

Vogt®

**P-24F
TUBE-ICE®
MACHINE**

Service Manual

\$50⁰⁰

NOTICE

This manual is the property of the owner of this particular Tube-Ice® machine.

Model # _____ Serial # _____.

It is to be left on the premises with this machine at all times. After start-up, it should be stored in a safe place where it can be readily available when needed for future reference in maintaining troubleshooting or servicing.

Failure to comply with this notice will result in unnecessary inconvenience and possible additional expenses.

This manual is intended as an informational tool for the installation, operation, maintenance, troubleshooting, and servicing of this equipment. If an existing situation calls for additional information not found herein, we suggest that you contact your distributor first. If further assistance or information is needed, please feel free to contact the factory at 502-635-3000 or FAX at 502-635-3024 or 502-634-0479.

IMPORTANT: The Warranty Registration/Start-Up Report found in the front of this manual is to be completed and returned to the factory promptly after the official start-up.

Please return to: Tube-Ice LLC
 1000 W. Ormsby, Suite #19
 Louisville, KY 40210
 Att. Tube-Ice Service Department

Vogt® Tube-Ice® Machine
MID & LARGE MACHINE WARRANTY REGISTRATION/START-UP REPORT
 MUST COMPLETE AND RETURN TO INITIATE WARRANTY

Machine Model No. _____ Serial No. _____

Installed at: _____ () _____
 Company Name Phone

Address City State Zip

Installed by: _____ () _____ / ____ / ____
 Company Name Phone Date

Address City State Zip

Describe any damage to machine/repairs made: _____

Start up by: _____ () _____ / ____ / ____
 Company Name Phone Date

Address

Name of person starting up machine: _____

PRE START-UP CHECK

CHECK

- Service Manual on hand
- Machine room suitable 50°F minimum, 110°F maximum
- Proper power supply, actual voltage _____, _____, _____ (machine not running)
- Compressor crankcase heater on 12 hour minimum
- Necessary hand valves opened as required
- Solenoid valve stems in auto position
- System leak checked/tight
- Auxiliary equipment overloads wired into control circuit
- Compressor oil level _____ (1/4 glass min.)
- All water distributors in place (visually inspected)
- Water supply and drain lines installed and connected properly
- Compressor, pump, cutter and other motor direction of rotation correct
- Make-up water float valve adjusted properly
- Hour meter in control panel connected

OPERATION CHECK

Machine charged with refrigerant lbs. _____ Actual voltage _____, _____, _____ (machine running)

Ambient temp. _____ °F Fan cycles On _____ Off _____ Tower water in _____ °F out _____ °F

Comp motor RLA _____, _____, _____, Actual _____, _____, _____

Pump RLA _____, _____, _____, Actual _____, _____, _____

Cutter motor RLA _____, _____, _____, Actual _____, _____, _____

Suction pressure end of freezing _____, end of harvest _____ Discharge pressure end of freezing _____, end of harvest _____

Evaporator/suction line frost _____ Receiver liquid level operating _____

Test Cycle	Water Temp	Freeze Time Min/Sec	Harvest Time Min/Sec	First Ice Out Min/Sec	All Ice Out Min/Sec	Avg. Hole Size	Ice Lb. Per Harvest	Ice Lb. Per Day
#1								
#2								
#3								
#4								

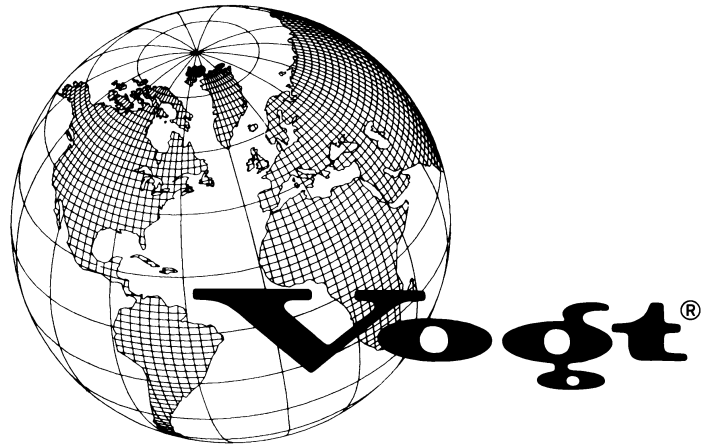
Note: Ice lb. per day can be found by: $\frac{\text{ice lb. per harvest}}{\text{(freeze time + harvest time)}} \times 1440$

The machine operated satisfactorily for _____ continuous hours. Date _____

Comments _____

Installer signature _____ End user signature _____

Please return to: Tube-Ice LLC., 1000 W. Ormsby, Suite #19, Louisville, KY 40210



**The Tube-Ice LLC, located in
Louisville, Kentucky since 1880.**

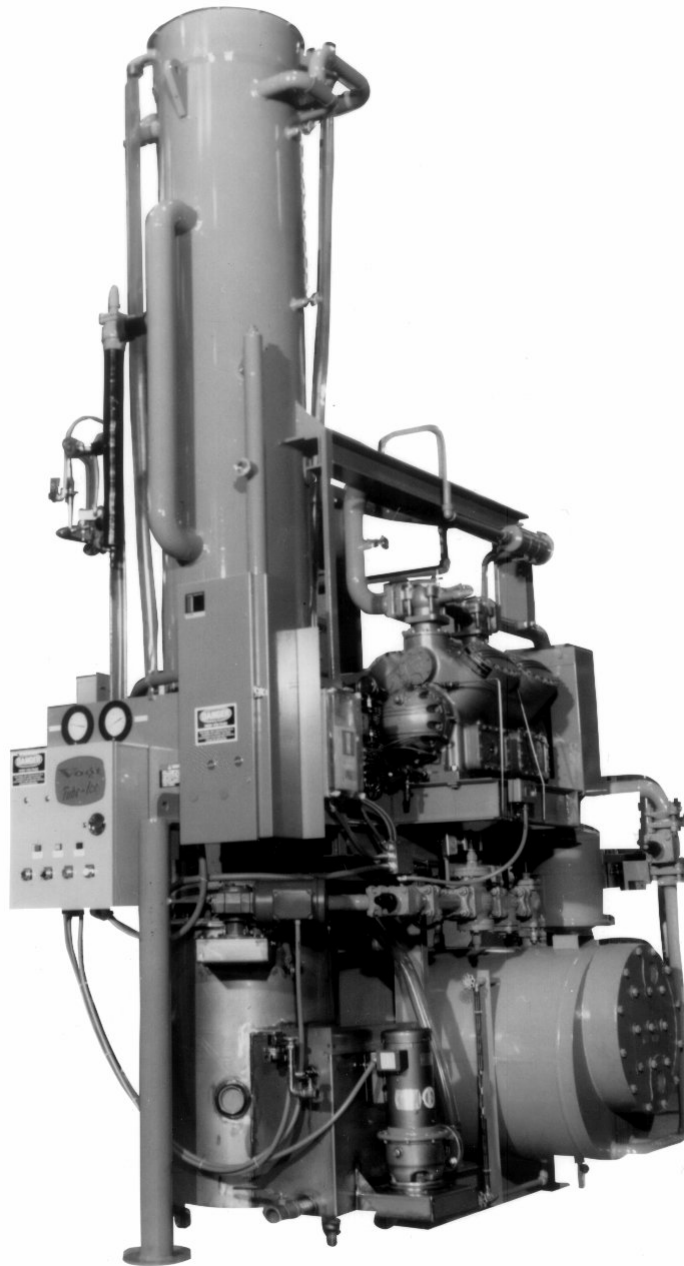
Sales & Service - (502) 635-3000

Parts - Your Local Distributor

Call your local distributor **first** for all of your parts and service needs.

Since 1938, Manufacturers of Quality
Tube-Ice® Machines

VOGT®
TUBE-ICE® MACHINES



Installation, Service Manual, and Parts Catalog #12A-4171L16

P24F Model

Tube-Ice LLC
1000 W. Ormsby, Suite #19
Louisville, Kentucky 40210
502-635-3000
FAX #502-634-0479

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1. Introduction

Tube-Ice LLC

A Brief History Of Our Company. In 1938, Vogt built the first Tube-Ice® machine and revolutionized the ice-making industry. Our first “sized-ice” machine quickly replaced the old can-ice plants, which required hard labor and large amounts of floor space for freezing, cutting, and crushing ice by hand.

Vogt Energy-Saving Tube-Ice Machines Are Cost Effective. Today, Vogt Tube-Ice® machines enjoy a well-earned reputation as the most energy efficient, dependable ice-making equipment in the world.

Using as little as one-half to one-third the energy required by competitors’ ice makers, Tube-Ice® machines produce the same amount of ice--in restaurants, sports arenas, packing plants, and wholesale operations around the globe--at great savings.

In addition, Tube-Ice® machines are renowned for their long life, giving many customers more than 35 years of dependable service. **Ask someone who owns one.**

Preview. All the skill in engineering and fabrication that we’ve learned in over a century of experience is reflected in every Tube-Ice® machine. Since Vogt introduced Tube-Ice® machines in 1938, the process of making Tube-Ice® ice has been widely recognized as the most economical means of production. The machine’s economic and reliable operation has been proven over and over again, in a network of varied types of installations throughout the world.

Furnished with your machine is the Certificate Of Test--the report of operating data which is a record of the unit’s satisfactory operation at our factory test floor. It is evidence of our desire to deliver to you “the finest ice-making unit ever made.”

This manual is designed to assist you in the installation, start-up, and maintenance of your unit. Your Tube-Ice® machine will give you a lifetime of service provided you install, maintain, and service it properly.

Please read your manual carefully before attempting installation, operation, or servicing of this professionally designed piece of equipment. Also, make sure the Warranty Registration/Start-up Report is completed and returned.

If you have additional questions, please call your distributor. Also, feel free to phone the factory direct at **(502) 635-3000**.

Important Safety Notice. This information is intended for use by individuals possessing adequate backgrounds in electrical, refrigeration and mechanical experience. Any attempt to repair major equipment may result in personal injury and/or property damage. The manufacturer or seller cannot be responsible for the interpretation of this information, nor can it assume any liability in connection with its use. It is important that personnel understand the properties of these refrigerants and that they be thoroughly trained in safe practices for their use and handling. Refer to the enclosed “Freon Compounds and Safety” in Appendix A.

INTRODUCTION

Safety Symbols & What They Mean. Prior to installation or operation of the Tube-Ice® machine, please read this manual. Are you familiar with the installation, start-up, and operation of a Tube-Ice® machine? Before you operate, adjust or service this machine, you should read this manual, understand the operation of this machine, and be aware of possible dangers.

**These safety symbols will alert you
when special care is needed.**

Please heed them.

! DANGER !
Indicates an immediate hazard, and that special precautions are necessary to avoid severe personal injury or death.
! DANGER !

! WARNING !
Indicates a strong possibility of a hazard, and that an unsafe practice could result in severe personal injury.
! WARNING !

! CAUTION !
Means hazards or unsafe practices could result in personal injury or product or property damage.
! CAUTION !

Special Precautions To Be Observed When Charging Refrigeration Systems. Only technically qualified persons, experienced and knowledgeable in the handling of R-22 or R-404a refrigerants, and the operation of refrigeration systems, should perform the operations described in this manual. All local, federal, and EPA regulations must be strictly adhered to when handling R-22 or R-404a refrigerants. See “Material Safety Data Sheet”, MSDS Code No. DU000025 (R-22) or MSDS Code No. DU005612 (R-404a) in Appendix A. For further information concerning refrigerants and handling practices see internet web site : www.dupont.com/suva/

If a refrigeration system is being charged from refrigerant cylinders, disconnect each cylinder when empty or when the system is fully charged. A gage should be installed in the charging line to indicate refrigerant cylinder pressure. The cylinder may be considered empty of liquid refrigerant when the gauge pressure is 25 pounds or less, and there is no frost on the cylinder. Close the refrigerant charging valve and cylinder valve before disconnecting the cylinder. Loosen the union in the refrigerant charging line--carefully to avoid unnecessary, excessive or illegal release of refrigerant into the atmosphere.

! CAUTION !

Immediately close system charging valve at commencement of defrost or thawing cycle if refrigerant cylinder is connected. Never leave a refrigerant cylinder connected to system except during charging operation. Failure to observe either of these precautions can result in transferring refrigerant from the system to the refrigerant cylinder, over-filling it, and possibly causing the cylinder to rupture because of pressure from expansion of the liquid refrigerant brought on by an increase in temperature.

