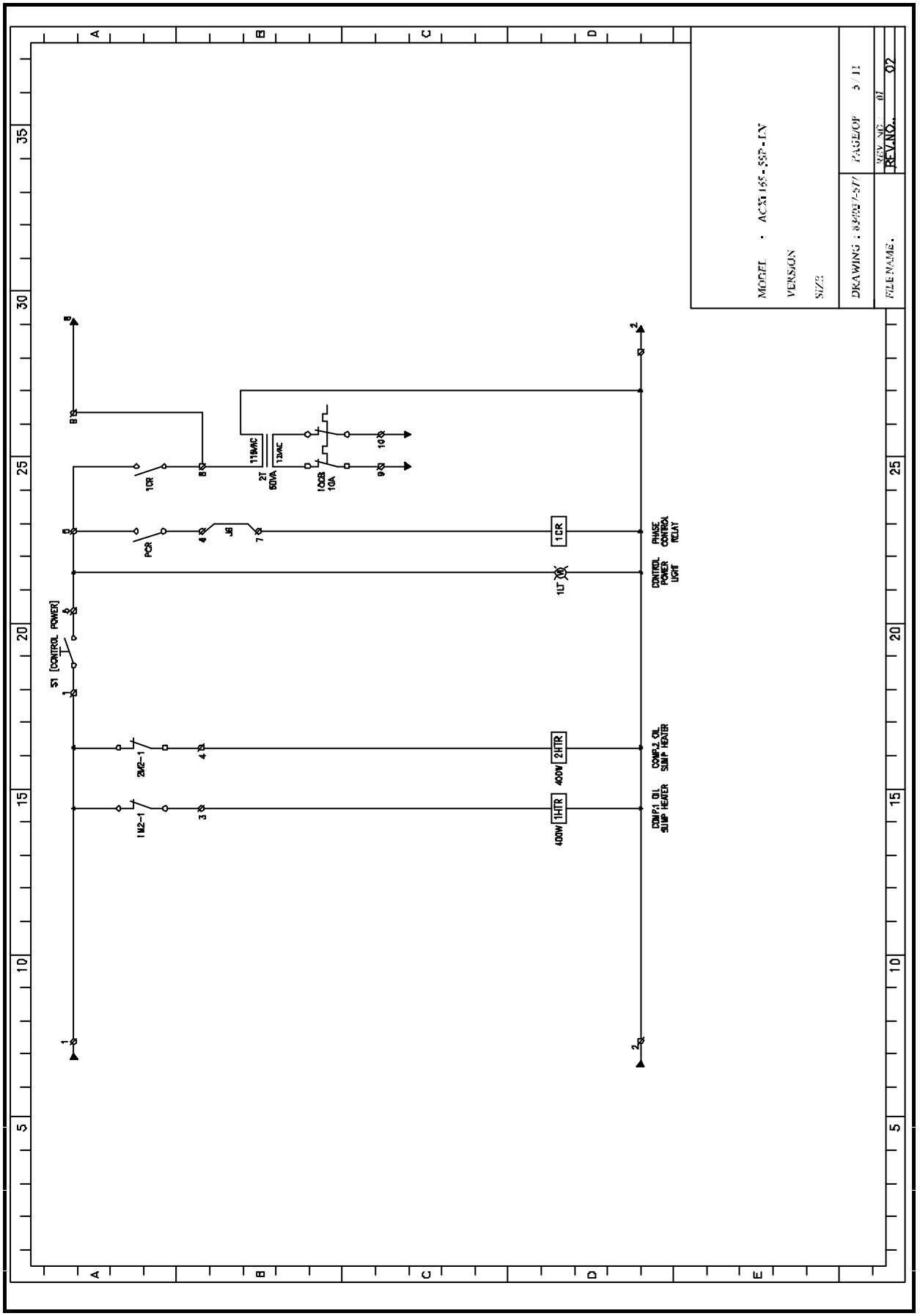

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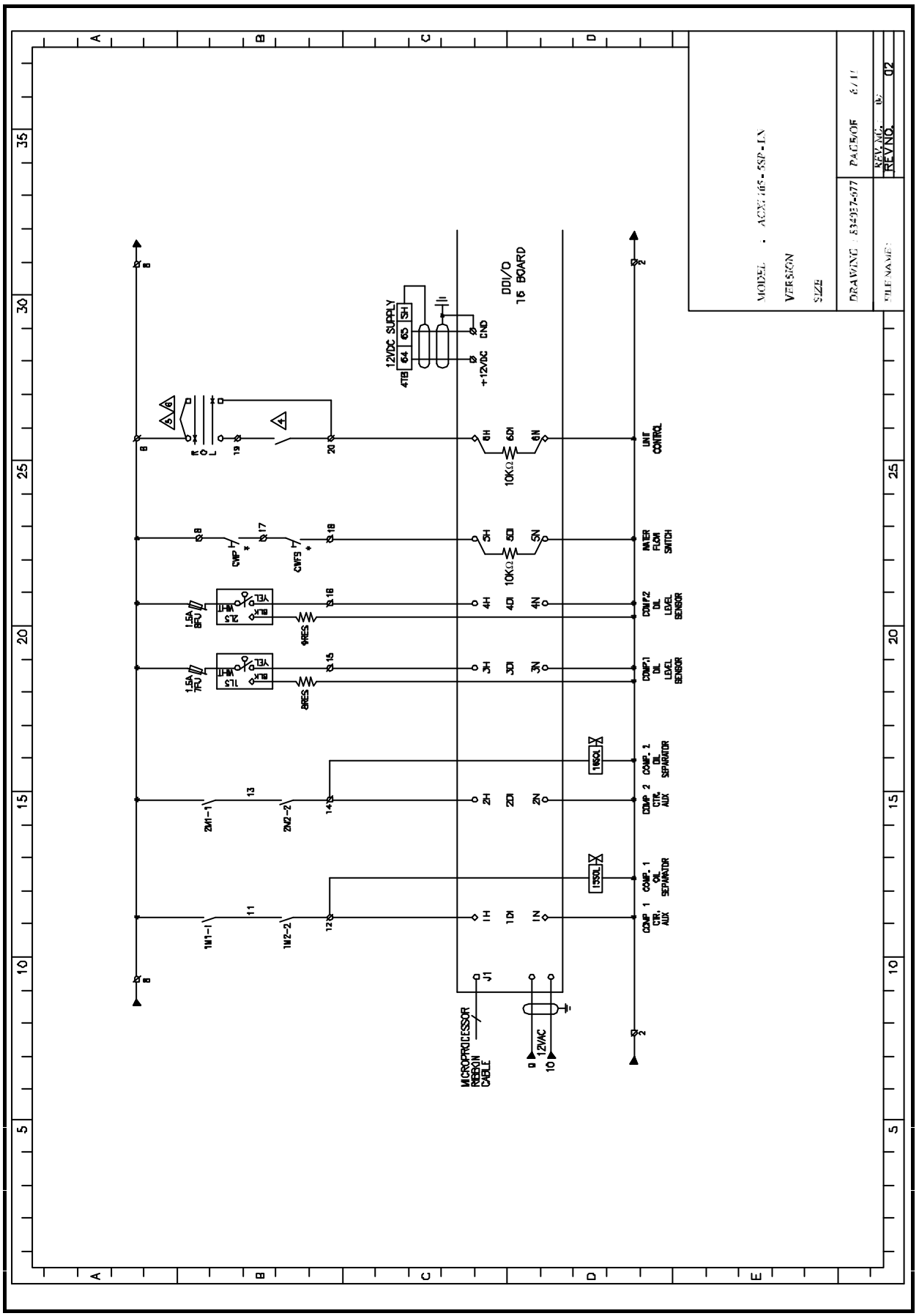