! CAUTION !

Always store cylinders containing refrigerant in a cool place. They should never be exposed to temperatures higher than 120°F (R-22) or 108°F (R-404a), and should be stored in a manner to prevent abnormal mechanical shocks.

Also, transferring refrigerant from a refrigeration system into a cylinder can be very dangerous and is not recommended.

! CAUTION !

It is not recommended that refrigerant be transferred from a refrigeration system directly into a cylinder. If such a transfer is made, the refrigerant cylinder must be an approved, CLEAN cylinder--free of any contaminants or foreign materials--and must be weighed continuously to assure contents do not exceed net weight specified by cylinder manufacturer or any applicable code requirements.

! CAUTION !

INTRODUCTION

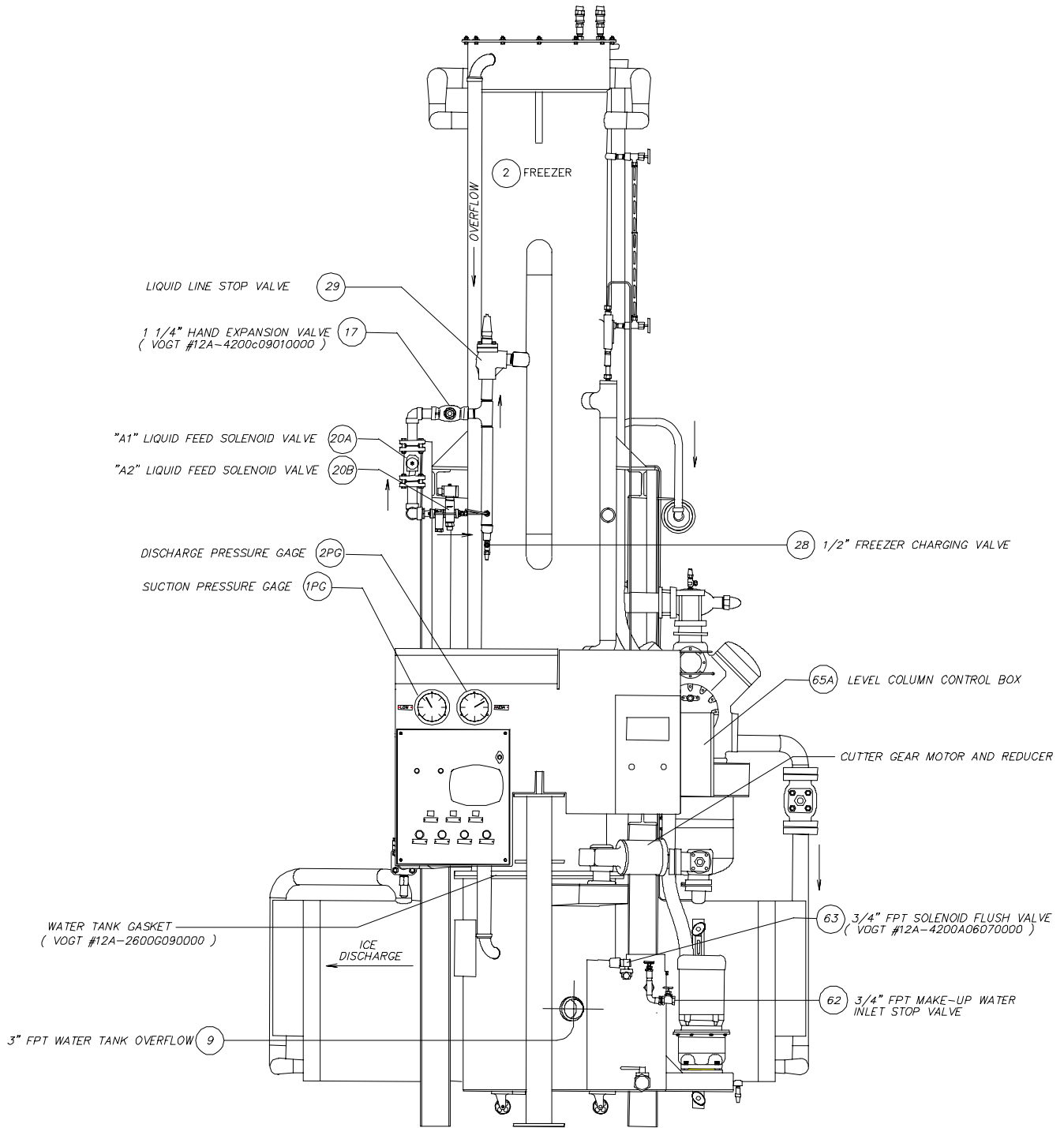


FIGURE 1-1
P24F Front Side (Control Panel)

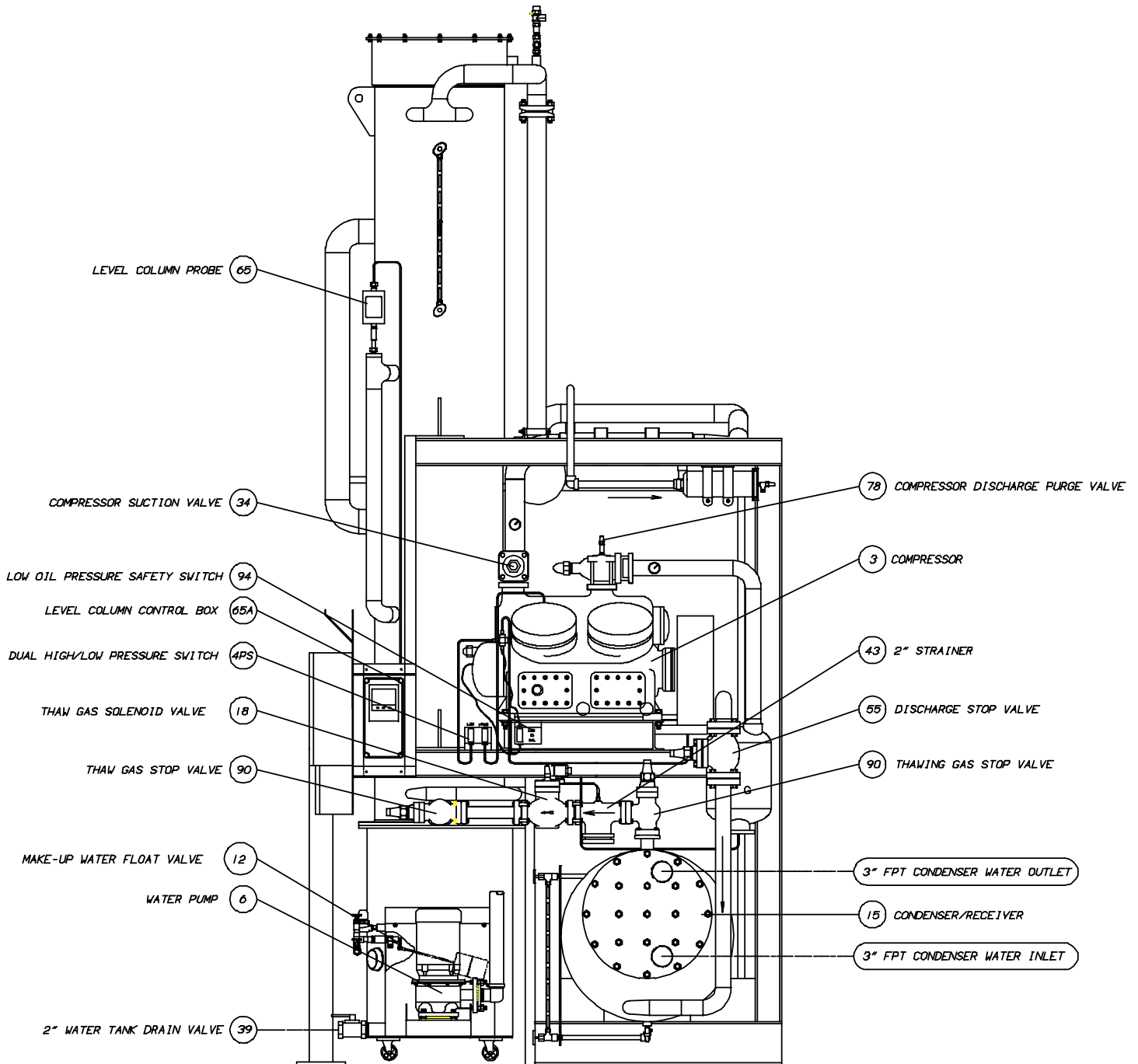


FIGURE 1-2
P24F Right Side

INTRODUCTION

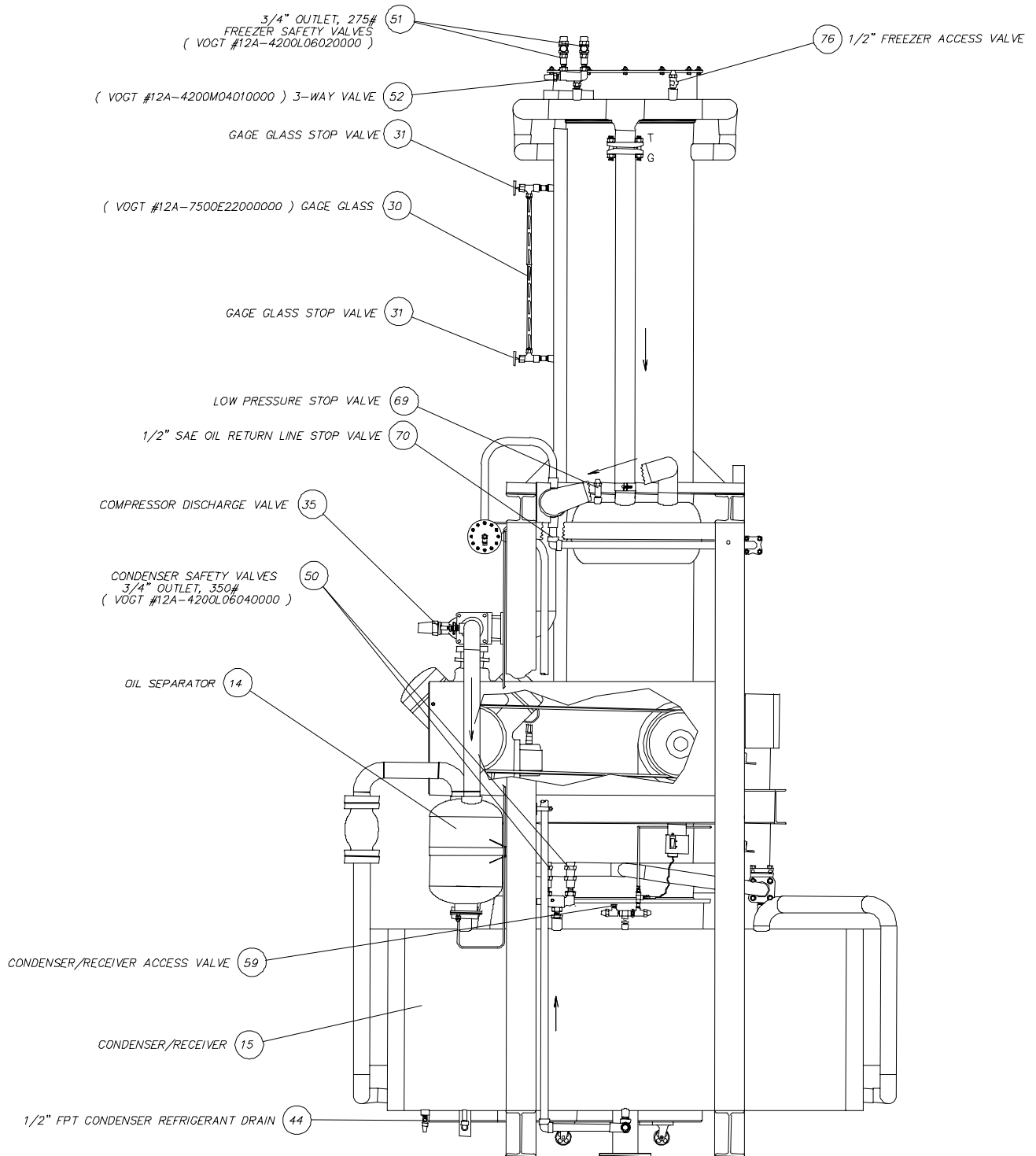


FIGURE 1-3
P24F Back Side

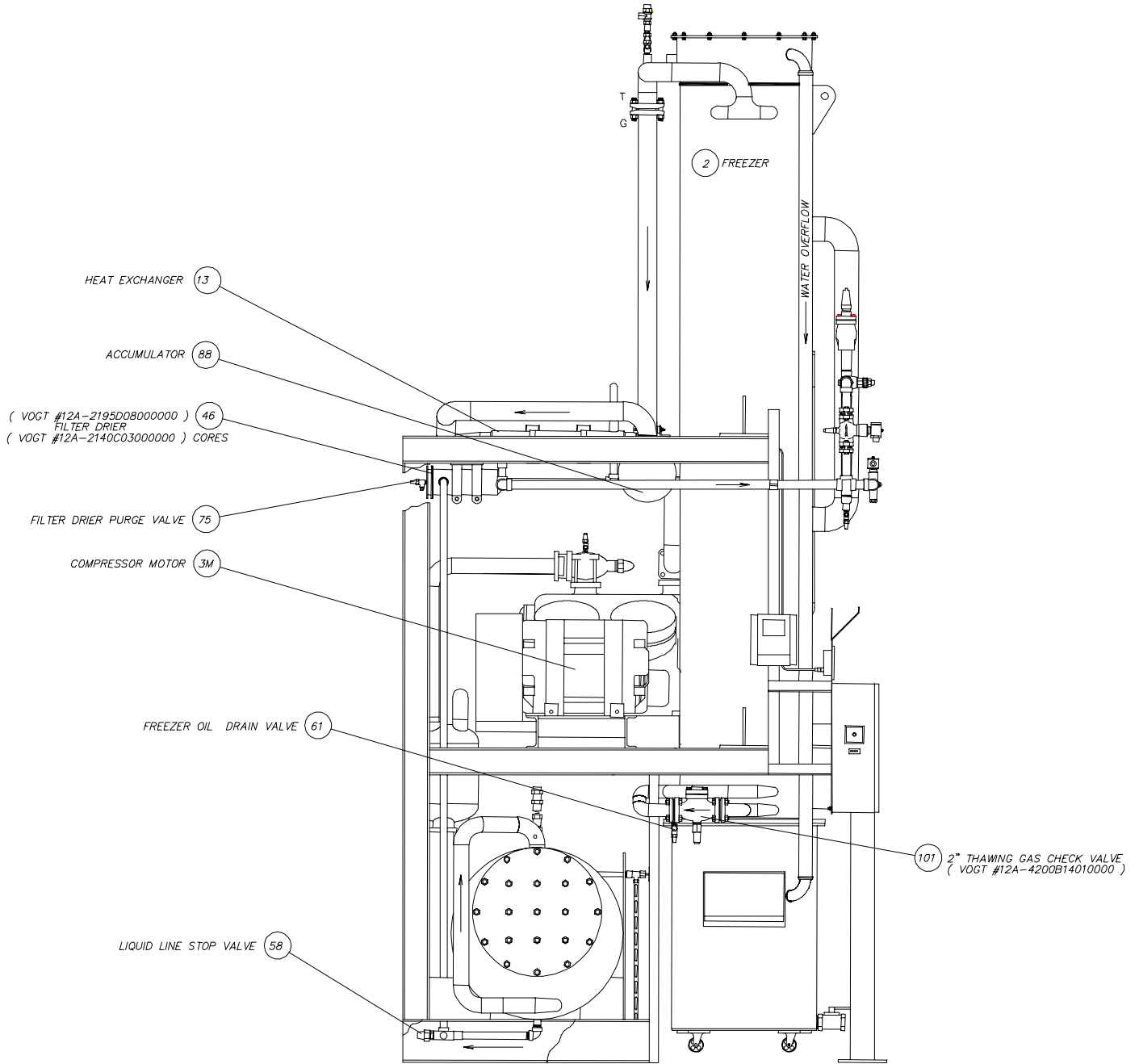


FIGURE 1-4
P24F Left Side

2. Receipt Of Your Tube-Ice Machine

! CAUTION !

Only service personnel experienced in refrigeration systems and qualified to work on high amperage electrical equipment should be allowed to install or service this Tube-Ice[®] machine.

Eye protection should be worn by all personnel working on or around the Tube-Ice[®] machine.

It is very important that you are familiar with and adhere to all local, state, and federal, etc. ordinances and laws regarding the handling, storing, and use of R-22 or R-404a refrigerant.

An approved refrigerant mask should be readily available for use in an emergency and all personnel should be aware of its location and proper use.

! CAUTION !

Inspection. As soon as you receive your machine, inspect it for any damage. If damage is suspected, note it on the shipper's papers (i.e., the trucker's Bill of Lading). **Immediately** make a separate written request for inspection by the freight line's agent. Any repair work or alteration to the machine without the permission of Tube-Ice LLC can void the machine's warranty. You should also notify your Vogt distributor or the factory.

Description Of Machine. A Vogt package Tube-Ice[®] machine is a complete ice producing plant requiring only make-up water supply, condenser water supply, electrical connection, and the proper refrigerant charge.

The machine has been fully factory tested prior to shipment and should require minimum adjustment.

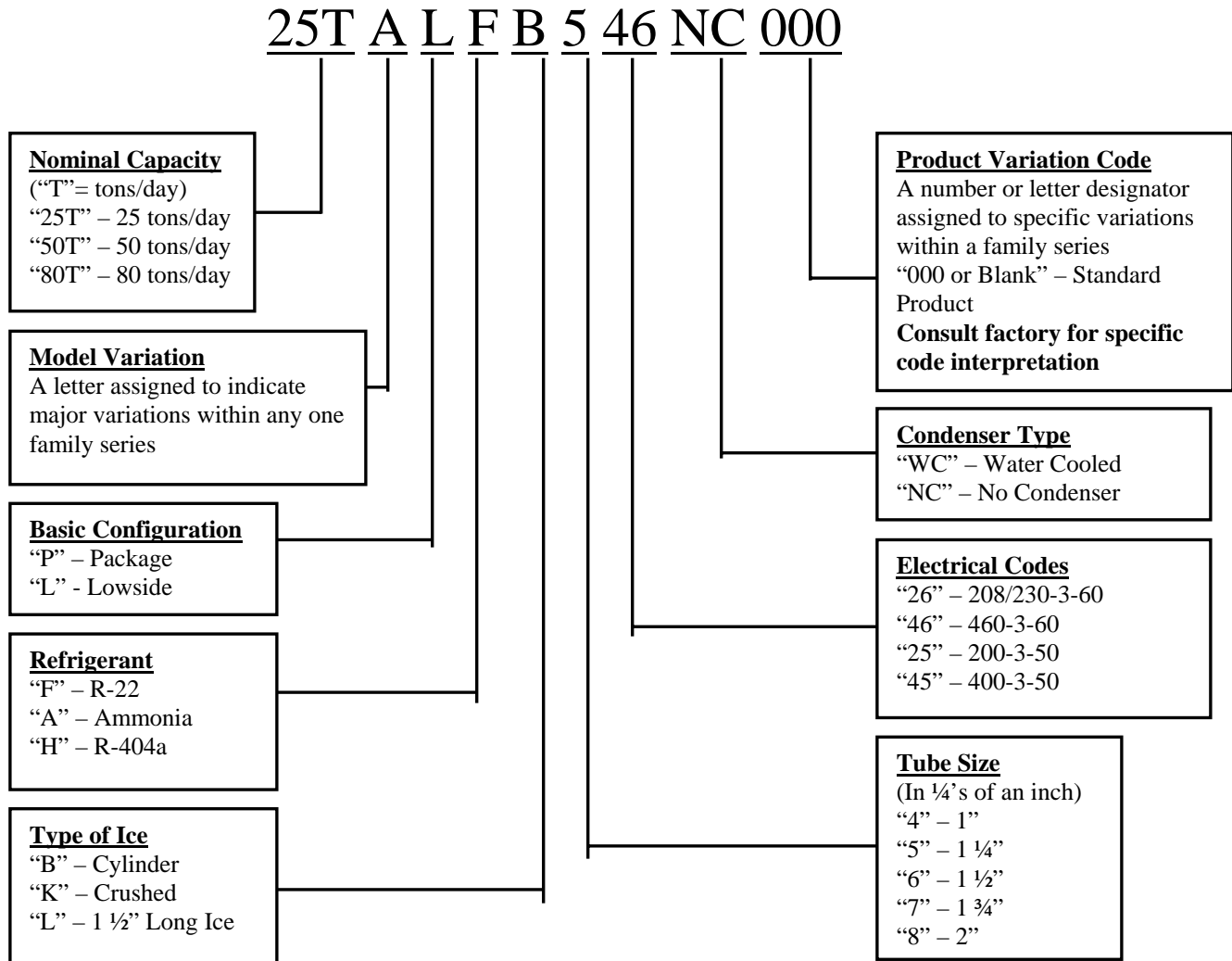
The compressor oil is drained and the compressor suction strainer is cleaned and the cloth filter is removed. The crankcase is inspected and cleaned by removing the side handhole cover, swabbing out the remaining oil and wiping the interior sides and bottom with a clean dry cloth. New oil is added, and the compressor is evacuated then pressurized to 20-25 psig with refrigerant.

Refer to your compressor manual for additional operation, service, maintenance instructions, and information.

Safety Tags and Labels. Be sure to read and adhere to all special tags and labels attached to valves or applied to various areas of the machine. They provide important information necessary for safe and efficient operation of your equipment.

RECEIPT OF YOUR TUBE-ICE MACHINE

The machine is available in three different tube sizes for producing ice 7/8" OD x 1" long, 1 1/8" OD x 1" long, or 1 3/8" OD x 1" long (1" long ice is standard length). The ice is cut to length by a rotating breaker type cutter. Ice can be produced up to 1 1/2" long by modifying the spacers under the adapter plates (see Chapter 10, "Ice Length" for modifying instructions). Crushed ice is also available by modifying the cutter and making minor adjustments to the machine (see Chapter 10, "Crushed Ice").



**FIGURE 2-1
 Model Designation for P-Series Ice Machines**

Rated Capacity. The Tube-Ice[®] machine is rated to produce a given amount of ice when operating under the proper conditions as specified in this manual. You should be prepared to handle the ice produced as it is discharged from the machine and move it to your storage or bagging area promptly. The following specifications are given to help you do just that.

Makeup Water Temp.	Model P24F-1.5"		Model P24F-1.25"		Model P24F-1"	
	Capacity Tons/day (2000 lbs/24 hours)	Makeup Water GPM	Capacity Tons/day (2000 lbs/24 hrs.)	Makeup Water GPM	Capacity Tons/day (2000 lbs/24 hours)	Makeup Water GPM
85°F/29°C	21.4	4.46	21.5	4.48	20.8	4.33
80°F/24°C	21.9	4.57	22.6	4.71	21.7	4.53
75°F/23°C	22.5	4.69	23.2	4.83	22.3	4.64
70°F/21°C	23.1	4.81	23.8	4.95	22.8	4.76
65°F/18°C	23.7	4.94	24.4	5.09	23.4	4.88
60°F/15°C	24.3	5.07	25.1	5.23	24.0	5.00
55°F/13°C	25.0	5.70	25.8	5.37	24.7	5.14
Ice lb/harvest	750 lbs/340 Kg		600 lbs/272 Kg		450 lbs/204 Kg	
Shipping weight (without charge)	12,500 lbs/5443 Kg		12,700 lbs/5443 Kg		12,300 lbs/5261 Kg	
Operating weight	14,700 lbs/ 6259 Kg		14,800 lbs/ 6259 Kg		14,190 lbs/6010 Kg	

Notes:

1. Makeup water is average flow and includes 25% blowdown. Peak flow rate is 15 GPM. at 40 PSI minimum. When water quality is good, machine can be operated with 5% to 10% blowdown.
2. Ratings are at 90°F ambient for ice machine.
3. Capacity ratings are based on 85°F water entering condenser. For entering water temperatures above 85°F, deduct 4% in capacity for each 5°F.
4. Capacity shown is the average for model. Individual machines may vary up to 5% above or below depending on field conditions.

TABLE 2-1
P24F Specifications

Storage (prior to installation or start-up). The machine must not be stored or installed in an area that is subject to reach temperatures at or above 110°F (43.3°C). Temperatures above this may cause the relief valves to open and result in the loss of refrigerant.