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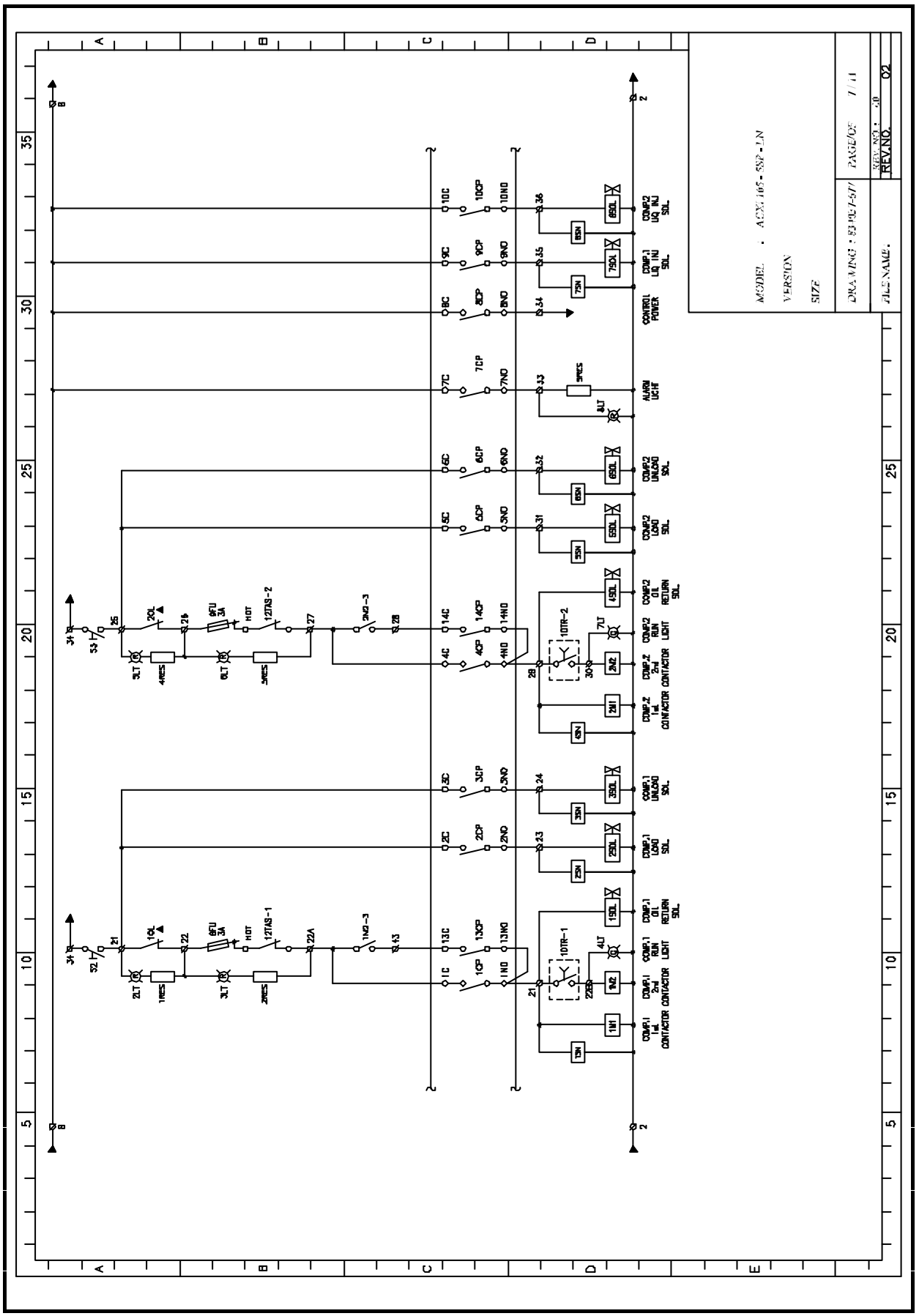

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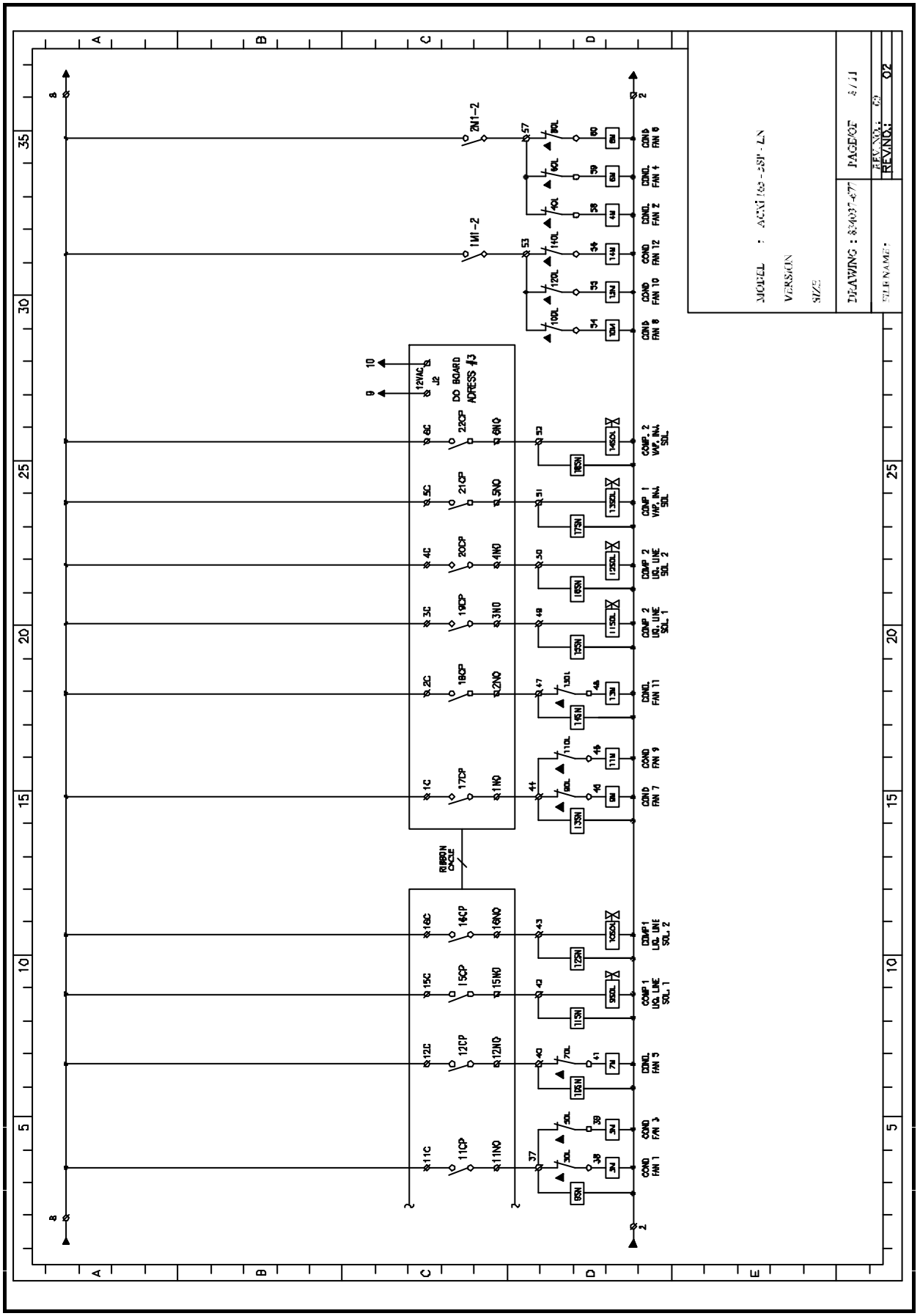