RECEIPT OF YOUR TUBE-ICE MACHINE

3. Installing Your Tube-Ice Machine

Your machine will be shipped to you as one package. You will need to arrange for the handling of the package as soon as it arrives, see the machine specifications Table 2-1 for shipping and operating weight. Before you remove the unit from the truck, be certain that any sign of damage, however slight, is noted on the carrier's papers.

Note: See "Lifting Procedure" drawing furnished with this manual, Figure 3-3.

Machine Room. The machine must be located inside a suitable building and must not be subjected to ambient temperatures below 50°F (10°C) or above 110°F (43.3°C). Heat radiation from other sources (sunlight, furnaces, condenser, etc.) and unusual air current may affect the operation of the machine and should be avoided. **The electrical components of the Tube-Ice® machine are rated IEC. Therefore, the machine should not be located in a hazardous area or sprayed with water.** The machine should be installed in an area where water will not stand, but will readily drain away from the machine.

Space Requirements. Refer to the space diagrams, Figures 3-1A and 3-1B, for recommended minimum clearance around the machine for ease of servicing and observation. Pay particular attention to the additional space required. If it ever becomes necessary to mechanically clean the condenser tubes, extra space will be required on one end (preferably on the opposite end from the water inlet and outlet) for the cleaning tools.

Foundation. Refer to the foundation drawings, Figure 3-2, for recommended minimum foundation requirements. The figures show anchor bolt details and machine anchor hole details. Contact your local distributor for seismic anchoring requirements in your area.

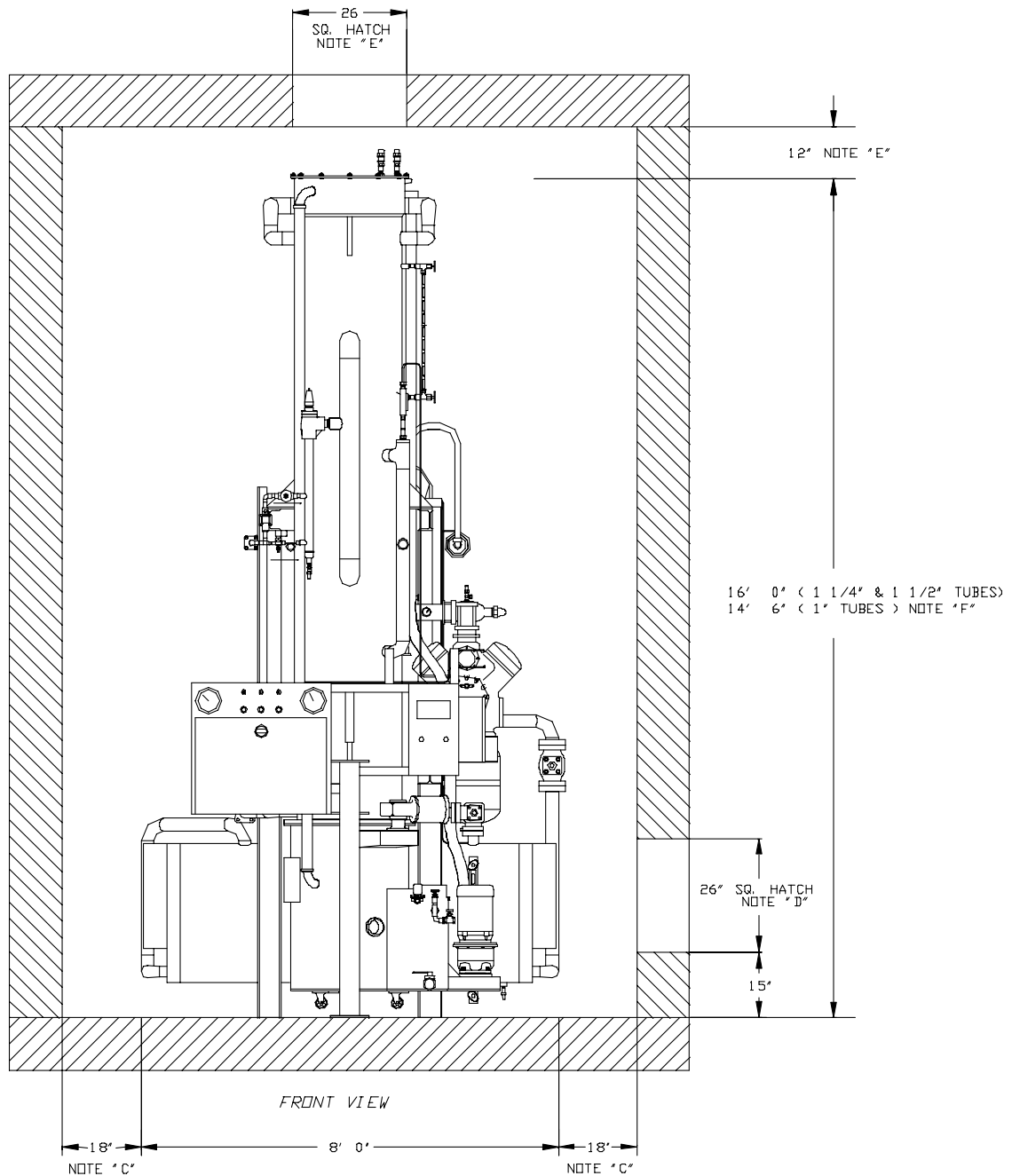
! WARNING !
Lifting or moving heavy equipment should only be attempted by competent rigging and hoisting contractors. Never allow personnel near or under heavy equipment when it is being moved or lifted. Failure to comply could result in personal injury or loss of life.
! WARNING !

Lifting Procedures. Your Tube-Ice® machine is provided with lifting lugs for the purpose of unloading and moving the machine to its operation location. Refer to the enclosed drawings for instructions and illustrations of their use.

P24F - Figure 3-3. Machine weight 12,500 lbs. (See TABLE 2-1)

This figure are intended as a guide to unloading and lifting the P24F Tube-Ice® machine. **Tube-Ice LLC is not responsible for product damage or personnel injury or loss of life during the loading or lifting procedure.**

INSTALLING YOUR TUBE-ICE MACHINE



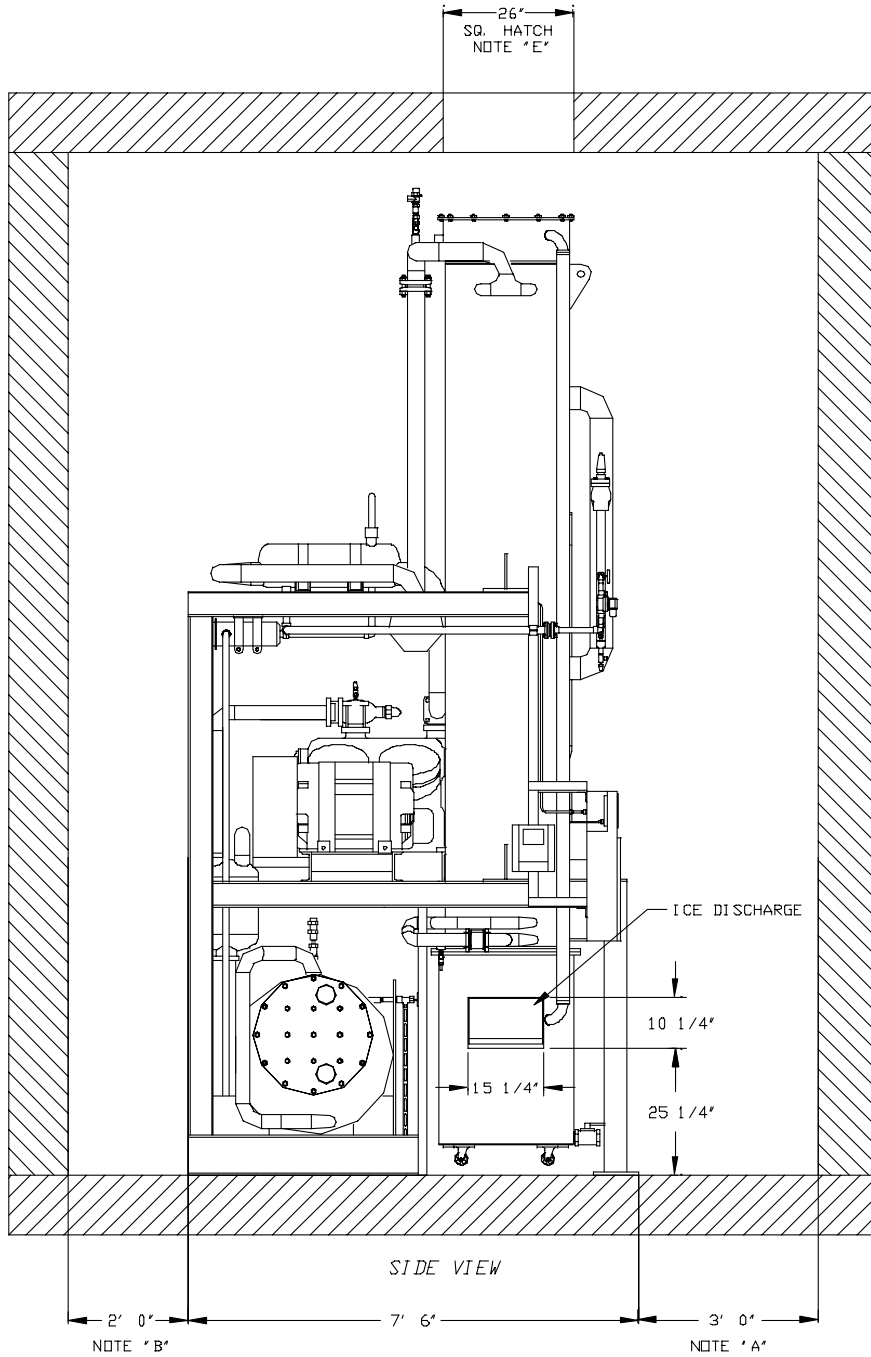
NOTES:

- *A* REQUIRED TO SERVICE ELECTRICAL CONTROLS AND CUTTER ASSEMBLY.
- *B* REQUIRED TO REMOVE COMPRESSOR CRANKSHAFT.
- *C* REQUIRED TO REMOVE CONDENSER HEADS AND SERVICE TUBES.
- *D* REQUIRED TO CLEAN OR REPLACE CONDENSER TUBES (EITHER END).
26" SQUARE OPENING NOT REQUIRED IF THERE IS AT LEAST 7"-2" CLEARANCE BETWEEN END OF CONDENSER AND WALL (EITHER END).
- *E* REQUIRED ABOVE FREEZER TO SERVICE FREEZER TUBES.
- *F* MACHINE SHOWN WITH STANDARD SUPPORTS. INCREASE AS REQUIRED TO ACCOMMODATE EXTENDED BASE (IF USED).

CUSTOMER NOTE: THIS DRAWING IS INTENDED TO BE USED AS A GUIDE ONLY FOR MINIMUM SPACE REQUIREMENT FOR SERVICING AND OPERATING A P24F VOGT TUBE-ICE MACHINE. SPACE REQUIREMENTS FOR OTHER EQUIPMENT SUCH AS CONVEYORS, AUGERS, BAGGERS, ETC. MUST BE CONSIDERED.

FIGURE 3-1A
P24F Space Diagram (Front View)

INSTALLING YOUR TUBE-ICE MACHINE



NOTES:

- *A* REQUIRED TO SERVICE ELECTRICAL CONTROLS AND CUTTER ASSEMBLY.
- *B* REQUIRED TO REMOVE COMPRESSOR CRANKSHAFT.
- *C* REQUIRED TO REMOVE CONDENSER HEADS AND SERVICE TUBES.
- *D* REQUIRED TO CLEAN OR REPLACE CONDENSER TUBES (EITHER END).
26" SQUARE OPENING NOT REQUIRED IF THERE IS AT LEAST 7'-2" CLEARANCE BETWEEN END OF CONDENSER AND WALL (EITHER END).
- *E* REQUIRED ABOVE FREEZER TO SERVICE FREEZER TUBES.
- *F* MACHINE SHOWN WITH STANDARD SUPPORTS. INCREASE AS REQUIRED TO ACCOMMODATE EXTENDED BASE (IF USED).