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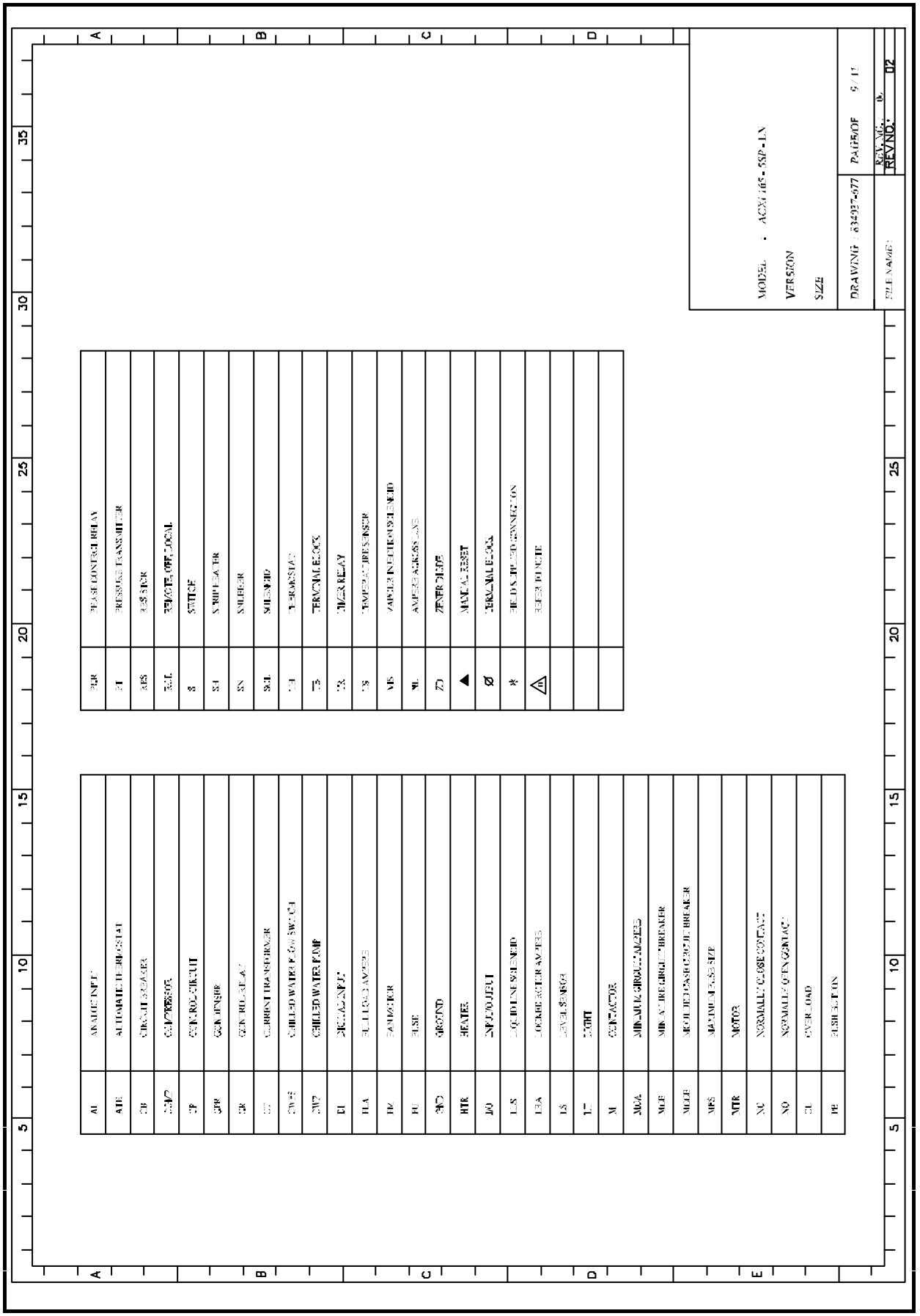

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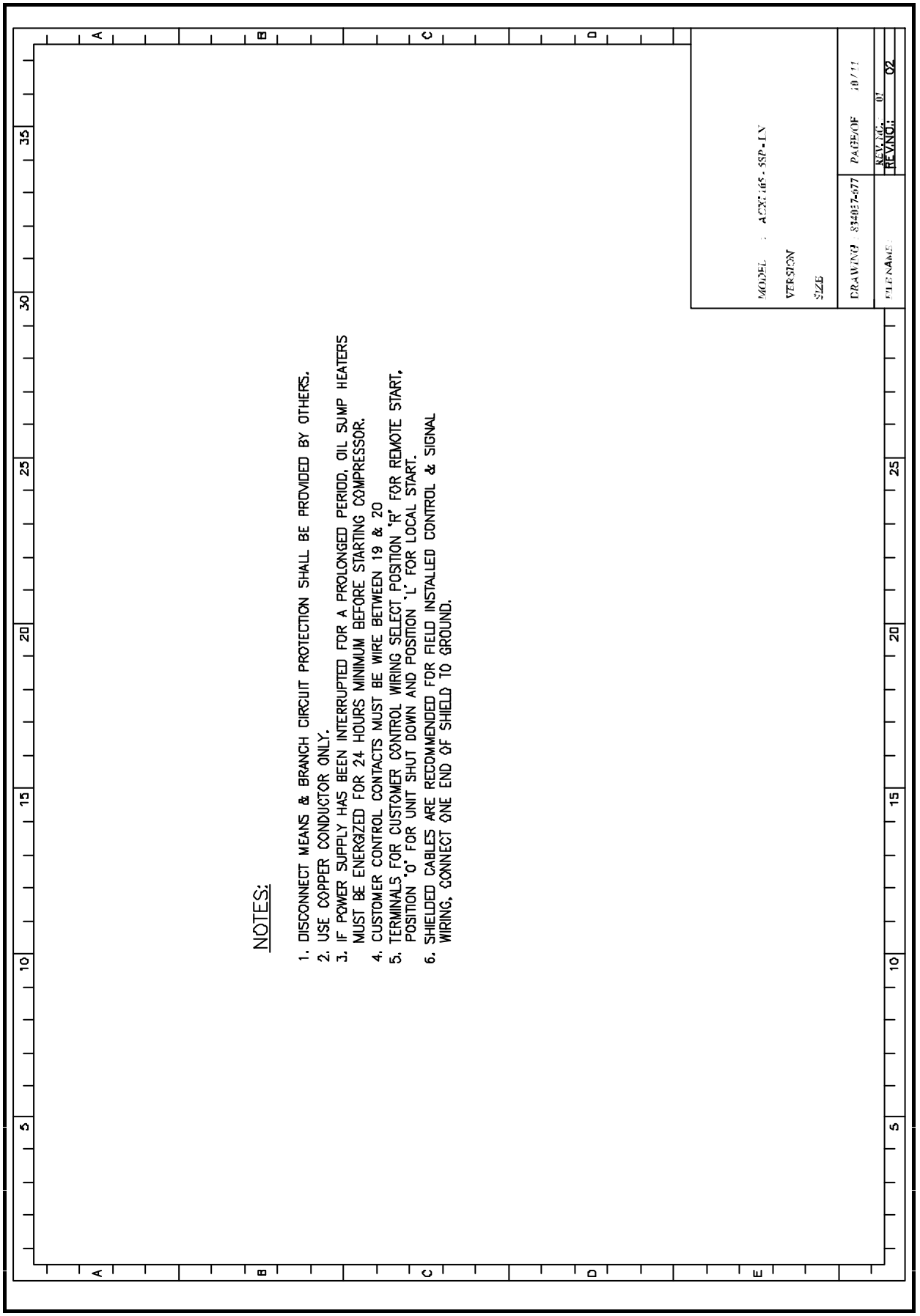