CUSTOMER NOTE: THIS DRAWING IS INTENDED TO BE USED AS A GUIDE ONLY FOR MINIMUM SPACE REQUIREMENT FOR SERVICING AND OPERATING A P24F VOGT TUBE-ICE MACHINE. SPACE REQUIREMENTS FOR OTHER EQUIPMENT SUCH AS CONVEYORS, AUGERS, BAGGERS, ETC. MUST BE CONSIDERED.

FIGURE 3-1B
P24F Space Diagram (Side View)

INSTALLING YOUR TUBE-ICE MACHINE

CUSTOMER NOTE
 THE SIZE OF THE FOUNDATION SHOWN ON THIS DRAWING IS THE MINIMUM REQUIRED SIZE SUGGESTED BY THE HENRY VOGT MACHINE COMPANY. THE ACTUAL SIZE OF THE FOUNDATION AND CLEARANCE AROUND IT FOR SERVICING SHOULD BE DETERMINED BY THE CUSTOMER TO BEST FIT HIS NEEDS. IT IS THE RESPONSIBILITY OF THE CUSTOMER TO BUILD THE FOUNDATION IN ACCORDANCE WITH ALL LOCAL AND FEDERAL OSHA CODES AND BUILDING REGULATIONS.

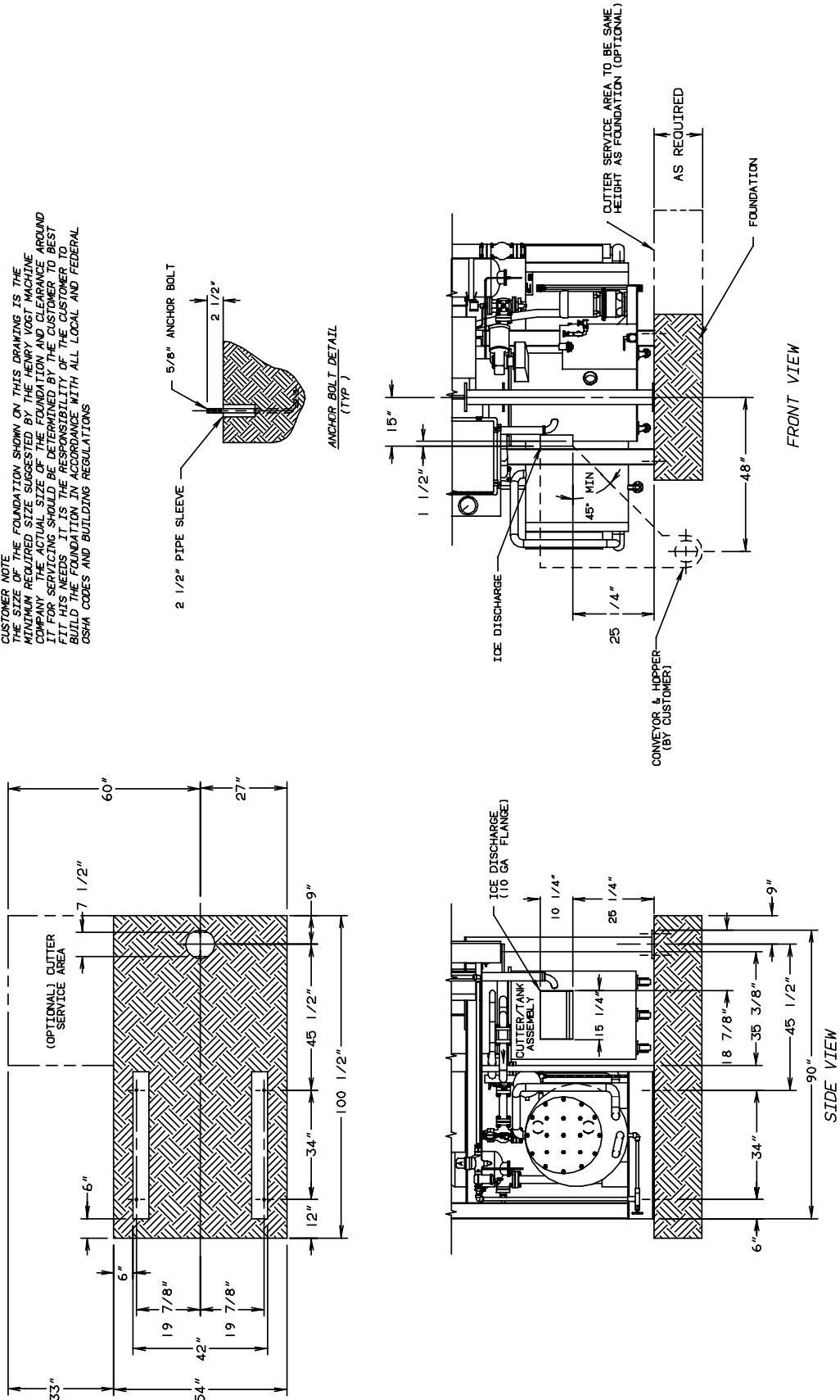


FIGURE 3-2
P24F Foundation Layout

INSTALLING YOUR TUBE-ICE MACHINE

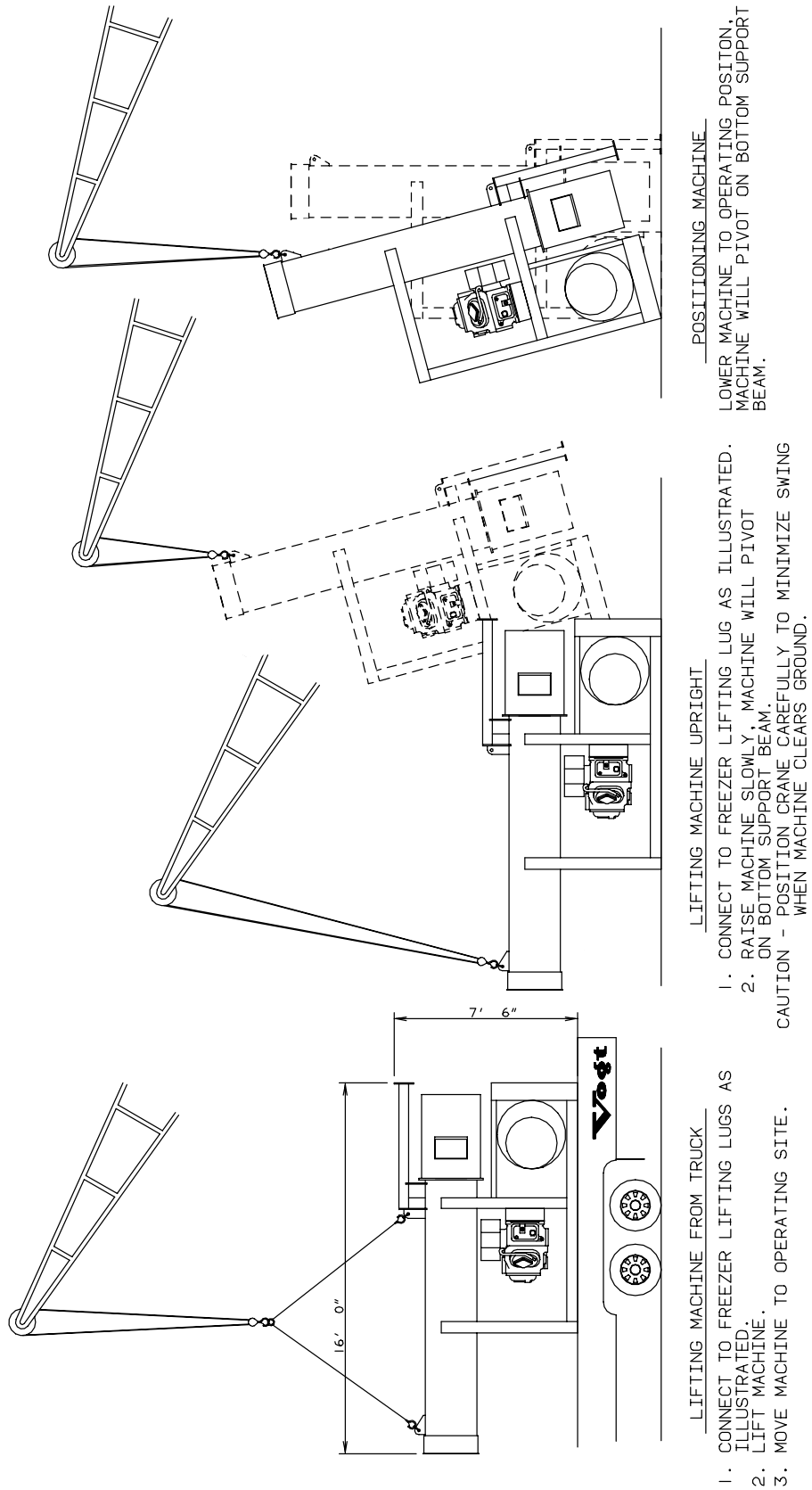


FIGURE 3-3
Lifting Procedure for P24F

INSTALLING YOUR TUBE-ICE MACHINE

Piping and Drain Connections. See Figure 1-1 to 1-4 for connection locations.

! CAUTION !
Exterior shut-off valves must be provided in the water inlet lines. The minimum inlet water pressure for satisfactory operation of the machine is 40 psig. The maximum allowable pressure is 100 psig.
! CAUTION !

Model	Make-up Water In	Flushing Water In	Compressor Cooling Water In	Compressor Cooling Water Out	Condenser Water In and Out	Water Tank Drain	Water Tank Overflow
P24F	3/4" FPT	3/4" FPT	3/4" FPT	1" FPT	3" FPT	2" FPT	3" FPT

**TABLE 3-1
Water Supply and Drain Connections**

Make-Up Water In. The water required for ice making must be potable water, safe for human consumption, and should be of the highest quality available. The best way to determine water quality is to have a complete water quality analysis, by a qualified laboratory.

It is advisable to install a particle filter in the make-up and flushing water lines to trap dirt, sand, rust, or other solid particles prior to entering the water tank and contaminating the ice. Be sure to size the filter large enough to meet the water demands of 15 GPM (peak flow), allowing for a restriction through the filter as it traps these particles. The inlet water pressure should be a minimum of 40 psi. Refer to TABLE 3-1 for line size and TABLE 2-1 for average flow rate at various water temperatures.

Flushing Water In. Flushing water (blowdown) is necessary to melt ice fines and flush dissolved solids from the water tank during the thawing (harvest) cycle. This function is important and helps to maintain good ice quality. If water quality is superior, installing a smaller orifice in the flushing outlet elbow can reduce this blowdown. Make sure there is enough flushing water to prevent the accumulation of excessive ice fines in the tank.

If make-up and flushing water are from the same source, a common line to the machine can connect them.

Water Tank Drain. This valve and connection (located at the bottom of the water tank) is for the purpose of flushing and draining the water tank of impurities, foreign material and cleaning chemicals used during servicing. It should be piped to an open drain or sump for visible discharge. It can be tied in with the overflow line but no others.

Water Tank Overflow. A 3" FPT connection on the side of the water tank is provided to carry away overflow water during the thawing (harvest cycle). This water contains ice fines accumulated during harvesting and dissolved solids accumulated during the freezing cycle. **Do not reduce the size of this line.** Three inches is needed to provide sufficient area for ice fines to be flushed out, especially if the incoming flushing water is 55°F (13°C) or below. This overflow line should not tie in with any other drain line except the water tank drain.

Condenser Water In and Out. One end of the condenser has two water connections. The lower connection is the inlet and the upper connection is the outlet. See TABLE 3-2 for condenser water requirements and machine total heat rejection. The condenser water outlet must be extended to an open drain or sump for visible discharge.

! CAUTION !

The condenser water outlet must not be connected onto a pressure tight common header with the water tank due to the possibility that contaminated condenser water may back up into the water tank. The condenser water outlet must be piped separate from the drain or sump.

! CAUTION !

Cooling Tower. When selecting a cooling tower, careful attention must be given to operating wet bulb conditions. It is advisable to check with your local cooling tower distributor for their recommendations based on actual operating conditions in your area. An average wet bulb of 78°F is typical in the U.S., but many localities have designed wet bulbs as low as 72°F or as high as 82°F.

The cooling tower water pump must be capable of delivering the required volume of water through the condenser. Due to cooling tower location and pressure drop through water lines and regulating valves, the water pump must be sized for each installation. Refer to TABLE 3-2 for condenser water requirements. The water piping for the cooling tower and the installation of the pump must be in accordance with the manufacturer's instructions. Caution must be used to prevent the condenser water pump from losing its' prime during off cycles.

Proper water treatment for the prevention of mineral and foreign matter accumulation in the condenser or cooling tower is recommended. A water analysis should be obtained to determine the proper chemicals to use. The use of a 40-mesh strainer in the condenser water supply line is also recommended.

Condenser water flow is based on pulldown of 30°F SST and 105°F SDT. Condenser water pressure drop does not include water-regulating valve. Consult factory for sizing if desired.

INSTALLING YOUR TUBE-ICE MACHINE

P24F Condenser Water		
Entering Water	Flow GPM	Cond. PSID
85°F	196	15
80°F	131	7
75°F	98	4
70°F	78	2
65°F	65	2
60°F	56	1
55°F	49	1
50°F	44	1
Total Heat Rejection THR = 1,031,625 BTUH		

TABLE 3-2
Condenser Water Requirements

The following table shows the model of Marley cooling tower required for operating at various wet bulbs to cool 91°F (33°C) entering water to 85°F (29.4°C) exiting water.

Model	GPM	Cond. PD PSIG	75°F	76°F	77°F	78°F	79°F	80°F
P24F	206	18	495A	495A	495A	495A	495A	495A

TABLE 3-3
Marley Cooling Tower Recommendations

Tower nozzles will be selected based on GPM required for condenser.

The condenser water pump should be sized on GPM required for condenser at 80 ft. total discharge head for a typical installation. However, due to cooling tower location and pressure drop through water lines, the water pump should be sized for each installation.

The ice machine is supplied with a fan control switch for cycling the cooling tower fan on and off, thereby maintaining the proper operating head pressure. If the condenser inlet water temperature is expected to be below 75°F/24°C, a water-regulating valve should be installed in the condenser water inlet line and adjusted to maintain a head pressure of not less than 190 psig.

See FIGURES 3-5 through 3-7 for possible cold climate installations with indoor sump.

Safety Valves. Four safety pressure relief valves are an integral part of the packaged Tube-Ice[®] machine. Two are located in the low side of the system on the freezer, and two are in the high side of the system on the receiver. Vent each of the pressure relief valves to the atmosphere in such a manner as to comply with local and national codes.

INSTALLING YOUR TUBE-ICE MACHINE

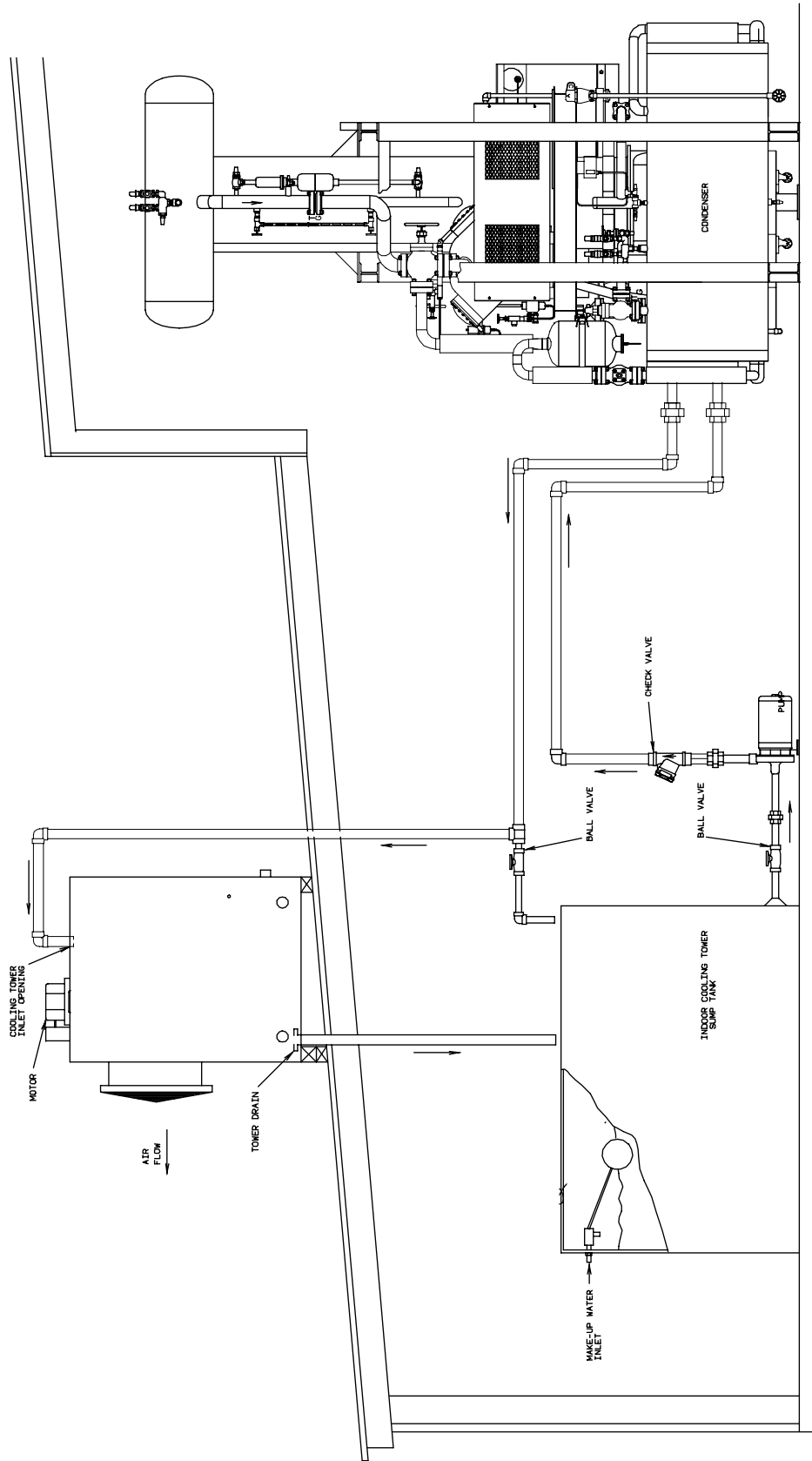


FIGURE 3-4
Cooling Tower Piping Diagram

INSTALLING YOUR TUBE-ICE MACHINE

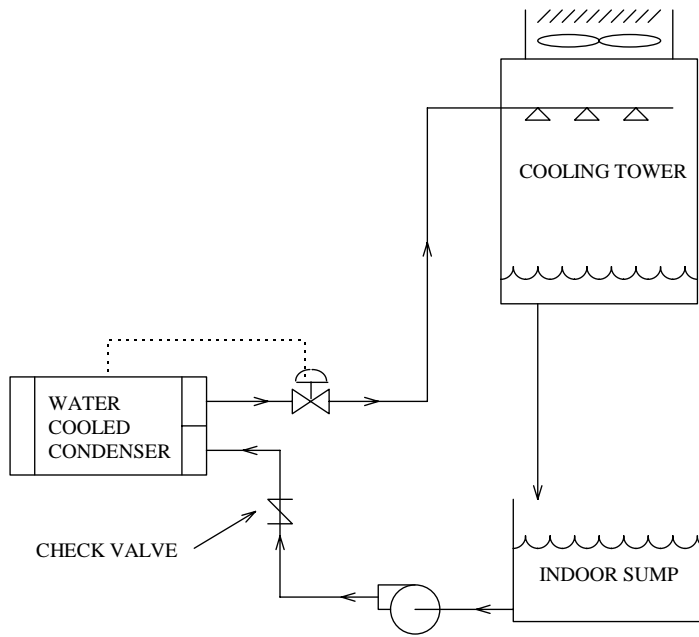


FIGURE 3-5
1 PUMP/2-WAY VALVE

*** Poor Freeze Protection**

Because low flow rate = high freeze chance

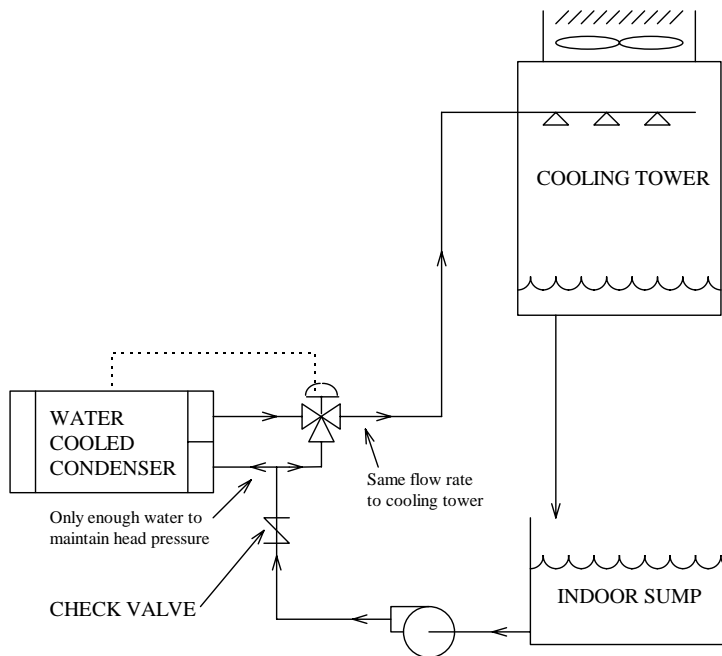


FIGURE 3-6
1 PUMP/3-WAY VALVE

*** Better Freeze Protection**

INSTALLING YOUR TUBE-ICE MACHINE

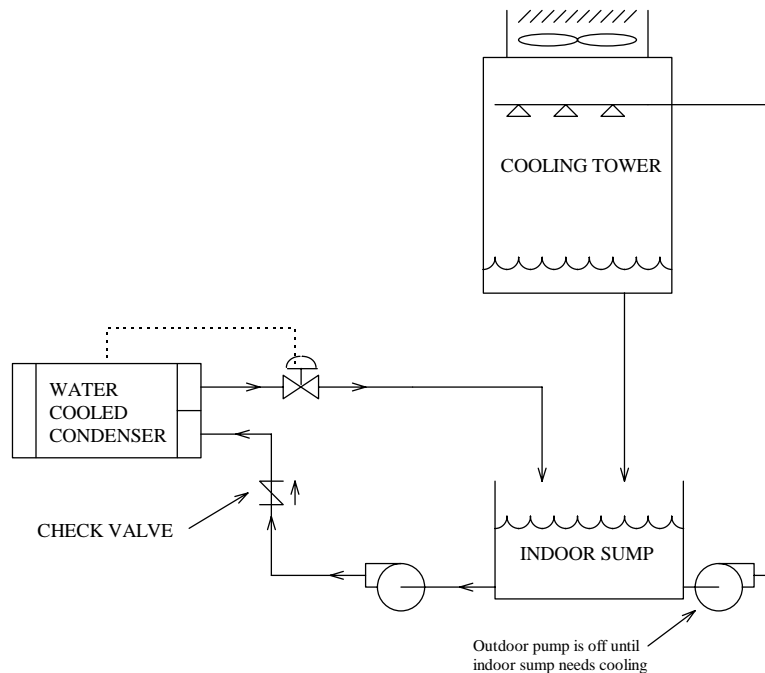


FIGURE 3-7
2 PUMP/2-WAY VALVE
*** Best Freeze Protection**

Wiring and Electrical Connections.

! WARNING !
Only service personnel experienced in refrigeration and qualified to work with high voltage electrical equipment should be allowed to install or work with the Tube-Ice[®] machine.
! WARNING !

A fused disconnect must be provided near the Tube-Ice[®] machine. The control panel and compressor motor starter are attached to the structurals on the front of the Tube-Ice[®] machine (see FIGURE 3-8). Incoming 3 phase power will be connected at the compressor motor starter (1M). Terminals L1, L2, L3 for operation of the Tube-Ice[®] machine and its controls. Rotation checking of the compressor, cutter motor, and water pump is required (see rotation check). Also, if one leg of the 3 phase power is higher or lower (“wild”), then it should be connected to terminal L2. Connect the ground wire to the “ground” terminal provided.

Make sure wires #22 and #27 are connected to the elapse time (ET) indicator in the control panel.