Item Number	Control points (CP)	Digital Input (DI)	Analog Input (AI)	Setpoint B	Setpoint A	Alarm Codes	Item Number
1	Compressor 1	Comp 1	Leaving Water Temperature		Leaving Water Temperature Sensor		1
2	Comp 1 Load	Comp 2	Entering Water Temperature	Lead			2
3	Comp 1 Unload	Oil Level Sensor 1	C1 Suction Pressure	Ramp Start	Ramp Start		3
4	Compressor 2	Oil Level Sensor 2	C1 Discharge Pressure	Amp Limit 1	AMP Limit 1		4
5	Comp 2 Load	Flow Switch	C2 Suction Pressure	Amp Limit 2	AMP Limit 2		5
6	Comp 2 Unload	Unit Control	C2 Discharge Pressure	Power Loss			6
7	Alarm		C1 Discharge Temperature	Low Pressure	High Pressure		7
8	Control Power		C2 Discharge Temperature	Freeze	High Disch Temp		8
9	Comp 1 Liq. Inj. Sol.		Volts	Fan Stage 2 (off)	Fan Stage 2 (on)		9
10	Comp 2 Liq. Inj. Sol.		C1 AMPS	Fan Stage 3 (off)	Fan Stage 3 (on)	No Run 1	10
11	Cond. Fans 1 & 3		C2 AMPS			Low Suct. 1	11
12	Cond. Fan 5			Liquid Injection (off)	Liquid Injection (on)	High Disch. 1	12
13	Comp 1 Pump Down					Low Different 1	13
14	Comp 2 Pump Down					Low Oil 1	14
15	Comp 1 Liq. Line Sol. 1					Sensor Error 1	15
16	Comp 1 Liq. Line Sol. 2					Disch. Temp. Error 1	16
17	Cond. Fans 7 & 9					No Run 2	17
18	Cond. Fan 11					Low Suct 2	18
19	Comp 2 Liq Line Sol 1					High Disch. 2	19
20	Comp 2 Liq Line Sol 2		Target %			Low Different 2	20
21	CWP 1 Vap. Inj Sol.		% FLCP C1			Low Oil 2	21
22	CWP 2 Vap. Inj. Sol.		% FLCP C2			Sensor Error 2	22
23			KW 1			Disch. Temp. Error 2	23
24			KW 2			Freeze	24
25			Full Load KW 1			Temp Error	25
26			Full Load KW 2			Power Loss	26
27						High/Low Volt	27
28						Low Flow	28
29						No Stop 1	29
30						No Stop 2	30
31							31
32							32
33							33

MODEL . ACX 165 - 5SP - LN

VERSION

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REV.NO. 02

4.4 MICROCOMPUTER CONTROLLER

This unit is controlled by a microcomputer control system. The system is composed of four microcomputer boards, a display board and analog and digital sensors. The following sections describe the system and how to operate it.

The display board has a 20-key keypad and a 2 x 40 LCD display. The keypad and display can be used to determine the status of the compressor, and refrigeration system. Various setpoints can also be displayed and altered.

The status of the machine can also be monitored by a computer terminal either locally or remotely by a modem. The terminal must be able to handle RS232 communications. For more information, Please contact Dunham-Bush Industries, M & E Service Department.

4.4.1 TO DISPLAY DATA FROM THE MENU

1. Press the MENU key.
2. Use the up or down arrow keys to select the type of information desired. The main menu items are:
   DATE & TIME SET
   CONTROL POINTS
   ANALOG SENSORS
   DIGITAL SENSORS
   SETPOINTS A & B
   ALARMS
   AUTHORIZATION
3. Press the ENTER key.
4. Use the up or down arrow keys to select the desired data. For control points, additional data such as compressor operating hours and number of starts can be viewed with the right and left arrow keys.

   NOTE: When displaying analog sensors, the PAGE MODE key can be pressed to display two new analog inputs after each arrow key is pressed. Press PAGE MODE again to return to displaying one new analog input.

4.4.2 TO RESET ALL CONTROL POINTS TO COMPUTER CONTROL

1. Press the RESET key. The display will show RESET ALL CPs to COM MODE? N Y
2. Press the right arrow key to select Y.
3. Press the ENTER key. The reset will not be accepted if a lockout control point is active. Resolve the problem and reset again.

4.4.3 TO DISPLAY ALARMS

1. Press the MENU key.
2. Use the up or down arrow to select ALARMS.
3. Press ENTER.
4. The day, time, and alarm code is displayed. Alarm 1 is the most recent alarm.
5. Press the down arrow to view previous alarms.
6. Determine identity of alarm from alarm codes on computer instruction label.

4.4.4 TO BECOME AUTHORIZED

1. Select AUTHORIZATION on the main menu. Press ENTER.
2. If the current status shown is VIEW, press the authorization code (64) on the number keys.
3. Press ENTER. the current status will change to PROG (program) if accepted.

4.4.5 TO ALTER SETPOINT DATA

1. You must be authorized and in the PROG mode. See section 4.4.4.
2. Select SETPOINTS A & B on the main menu. Press ENTER.
3. Use the up or down arrow keys to select the setpoint to be changed. Press ENTER. A cursor will flash over the setpoint A value.

4. a.) If you want to change setpoint A, press in the desired new value and press ENTER. if the new value is within allowable limits, it will be stored in memory. The cursor will then move to setpoint B.

   b.) If you do not want to change setpoint A, press ENTER.

5. Repeat 4, for Setpoint B.

4.4.6 TO CALIBRATE TEMPERATURE AND PRESSURE SENSORS

1. You must be authorized and in the PROG mode. See Section 4.4.4.
2. Display the analog sensor to be calibrated on the top line of the display.
3. Press ENTER to show ZERO CALIBRATION value.
4. Use an accurate gauge to measure the analog value when it is stable and near design conditions.
5. Determine the revised zero calibration required as follows: Meter Reading - AI Display + Zero Calibration = New Zero Calibration. The new zero calibration must be rounded to the nearest whole number.
6. Press ENTER to place the cursor on the zero calibration value.
7. Enter the new value from 5. Negative values are entered by pressing LOWER FUNCTION +/- before the number.
8. Press ENTER to store the revised zero calibration.