INSTALLING YOUR TUBE-ICE MACHINE

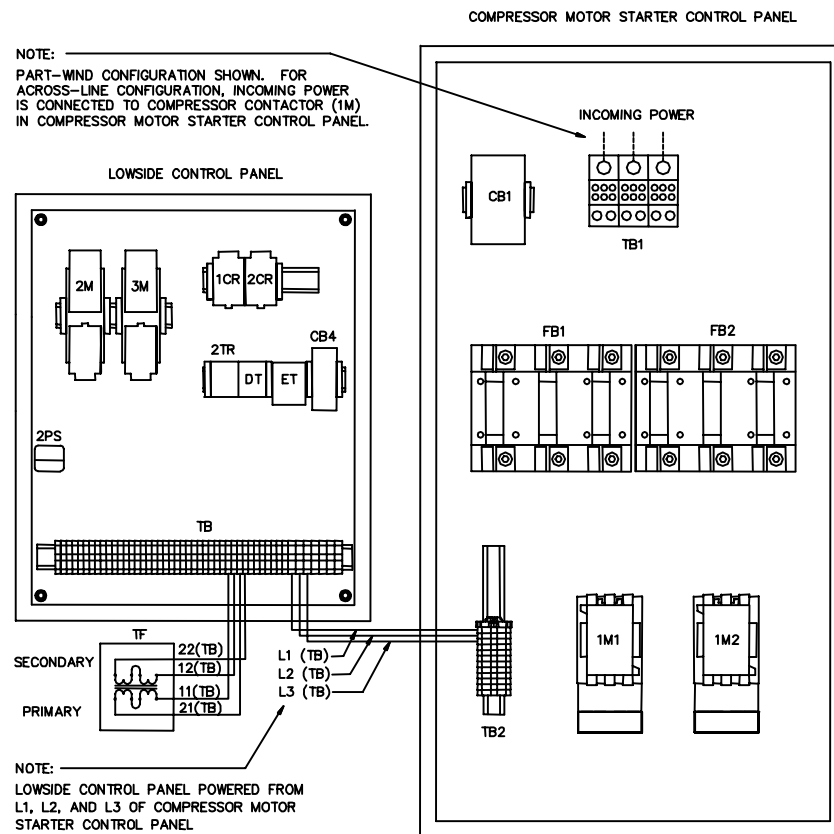


FIGURE 3-8
Power Supply Connections

Voltage Unbalance. Voltage unbalance can cause motors to overheat and fail. Voltage imbalance between any two legs should be no greater than 2%.

Example: Supply voltage = 230-3-60
Voltage Readings: AB = 220 Volts
BC = 225 Volts
AC = 227 Volts

$$\text{Average} = (220 + 225 + 227)/3 = 224 \text{ Volts}$$

(AB) $224 - 220 = 4$ Volts (Highest Deviation)
(BC) $225 - 224 = 1$ Volts
(AC) $227 - 224 = 3$ Volts

$$\% \text{ Voltage Unbalance} = 100 \times (4/224) = 1.78\% \text{ "Acceptable"}$$

Important: If the supply voltage phase unbalance is more the 2%, contact your local electric utility company.

Current Unbalance. Voltage unbalance will cause a current unbalance, but a current unbalance does not necessarily mean that a voltage unbalance exists. A loose terminal connection or a buildup of dirt or carbon on one set of contacts would cause a higher resistance on that leg than on the other two legs. Current follows the path of least resistance, therefore if terminal connection L1 is loose or dirty, L2 and/or L3 will have higher current.

INSTALLING YOUR TUBE-ICE MACHINE

Higher current causes more heat to be generated in the motor windings. The maximum acceptable current unbalance is 10%.

Example:

Current Readings: L1 = 96 Amps
 L2 = 91 Amps Average = (96 + 91 + 98)/3 = 95Amps
 L3 = 98 Amps

(L1) 96-95 = 1 Amps
 (L2) 95-91 = 4 Amps (Highest Deviation)
 (L3) 98-95 = 3 Amps

% Current Unbalance = $100 \times (4/95) = 4.2\%$ "Acceptable"

Rotation Check. The compressor, cutter, and pump motor rotation are factory synchronized, but must be checked at installation. For cylinder ice production, the cutter disc as viewed at the ice discharge opening should turn from left to right.

Check rotation by the following procedure:

1. Turn the power to the machine on and check voltages.
2. Make sure the water tank is full of clean water.
3. Turn the Hand-Auto switch (ISS) to HAND position. The water pump will start and the freezing (1LT) and the liquid feed (2LT) pilot lights will illuminate. Check pump rotation.
4. Push the MANUAL HARVEST button. The water pump will stop, the "Freezing and Liquid Feed" lights will go out, and after 20-30 seconds, the cutter motor will start. The thawing gas solenoid valve will open and the "Thawing" pilot light (3LT) will illuminate.
5. Check the cutter disc rotation. It should be turning from left to right (CCW looking from the top).
6. Turn the HAND-AUTO switch to AUTO to stop the cutter.

To change rotation, follow this procedure:

1. Disconnect power to the machine and lock it out to make sure it can't be turned back on.
2. Check for power at L1, L2, L3 with a volt meter to make sure it is off.
3. At the compressor motor starter (1M) or at the power disconnect, reverse wires L1 and L2.
4. Make sure these terminals are tight and restore power to the machine.
5. Perform rotation check again to confirm that it is correct.

! CAUTION !

Do not attempt to start the compressor motor until first making sure all conditions listed in the Installation Review Checklist and all necessary valves have been opened for operation.

! CAUTION !

Auxiliary Controls or Equipment. When connecting other equipment such as tower fan, condenser pump, conveyor motors, bin level control, etc., refer to the control panel wiring drawing for the proper connecting terminals and instructions. See Figure 6-3.

INSTALLING YOUR TUBE-ICE MACHINE

! IMPORTANT !

Be sure to follow the wiring schematic when incorporating overloads of conveyor, fan, or pump motor starters (i.e., 5 MOL, 6 MOL, 7 MOL). Also remove jumpers as instructed. This is necessary to provide proper protection for the Tube-Ice[®] machine and its component parts.

! IMPORTANT !

Installation Review: A Checklist. Make a visual check to be sure these steps have been taken BEFORE continuing.

CHECK: _____ PRIOR TO OPENING VALVES, check all joints for leaks which may have developed during shipment. (NOTE: the machine was shipped with a positive pressure of 20-25 PSIG, which should be indicated on the suction and discharge gages.)

CHECK: _____ All water supply and drain connections for conformity to requirements stipulated in this manual and properly connected to inlets and outlets.

CHECK: _____ Electrical supply for proper size of fuses and for compliance to local and national codes. See the machine nameplate for minimum circuit ampacity and maximum fuse size.

CHECK: _____ All field installed equipment (augers, conveyors, cooling towers, bin level controls, etc.) for proper installation.

CHECK: _____ The applicable portion of the warranty registration/start-up report for proper completion.

CHECK: _____ Cutter gear reducer oil level oil should run out of side pipe plug when removed.

CHECK: _____ The water distributors at top of freezer to make sure they are all in position (one seated firmly in each tube with a vent tube in each distributor).

! CAUTION !

The crankcase heater should be energized for a minimum of four hours and the oil temperature should be 100-110°F before attempting to start the compressor.

! CAUTION !

4. How Your Tube-Ice Machine Works

Operating Features. Your package Tube-Ice[®] machine is an efficient ice producing plant. If installed and maintained properly, it will give many years of operation with a minimum amount of repairs. Refer to piping schematic, FIGURE 4-1 to identify component parts while following the information and instructions in this manual.

The machine is manually started and stopped by the START and STOP push buttons. The machine will automatically stop by safeties such as compressor, cutter and pump overloads, as well as other auxiliary motor overloads. It will also stop automatically by high head pressure, low suction pressure or low compressor oil pressure. The circulating water pump can be operated independently for cleaning the freezer tubes and water tank by putting the HAND/AUTO selector switch in the HAND position. The machine can be manually forced into a harvest cycle with the manual harvest push button.

Principle of Operation. The freezer (2) is a shell and tube-type vessel. During the freezing period (cycle), water is constantly recirculated through the vertical tubes of the freezer by a centrifugal pump (6). Make-up water is maintained by a float valve (12) in the water tank (7). The capacitive level probe (65) opens and closes the liquid feed “A” solenoid valve (20A), and maintains the desired refrigerant level in the freezer (2) (evaporator). The constant feed solenoid valve (20B) remains open during this period. Refrigerant gas from the top of the freezer (2) passes through the suction accumulator (88), heat exchanger (13) and to the compressor (3). Here, the cool gas is compressed to a high temperature, high-pressure gas which discharges through the oil separator (14), then through the heat coil of the condenser and then into the P24F condenser/receiver (15). In the condenser, heat is removed and the gas is condensed to a high temperature, high-pressure liquid. The high-pressure liquid goes out the liquid line through a strainer (43), liquid “A” solenoid valves (20A & 20B) check valve (101), and hand expansion valve (17). At the hand expansion valve (17), the refrigerant expands from a saturated high-pressure liquid state to a low pressure, low temperature liquid. This cold liquid enters the freezer (2) where it absorbs heat from the circulating water in the freezer tubes. Cool gas is again pulled out of the freezer through the suction outlet, thereby completing the circuit.

The freezing period is completed by action of the freezer pressure switch (2PS) in the control panel. The water pump (6) stops and the “A” solenoid valve (20A) and constant feed solenoid valve (20B) closes. After a delay of 20-30 seconds, the cutter motor starts, the thawing gas “D” solenoid valve (18) opens, and the harvest (thawing) timer (2TR) is activated. Warm gas from the receiver is discharged through the thawing chamber (16), check valve (101), and into the freezer. There it warms the refrigerant and the outer surface of the freezer tubes, allowing the ice to release on the inside of the tubes and drop down onto the rotating cutter for sizing. After sizing, the ice drops on the tines cutter disc and discharged through the ice discharge opening.

See “Freeze Period” and “Harvest Period” for more detailed description of machine.

Freeze Period. The Tube-Ice[®] is frozen inside the stainless steel tubes of the freezer (2) by the direct application of refrigerant to the outside shell side of the tubes. Ice is produced from constantly recirculating water down each tube. As the ice thickness increases, the freezer pressure decreases. At a set pressure, the freezer pressure switch (2PS) energizes the relay (1CR), which stops the water pump, closes the “A” liquid feed solenoid valves (20A & 20B), turns out the two pilot lights, refrigerant feed and freezing.

HOW YOUR TUBE-ICE MACHINE WORKS

Harvest Period. About 20-30 seconds after the 1CR relay is energized, the thaw gas valve (18) opens, the “H” water flush solenoid valve (63) opens, the compressor unloads, the cutter motor starts, the thaw timer (2TR) is energized, the red thawing gas light illuminates, and auxiliary equipment such as conveyors etc. start. When the refrigerant in the freezer is warmed sufficiently to allow the ice in the tubes to release and be sized, the ice is discharged into the customers’ ice handling equipment. See “Ice Handling” for more information on this subject. The thaw timer (2TR) is adjustable and should be set for the time required for all the ice to clear the freezer plus 30 seconds more.

! CAUTION !

Make sure all the ice clears the freezer with at least 30 seconds to spare before the next freezer period begins. This is to prevent refreezing and to allow the ice moving augers etc. to clear.

! CAUTION !