   For example, if a suction pressure gauge shows 58 psig and the computer displays 60.3 psig with a zero calibration of -1, then new calibration would be 58 - 60.3 + (-1)= -3.3(-3). So the zero calibration should be changed to -3. Then the computer will display 58.3.

4.4.7 TO SET DATE AND TIME

1. You must be authorized. See Section 4.4.4.
2. Select DATE & TIME SET on the main menu. Press ENTER to display current date and time.
3. Press ENTER key to move cursor to each date/time item.
4. As each item flashes, use the number keys to enter revised data if necessary.
5. Press ENTER to continue. The last ENTER will store the new date and time.

WARNING: Setting the clock will cause a system reset. The entire unit will shut down and start over again. If the change was started inadvertently, press MENU key before completing the change.

4.4.8 TO DISPLAY DATA WITHOUT ACCESSING MENU

1. Press LOWER FUNCTION.
2. Press function desired (blue sub-script)
3. Press item number to be displayed.
4. Press ENTER.

EX: To display analog input #5, press LOWER FUNCTION, ANALOG INPUT, 5, ENTER.

4.4.9 UNIT SCHEDULE OF OPERATION

If a seven day time schedule of unit operation is desired, the internal real time clock of the microcomputer can be used. When the SCHEDULE control point is ON, the compressor is allowed to operate. The following procedure is used to modify the operating schedule.

1. Perform the authorization procedure (See Section 4.4.4).
2. Press MENU key.

3. Use Up and Down to select CONTROL POINTS.
4. Press ENTER.
5. Use Up and Down to select SCHEDULE control point.
6. Use ® to display the first schedule. The standard display screen would show:

   CP 17 SCHEDULE GRP: 1 SCH: 1 0000 2400 DAYS: *** ALL DAYS ***.

   This indicates that control point 17 named SCHEDULE is controlled by schedule group (GRP) #1. The first schedule (SCH:1) turns on at 0000 hours and off at 2400 hours (military time) every day of the week. Thus it is on all the time.
7. To change this schedule, press ENTER. The cursor will flash over the turn-on time.
8. Use the number keys (0-9) to enter the revised turn on time using military format.
9. Press ENTER. The cursor will move over to the turn-off time.
10. Use the number keys to enter the turn-off time in military format.
11. Press ENTER. The cursor will move to DAYS during which this schedule is active.
12. To change the days for this schedule, press one or more of the following number keys: 0- Clear all current days; 1- Sunday(S); 2- Monday(M); 3- Tuesday(T); 4- Wednesday(W); 5- Thursday(R); 6- Friday(F); 7- Saturday(A); 8- *** ALL DAYS***.
13. Press ENTER. The revised schedule number is now stored.
14. To add another schedule, press the right arrow key and repeat steps 7-13.
15. To delete a schedule, clear all of the days by pressing 0 at Step 12.

The schedule group turns on when any of the individual schedules turns on. The turn on time does not have to be earlier than the turn off time. Schedules turn on by time and day, but turn off by time alone. For example, a schedule from 1900 to 0700 Saturdays would turn on at 7:00 PM Saturday (time and day) and turn off at 7:00 AM Sunday (time only).

EXAMPLE: If a unit is to operate at all times except between the hours of 1:00 AM and 6:00 AM, the following schedules would be entered:

CP 17 SCHEDULE GRP :1 SCH:

1 0000 0100 DAYS:

*** ALL DAYS ***

CP 17 SCHEDULE GRP:1 SCH:

2 0600 2400 DAYS: ***ALL DAYS ***

ANOTHER EXAMPLE: A typical building may require cooling from 6:00 AM to 7:00 PM Monday - Friday and from 7:00 AM- 3:00 PM on Saturdays. The schedules would be entered as follows:

CP 17 SCHEDULE GRP:1 SCH:
1 0600 1900 DAYS: MTWRF

CP 17 SCHEDULE GRP: 1 SCH:
2 0700 1500 DAYS: A

4.5 CONTROL FUNCTIONS

4.5.1 Chilled Water Pump interlock And Flow Switch (CWP And CWFS)

These are field installed switches, both of which are used to ensure chilled water flow before the unit is allowed to start. Failure of either one during operation will cause the compressor to shut down.

A water flow alarm will be generated and RESET must be pressed to clear the alarm.

NOTE: The flow switch or pump interlock cannot be used for normal control of the unit. (See Section 4.5.2).

4.5.2 Customer Control interlock

Control contacts from an external controller can be used to enable or disable operation of the unit. The wiring diagram specifies the terminals to which the contacts must be wired. To enable the unit, the contacts must be closed. To disable the unit, the contacts must be opened.

4.5.3 Anti-Recycle Timer (Microcomputer)

The compressor motor requires an anti-recycle time delay which prevents restart for 15 minutes after a start. The purpose of this feature is to avoid frequent starts which tend to elevate the motor winding temperature and impose undue wear on contactors. The microcomputer will not restart the compressor motor until the 15 minutes have elapsed. COFF is displayed when the compressor control point (1 CP or 4CP for compressors 1 or 2 respectively) is addressed, and when other conditions for compressor start are satisfied. See Section 4.3.

4.5.4 Load Control (Microcomputer)

The microcomputer controls the leaving water temperature within a narrow deadband by pulsing load and/ or unload solenoids on the compressor. The load and unload solenoids position the slide valve within the compressor to control its capacity. The microcomputer determines a desired level of loading and varies pulse duration depending on difference between load target and actual load. The load target is varied based on rate of approach to desired temperature preventing significant temperature oscillations. The current limit function (see Section 4.5.7) overrides the temperature control.

The status of the compressor can be observed by displaying the compressor control point (1CP or 4CP). One of the following messages will be displayed:

COMP # LOAD	Automatic load
COMP # HOLD	Automatic hold
COMP # UNLD	Automatic unload
COMP # OFF	Off on temperature or customer control
COMP # COFF	Off on timer (C lock off)
COMP # LOFF	Manual off or safety shutdown

Where # is 1 or 4 for compressors 1 or 2 respectively.

4.5.5 Ramp Control (Microcomputer)

Another feature of the microcomputer is ramp control, which is the ability to vary load time of the machine from start. Often when the machine is started, the water in the chilled water circuit is warm, and the unit will go to full load quickly. With ramp control, the user can program the computer so that it loads at a predetermined rate. This is a valuable tool, since it can help reduce power consumption and demand charges. Two variables are used to define the ramp profile: Ramp rate and start point. Ramp rate defines the length of time the unit takes to load from start point to full load. Start point is the percent of full load at which the ramp begins. The ramp rate A setpoint can be set anywhere from 0.1 to 0.4, smaller values producing slower loading rates. The ramp start B setpoint can be set anywhere between 10 and 50%. The compressor will load quickly to this value and then follow the ramp slope from there. See Table 4.5.5 for ramp rates at various settings.

TABLE 4.5.5 SAMPLE RAMP TIMES (MINUTES) FOR TWO COMPRESSOR UNIT

Ramp Rate Setpoint	0% Start Point Setpoint	50% Start Point Setpoint	75% Start Point Setpoint
0.1	33.4	25.0	20.9
0.2	16.6	12.5	10.4
0.3	11.2	8.4	7.0
0.4	8.4	6.3	5.2
0.5	6.6	5.0	4.1
0.6	5.6	4.2	3.5
0.8	4.2	3.1	2.6
1.0	3.4	2.5	2.1

4.5.6 Current Limiting (Microcomputer)

A maximum desired current is specified by amp limit B setpoint for each compressor. Above the B setpoint, the compressor will not load. If the amps rise above the A setpoint, the computer will give an unload command to the compressor until the current drops below the A setpoint. The amp value in the A setpoint should be 10% of RLA higher than the B setpoint.

4.5.7 Staging Control (Microcomputer)

On multiple-compressor machines, when the microcomputer determines that a compressor is fully loaded and temperature is not being maintained, another compressor is added. When unloading, a compressor is taken off line when the computer determines that the remaining compressors can control water temperature.

4.5.8 Manual Lead-Lag Control (Microcomputer)

On multi-compressor machines, the lead compressor can be chosen by storing 0.0 or 1.0 in the lead setpoint B position. 0.0 is for lead on compressor #1, and 1.0 is for lead on compressor #2 (if applicable).

4.5.9 Manual Load-Unload Control (Microcomputer)

Loading of the compressor can be controlled manually. To place computer in manual control, do the following:

1. Press RESET if the compressor is locked out.
2. Obtain authorization per 4.4.4.
3. Select CONTROL POINTS on the main Menu. Press ENTER.
4. Use up or down arrow to select the compressor to be controlled manually. Press ENTER.
5. Press up or down arrow to select MAN ON. Press ENTER. The compressor will start and operate on manual control.
6. Use the following keys to control the status of the compressor:

   1 - Hold
   2 - Load
   3 - Unload

Manual control is maintained for 15 minutes after the last manual entry. After this, the compressor reverts to automatic control. To retain manual control, enter a 1, 2, or 3 command to the compressor at least once every 15 minutes. (See Item 5 above)

In manual control, to transfer from one compressor to another or to display data, press MENU, then continue as above.

CAUTION: Do not start compressor manually more than once every 15 minutes. Verify that chilled water flow switch is closed.

4.5.10 Chilled Water Reset and Customer Control Interlock (Optional)

The chilled water temperature setpoint can be raised automatically by a 0-5 VDC signal provided by an external controller. The reset signal must be between 0VDC and 5VDC, with 0VDC being no reset and 5VDC being max. reset. The maximum temperature reset (increase) desired must be stored in CWR max. B setpoint. For example, to raise the chilled water setpoint from 44°F to 50°F (6.0°F) with a 5VDC input, a 6.0 is stored in CWR max. setpoint.

Control contacts from an external controller can be used enable or disable operation of compressors. The wiring diagram specifies the terminals to which the contacts must to be wired. To enable the compressors, the contacts must he closed. To disable the compressors, the contacts must be opened.

4.5.11 Variable Fan Speed Control (Optional)

When variable fan speed control has been applied with the package, an output from the computer controls the Variable Speed Drive (VFD). The VFD is turned on to maintain the set discharge pressure. Fan speed increases as discharge pressure rises and decreases as discharge pressure drop. Refer VFD manual for drive operation.

4.5.12 Sump Heater Control

Each compressor is fitted with an oil sump band-heater. The heater is energized at all times when compressor is off and de-energized when the compressor is running.

Its purpose is to prevent refrigerant migration into the oil during shut down. For this reason, it is essential that heaters be energized for 24 hours before starting a compressor.

4.6 SAFETY FUNCTIONS

4.6.1 Control Power Loss (Microcomputer)

The microcomputer can be set up to start automatically or manually after a power failure to the microcomputer. The power loss B setpoint is factory set to 0.0 to allow automatic start after a control power loss. To select manual reset, set power loss B setpoint to 1.0. In this case, a power loss alarm will be stored by the microcomputer and RESET must be pressed to start.

4.6.2 Low Pressure Cut-off (Microcomputer)

This function protects the unit from operating at abnormally low evaporator refrigerant pressure. The microcomputer will shut down the compressor when Evaporator pressure falls below the low pressure setpoint and turn on the alarm pilot light.

A low pressure alarm will be recorded by the microcomputer. Reset by pressing the RESET button on the micro-computer. Standard setpoint is 45 psig for water systems.

4.6.3 Evaporator Freeze Shutoff (Microcomputer)

If the leaving chilled water temperature drops below the freeze setpoint, the microcomputer will shut down the unit and store the freeze alarm. After solving the problem, press RESET on the microcomputer to clear the alarm.

4.6.4 High Pressure Cut-off (Microcomputer)

This function protects the compressor from operating at abnormally high discharge refrigerant pressures. The microcomputer will shut down the compressor when condenser pressure

reaches the high pressure set-point, and turn on the alarm indicator lamp on the control box. The high discharge pressure alarm will be recorded by the micro-computer. Reset by pressing the RESET button on the micro-computer. Setpoint is 360 psig.

4.6.5 Oil Level Switch (LS)

An oil level switch is located in each compressor. If low oil indication (digital input is OFF) persists for 60 seconds during compressor operation, the microcomputer will then shut down the compressor. The status of the float switch can be seen on the computer display or the associated LED of the Digital I/O Board. Failure is indicated on the alarm pilot light. The low oil alarm code will be recorded by the computer. Press the RESET key to reset the system. See Section 5.8 concerning oil level.

4.6.6 Overload Protector (OL)

A solid state overload protects each compressor by three phase current monitoring to prevent high current draw. The trip setting is factory set and is reset by pressing button on overload after correcting problem. The RESET button on micro-computer must also be pressed to clear the alarm. A no-run error is stored in the microcomputer.

4.6.7 Phase Control Relay (PCR)

The PCR protects the unit from the following electric supply malfunctions: Under-voltage, phase reversal, under-voltage and single phasing. If the PCR trips, a control relay (lCR) will de-energize and open the control circuit. A LED light, located on the PCR, indicates a good voltage supply. The power loss A setpoint is factory set to 0.0 to allow automatic start after PCR failure. Compressor will not start for 15 minutes after failure. To select manual reset, set power loss A setpoint to 1.0. In this case, a power loss alarm will be stored by the microcomputer and RESET must be pressed to start.

4.6.8 Sensor Alarm (Microcomputer)

If the computer measures an analog value (temperature, pressure, volts.) that is far beyond normal operating values, the associated compressors are shutdown. The computer then stores the alarm code corresponding to the sensor alarm. A sensor alarm indicates a problem in the analog measurement system.

4.6.9 No-Stop Alarm (Microcomputer)

If the microcomputer turns off a compressor, but the compressor digital input does not turn off, a No-Stop alarm is generated. The computer will turn off the control power relay which disables all compressor control circuits and will turn on the alarm light. This alarm indicates a wiring or hardware error.

4.6.10 Low Differential Pressure Alarm (Microcomputer)

For proper lubrication, a compressor requires a 30 psi differential pressure between condenser and evaporator pressures. If the differential pressure is less than 30 psi for 3 minutes while a compressor is operating, all compressors will be shut down. The microcomputer will store the low differential pressure alarm code and turn on the alarm light. The RESET key must be pressed to clear the alarm.

5.0 MAINTENANCE

5.1 GENERAL

As with all mechanical equipment, a program of regular inspection, cleaning and preventive maintenance by trained personnel will contribute greatly to the long satisfactory service life of this product.

5.2 PERIODIC INSPECTION

Read essential temperatures and pressures periodically to see that they indicate normal operation. It is a good idea to record these readings on a log sheet. If any abnormal operation is observed, try to remedy it. See Trouble Shooting Guide Section.

5.3 MONTHLY INSPECTION

Remote dirt and debris from condenser coil. Shut unit down, open main disconnect, inspect control panel, checking for loose wires, burned contacts, signs of overheated wires, etc. Restart unit and check performance of controls. Check sight glasses for proper refrigerant charge, see charging.

5.4 VESSEL MAINTENANCE

5.4.1 GENERAL

The efficient performance of the evaporator and condenser heat transfer surfaces is essential for efficient performance of your packaged water cooling machine. If these surfaces accumulate a film of dirt, scale or slime, their performance efficiency will degrade substantially. The refrigerant side of heat transfer surfaces does not foul since refrigerant is a good solvent and it is in a closed, filtered cycle. Water side surfaces can foul from the water system. A program of water treatment can slow the rate of fouling on heat transfer surfaces, but not eliminate it.

5.4.2 WATER SIDE CLEANING OF EVAPORATOR

The effects of fouling of the evaporator heat transfer surfaces can be detected by recording full load performance data on the log sheet. The best measure of performance of evaporator is approach, which is the difference between leaving water temperature and saturated refrigerant temperature at the pressure in the vessel. At full load, read evaporator pressure and leaving chilled water temperature on the computer. Then use Table 5.4.2 to find saturated temperature in evaporator. Then calculate approaches as follows:

Evaporator Approach = T lvg chilled water - T sat Evaporator

If the approach increases by more than 2°F above the approach recorded at clean conditions, the tubes should be cleaned. It is generally advisable to clean the water side surfaces at least annually and more often if severely foul water is used. In chemical cleaning, a caustic solution is pumped through the heat exchanger, which attacks dirt, slime and mineral deposits and flushes then away. Chemicals can be recommended by water treatment specialists, but it is important to rinse the system thoroughly after cleaning to remove the chemicals before they attack the metal surfaces.

5.5 AIR COOLED CONDENSER CLEANING

The face of the condenser should be cleaned at least once month during operation. If conditions are bad and condensers pick up dirt very quickly, it is suggested that they can be cleaned more frequently. If the condenser is allowed to get too dirty, the unit will run at high head pressure and will not give satisfactory performance.

Dirty coils can be cleaned using a soft brush or by flushing with cool water or commercially available coil cleaners. DO NOT USE HOT WATER OR STEAM. To do so will cause excessive pressure in the system. The face of the condenser should be cleaned at the beginning of the season and periodically thereafter if conditions require.

TABLE 5.4.2 R-407c PRESSURE/ TEMPERATURE PROPERTIES

Pressure		Temperature				Pressure		Temperature			
		Bubble		Dew				Bubble		Dew	
psia	kPa	°F	°C	°F	°C	psia	kPa	°F	°C	°F	°C
1.0	6.9	-125.86	-87.70	-111.56	-79.76	50.0	344.8	5.95	-14.47	17.55	-8.03
1.5	10.3	-116.20	-82.33	-102.09	-74.49	55.0	379.3	10.70	-11.83	22.20	-5.44
2.0	13.8	-108.95	-78.31	-94.98	-70.54	60.0	413.8	15.13	-9.37	26.52	-3.04
2.5	17.2	-103.07	-75.04	-89.22	-67.34	65.0	448.3	19.28	-7.07	30.58	-0.79
3.0	20.7	-98.09	-72.27	-84.34	-64.63	70.0	482.8	23.20	-4.89	34.41	1.34
4.0	27.6	-89.91	-67.73	-76.32	-60.18	75.0	517.2	26.91	-2.83	38.03	3.35
5.0	34.5	-83.26	-64.03	-69.80	-56.56	80.0	551.7	30.44	-0.87	41.47	5.26
6.0	41.4	-77.61	-60.89	-64.27	-53.48	85.0	586.2	33.81	1.01	44.75	7.08
7.0	48.3	-72.69	-58.16	-59.44	-50.80	90.0	620.7	37.03	2.79	47.89	8.83
8.0	55.2	-68.30	-55.72	-55.15	-48.42	95.0	655.2	40.11	4.51	50.90	10.50
10.0	69.0	-60.71	-51.51	-47.71	-44.28	100.0	689.7	43.08	6.16	53.79	12.11
12.0	82.8	-54.25	-47.92	-41.38	-40.77	110.0	758.6	48.69	9.27	59.25	15.14
14.0	96.6	-48.60	-44.78	-35.84	-37.69	120.0	827.6	53.93	12.18	64.35	17.97
14.7	101.4	-46.79	-43.77	-34.06	-36.70	130.0	896.6	58.85	14.92	69.14	20.63
16.0	110.3	-43.56	-41.98	-30.90	-34.94	140.0	965.5	63.50	17.50	73.65	23.14
18.0	124.1	-38.99	-39.44	-26.43	-32.46	150.0	1034.5	67.90	19.94	77.92	25.51
20.0	137.9	-34.81	-37.12	-22.33	-30.18	160.0	1103.5	72.10	22.28	81.99	27.77
22.0	151.7	-30.94	-34.97	-18.55	-28.08	170.0	1172.4	76.10	24.50	85.86	29.92
24.0	165.5	-27.35	-32.97	-15.02	-26.12	180.0	1241.4	79.92	26.62	89.57	31.98
26.0	179.3	-23.97	-31.09	-11.72	-24.29	190.0	1310.4	83.60	28.67	93.12	33.96
28.0	193.1	-20.80	-29.33	-8.61	-22.56	200.0	1379.3	87.13	30.63	96.53	35.85
30.0	206.9	-17.80	-27.67	-5.67	-20.93	220.0	1517.3	93.81	34.34	102.98	39.43
32.0	220.7	-14.95	-26.08	-2.88	-19.38	240.0	1655.2	100.06	37.81	108.99	42.77
34.0	234.5	-12.23	-24.57	-0.23	-17.91	260.0	1793.1	105.93	41.07	114.64	45.91
36.0	248.3	-9.64	-23.13	2.31	-16.49	280.0	1931.0	111.48	44.16	119.95	48.86
38.0	262.1	-7.15	-21.75	4.74	-15.14	300.0	2069.0	116.74	47.08	124.98	51.66
40.0	275.9	-4.76	-20.42	7.08	-13.84	320.0	2206.9	121.74	49.86	129.75	54.31
42.0	289.7	-2.47	-19.15	9.32	-12.60	340.0	2344.8	126.52	52.51	134.30	56.83
44.0	303.5	-0.26	-17.92	11.49	-11.39	360.0	2482.8	131.09	55.05	138.63	59.24
46.0	317.2	1.88	-16.73	13.58	-10.23	380.0	2620.7	135.48	57.49	142.78	61.54
48.0	331.0	3.95	-15.58	15.60	-9.11	400.0	2758.6	139.70	59.83	146.75	63.75

5.6 ELECTRICAL MALFUNCTION

The unit has four devices designed to protect compressor motors and manual motor controllers from electrical malfunctions: Circuit breakers, starter overload relays, under voltage relay, and motor over temperature protectors (optional).

If the under voltage relay trips, it is a sign of trouble in incoming power. If it trips again after resetting, call your electric utility to investigate the problem. If circuit breaker or motor overload relay or motor over temperature protectors trip, this is a sign of possible motor trouble. DO NOT reset and try to run compressor again. Call authorized service representative to check for motor trouble. Resetting these safety devices and repeated starting could turn a minor motor problem into a costly major motor burnout.

5.7 REFRIGERANT CHARGE

5.7.1 GENERAL

All packaged chiller units are given a complete charge of refrigerant at the factory. The type and amount of refrigerant required is in Physical Specifications. The total refrigerant shown is for the entire system. Since these units have separate circuits, each circuit should be considered separately for charging.

In order to check proper refrigerant charge, look in each liquid line sight glass with the aid of a flashlight during system operation. At all operating conditions, the sight glass should be clear. If bubbles are visible at any operating condition, the circuit is short of charge.

Be careful not to overcharge the machine. Overcharging will result in considerable liquid logging in the condenser, and excessive condensing pressure.

To add refrigerant, connect a refrigerant vessel to the 1/4" back seating port of the suction valve. Purge the air from the tube with refrigerant gas before connecting. With the unit running, open the refrigerant vessel vapor connection slightly. If the refrigerant vessel is warmer than the evaporator, refrigerant will more readily flow from the vessel into the unit.

5.7.2 AIR COOLED PACKAGES

To determine the proper refrigerant charge, check the amount of subcooling if possible. The amount of subcooling at the liquid line (liquid line saturation temperature corresponding to liquid line pressure minus liquid line temperature) should be between 15°F and 20°F. Subcooling at the condenser outlet-subcooler inlet trap should not exceed 5°F. This sight glass should be clear with no bubbles.

5.8 OIL CHARGE

The proper oil charge is in the unit as supplied from the factory. Any operating compressor should show oil return and oil overflow at all time. If for some reason, a compressor runs low on oil, a low oil level switch in the compressor will shut it down before any damage is done. In the event of a low oil shutdown, call a D/B authorized service agent to correct the problem. **DO NOT ADD OIL TO THE SYSTEM.**

Note: Only DB 18 oil may be used in this package. Use of other oil is not approved by Dunham-Bush, and will result in poor performance of the package.

5.0 MAINTENANCE

5.9 TROUBLESHOOTING

SYMPTOM	POSSIBLE CAUSE	REMEDY
1. Unit will not start.	a.) Power off. b.) No control power. c.) Compressor circuit breakers open. d.) Undervoltage relay open. e.) Flow Switch open. f.) Compressor switch open. g.) Microcomputer shutdown not reset.	a.) Check main disconnect switch and main line fuses. b.) Check control transformer fusing. c.) Close circuit breakers. If trip, check compressor. d.) Check for power supply problems (low voltage, phase imbalance). When corrected, press reset button. e.) Start pumps, check flow switch. f.) Turn switch on. Check alarm status. Correct problem. g.) Press reset button.
2. Compressor hums but does not start.	a.) Low voltage. b.) No power on one phase of 3 phase unit. c.) Faulty starter or contactor.	a.) Check at main entrance and at unit. Consult power company if voltage is low and increase wire size to the unit if voltage is normal at main and low at unit. Voltage must be within 10% of motor nameplate rating. b.) Check fuses and wiring. c.) Check the contacts and time delay on part wind start.
3. Compressor will not start when reset button is pushed. Check light: None	a.) Cooling not required. b.) Computer's time delay active. c.) Undervoltage relay open. d.) Flow switch open. e.) Compressor switch open. f.) Burned out signal light. i.) Wiring problem	a.) Apply load. b.) Wait 15 minutes max. c.) See 1.(d.) above. d.) See 1.(e.) above. e.) See 1.(f.) above. f.) Check signal light bulbs. i.) Check wiring against drawing.
4. Compressor overload.	a.) Compressor drawing high amps.	a.) Check motor megohms. Reset overloads , run compresssor an check amps. Do not exceed RL x 1.25. Call D/B serviceman.
5. High motor temperature	a.) Motor windings failing.	a.) Check megohms. Reset by turning compressor switch off and then on.
6. Low suction	a.) Inadequate feed to Evaporator. b.) Inadequate refrigerant charge. c.) Fouling of water side of Evaporator. d.) Inadequate chilled water flow. e.) Too much oil in system.	a.) Check to see that main expansion valve superheat. b.) See information on charging in Section 5.7 c.) At high load, check Evaporator approach (See Section 5.4). If approach is more than 2°F above clean valve, fouling is probably the trouble. Clean tube. d.) Measure pressure drop across vessel and determine gpm from Figure 3.3. If gpm is low, check chilled water pump, valves and strainers. e.) If all oil level sight glasses are full at all times, remove oil until oil level shows at top of glass on a compressor.
7. High discharge pressure.	a.) Inadequate air flow across condenser	a.) Check condenser fan operation and condenser coil for clogging.
8. Oil low in sump.	a.) Low oil level in compressor.	a.) Low oil level in compressor sight glass is acceptable.
9. Low oil shutdown.	a.) Low oil in compressor.	a.) See Section 5.7.2.
10. Freeze warning.	a.) Operating setpoint too low. b.) Load changing too rapidly.	a.) Check leaving water setpoint on microcomputer. b.) Load on package must drop at reasonable rate for automatic control to work properly.
11. Improper capacity control.	a.) Ramp rate incorrect.	a.) See Section 4.5.5.

5.10 SAMPLE LOG SHEET

SHEET NO. .....

DUNHAM-BUSH SCREW COMPRESSOR PACKAGED CHILLER

NAMEPLATE DATA:

UNIT MODEL NO. .....**UNIT NO.**.....**VOLTS:** .....**Hz**.....

UNIT SERIAL NO. .....**COMPRESSOR MODEL NOS.**.....

START UP : **DATE**.....**TIME**.....

DATE									
TIME									
ELAPSED TIME METERS									
COMP. NO.									
SUCTION PRESSURE	1.								
	2.								
	3.								
	4.								
DISCHARGE PRESSURE	1.								
	2.								
	3.								
	4.								
DISCHARGE TEMPERATURE	1.								
	2.								
	3.								
	4.								
DISCHARGE SUPERHEAT (DISC. TEMP.-SAT. DISCH.)*	1.								
	2.								
	3.								
	4.								
DISCHARGE SUPERHEAT (DISC. TEMP.-SAT. SUCT.)*	1.								
	2.								
	3.								
	4.								
EVAPORATOR WATER TEMPERATURE-IN									
EVAPORATOR WATER TEMPERATURE-OUT									
EVAPORATOR PRESSURE DROP PSI/IN WATER									
EVAPORATOR WATER FLOW (GPM)									
CONDENSER AIR TEMPERATURE-IN (AMBIENT) AC ONLY									
ACTUAL VOLTAGE COMPRESSOR AMPS	1.								
	2.								
	3.								
	4.								
FAN AMPS									
VOLTS									

*USE TABLE 5.4.2 FOR OBTAINING SATURATED TEMPERATURE

THIS LOG SHEET IS PROVIDED AS A RECOMMENDATION OF THE READINGS THAT SHOULD BE TAKEN ON A PERIODIC BASIS. THE ACTUAL READINGS TAKEN AND THE FREQUENCY WILL DEPEND UPON THE UNITS APPLICATION, HOURS OF USE, ETC. THIS TYPE OF INFORMATION CAN PROVE VERY USEFUL IN PREVENTING AND/ OR SOLVING PROBLEMS THAT MIGHT OCCUR DURING THE LIFE OF THE UNIT.