1	Control Panel	39	Water Tank Drain Valve (2”FPT)
1PG	Suction Pressure Gauge	41	Condenser Water Regulator
2PG	Discharge Pressure Gauge	41A	Condenser Pressure Control
2	Freezer	43	Strainer
3	Compressor	44	Receiver Drain Valve
4PS	Dual High/Low Pressure Switch	46	Filter/ Drier
5M	Cutter Motor	50	Receiver Safety Valve (350 psi)
5R	Gear Reducer	51	Freezer Safety Valve (325 psi)
6	Water Pump	52	3-Way Valve
7	Water Tank (includes cutter assembly)	55	Discharge Line Stop Valve
8	Water Distributing Chamber	56	Freezer/Pressure Switch (2PS)
9	Water Tank Overflow (3” FPT)	58	Liquid Outlet Valve (King Valve)
12	Make-Up Water Float Valve	59	Receiver Access Valve
13	Heat Exchanger	61	Freezer Oil Drain Valve
14	Oil Separator	62	Make-up Water Inlet Valve
15	Condenser	63	Water Flush Solenoid Valve
15R	Receiver	65	Capacitive Level Probe
16	Thawing Chamber	69	Low Suction Pressure Stop Valve
17	Hand Expansion Valve	70	Oil Return Stop Valve
18	Thawing Gas Solenoid Valve “D”	75	Filter /Drier Access Valve
20A	Liquid Feed Solenoid Valve “A”	76	Freezer Access Valve
20B	Constant Feed Solenoid Valve	77	Compressor Suction Access Valve
23	Condenser Water Inlet (W/C Machines)	78	Compressor Discharge Access Valve
24	Condenser Water Outlet (W/C Machines)	82	Discharge Pressure Gage Stop Valve
28	Refrigerant Charging Valve	88	Accumulator
29	Liquid Line Stop Valve	89	Thawing Gas Stop Valve
30	Sight Glass	92	Receiver Liquid Return Stop Valve
31	Gage Glass Stop Valve	94	Compressor Oil Pressure Safety Control (OPS)
34	Compressor Suction Service Valve	101	Check Valve
35	Compressor Discharge Service Valve		
37	Oil Charging/Drain Valve		

Piping Nomenclature

HOW YOUR TUBE-ICE MACHINE WORKS

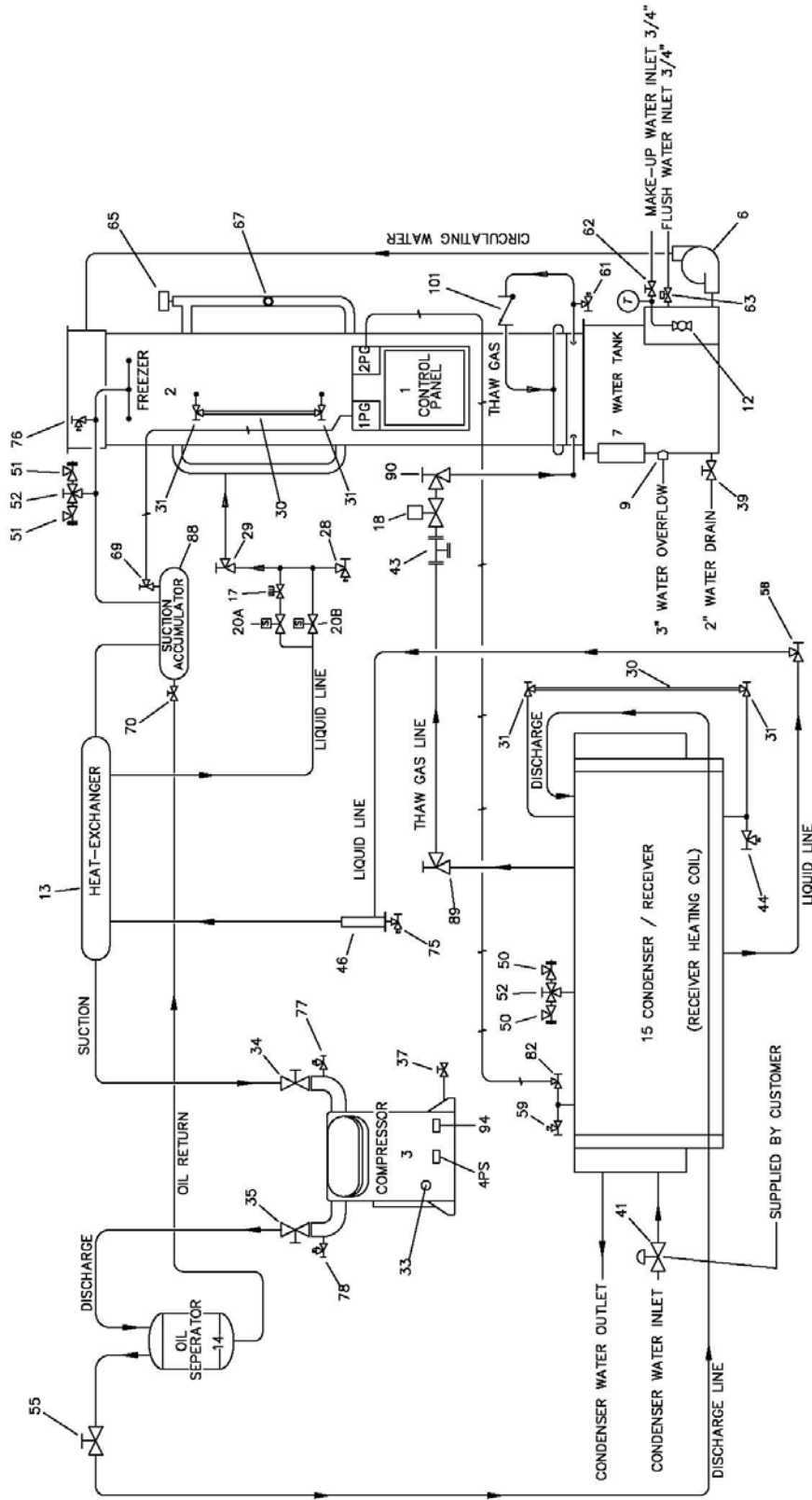


FIGURE 4-1
Piping Schematic for P24F

HOW YOUR TUBE-ICE MACHINE WORKS

5. Start-Up & Operation

Refrigeration System Review. The refrigeration system uses R-22 or R-404a refrigerant. Following the piping schematic (Figure 4-1), you will see that during the machine's freeze cycle, the compressor discharge gas goes through the oil separator (14) to remove any oil present in the discharge gas and return the oil to the suction accumulator (88). From the oil separator, the discharge gas continues through a heat coil in the lower part of the condenser/receiver (15). It is then discharged into the condenser and condensed into a liquid by the removal of heat by water passing through the condenser tubes. A reservoir of liquid refrigerant is accumulated in the receiver and is required for thawing purposes. Liquid from the receiver flows through the filter/drier (46), and the heat exchanger (13), to the liquid feed solenoid valve (20A), which opens and closes by action of the capacitive level probe (65). The liquid is then expanded through the hand expansion valve (17) and into the evaporator (2) (freezer). The liquid is also fed through a bypass line and the constant feed solenoid valve (20B), which is open throughout the freeze cycle. The cold wet refrigerant that is fed through these valves floods the evaporator and is in contact with the outside of the ice making tubes which water is being circulated through. The heat contained in the water passes through the wall of the tubes, lowering the temperature of the water and causing it to freeze and form a long tube of ice that adheres to the inside of the freezer tubes. Since the purest water freezes first, the circulating water continues to wash the dissolved solids down into the sump area of the water tank (7). The flushing valve (63) helps to rid the water tank of increased dissolved solids by flushing them out the overflow during the harvest (thawing) period.

The wet suction gas leaves the freezer (2) and passes through the suction accumulator (88) and heat exchanger(13), where liquid droplets are removed, allowing the super heated dry gas to enter the suction side of the compressor (3). The suction gas is then compressed and discharged once again, completing the cycle. As ice continues to form in the freezer tubes, the suction pressure steadily decreases until the freezer pressure switch (not shown) is satisfied and the contact closes, initiating the thaw (harvest) cycle.

Note: Freezing time will vary, depending on make-up water temperature and thickness of ice produced.

During the harvest period, the "D" thawing gas valve (18) opens and the compressor unloads, allowing the warm high pressure gas from the receiver to enter the freezer. As the tubes warm up to slightly above freezing, the ice inside the tubes releases and falls down onto the rotating cutter in the water tank for sizing and discharging. Harvesting requires about three minutes, but can vary depending on ice thickness, suction pressure, and discharge pressure (thawing gas temperature).

! IMPORTANT !

It is a good idea and will be profitable for you to observe and become familiar with the proper operating characteristics of your Tube-Ice[®] machine. It will help you to recognize and correct minor irregularities as they occur in order to help prevent major problems.

“An ounce of prevention is worth a pound of cure.”

! IMPORTANT !

START-UP & OPERATION

Start-up Checklist. Be sure to complete and return the “Warranty Registration/Start-up Report” located in the front of the manual.

1. See that the water-inlet connections are attached properly. The water inlet shutoff valve (62) for the water tank should be open. The water level in the water tank should be at a height where the make-up float valve will be closed when the machine is idle and water is not running out of the overflow (9).
2. See that the condenser cooling water is connected properly and the valves are opened for circulation.
3. Fill the cooling tower sump and check the tower manufacturer’s installation and operation instructions to make sure it is ready to run.
4. Check condenser cooling water pump rotation.
5. Check rotation of augers or ice handling equipment to make sure they are rotating in the proper direction.
6. Check all tagged valves and make sure they are in their correct operational position (opened, closed, or automatic).
7. See that the electrical disconnect is closed and the proper power is supplied to the machine.
8. See that the compressor oil temperature is 100-110°F and there is no liquid refrigerant in the crankcase. The oil level should be 1/2-3/4 of the sight glass.
9. Check the elapsed time indicator (ET) and make sure wire #22 and #27 are attached.
10. Reconfirm “Rotation Check” for compressor, cutter and water pump (See Section 3).

Refrigerant Charge. Prior to shipping, the machine is charged with the required amount of refrigerant and pumped down to the condenser / receiver. All valves tagged prior to shipping must be opened prior to starting the machine.

Total refrigerant charge required is approximately;
P24F = 1200 lbs of R22 or 1058 lbs of R404a.

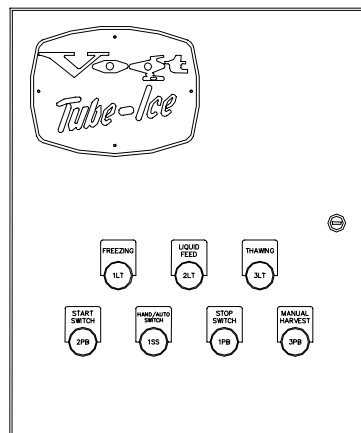


FIGURE 5-1.
Control Panel

Start-Up. Starting the machine in a freezing cycle can be accomplished as follows:

1. Make sure the crankcase oil temperature is approximately 100°F and there is no liquid refrigerant in the compressor crankcase.
2. Turn the Hand/Auto switch (1SS) to the “Hand” position and allow the water tank to refill. **MAKE SURE THE DRAIN VALVE IS CLOSED.**
3. Push the green “Start” push button to start the compressor and immediately observe the oil pressure, the oil level, the discharge pressure, and listen for any unusual sounds. The compressor starts unloaded and will load automatically after several seconds by action of the delay timer (DT).
4. Turn the Hand/Auto switch to the “Auto” position.
5. When the discharge pressure increases to about 170 psi (R-22) or 205 psi (R-404a), push the “Manual Harvest” button to initiate the harvest cycle. See “Harvest Period”.
6. When the suction pressure raises to 65-70 psig (R-22) or 81-85 psi (R-404a), any ice made should release and discharge. After all of the ice clears the cutter and auger, turn the Hand/Auto switch to “Hand” and back to “Auto”. This will interrupt the harvest cycle and start another freeze cycle. See “Freeze Cycle”.

As the machine continues its freezing cycle, the liquid refrigerant will feed into the freezer until the level float switch (10) is satisfied. The float switch will open and close the liquid line solenoid valve (20) to maintain that level of refrigerant in the freezer during the freeze cycle. When the suction pressure pulls down to the setting of the freezer pressure switch (2PS), the switch will close and initiate the harvest cycle. See “Harvest Period”.

Be sure to observe several complete cycles of ice production to confirm the satisfactory operation of the machine.

! IMPORTANT !
Complete the remaining part of the “Warranty/Registration Start-Up Report” and return it to Tube-Ice LLC
! IMPORTANT !

Check the refrigerant level at the receiver liquid gage glass to make sure it is near the operating level mark.

Adding Refrigerant. Add refrigerant while the machine is running by the following procedure:

1. With a cylinder of refrigerant laying on its side, cylinder valve outlet pointing up and bottom end raised two inches higher than the valve end, connect an “approved for R-22 or R-404a” charging hose between the freezer charging valve (28) and the cylinder valve.
2. Purge all air from the charging hose and open the cylinder valve gradually to check for possible leaks around the packing nut or hose fittings. Then open the cylinder valve fully.
3. While the “Refrigerant feed light” is not illuminated, open the charging valve (28) and refrigerant will flow from the cylinder to the freezer.
4. Close the cylinder valve immediately when the “refrigerant feed light” comes on and reopen it when the light goes out. Repeat until properly charged.

As the machine is being charged, continually observe the following operating characteristics:

START-UP & OPERATION

- a) Discharge pressure - 190 psi to 210 psi maximum
- b) Compressor oil pressure - 11-15 psi above suction
- c) Liquid level in receiver - marked on gage glass guard
- d) Compressor oil level - approximately 1/2 glass

! CAUTION !

Immediately close system charging valve at commencement of defrost or thawing cycle if refrigerant cylinder is connected. Never leave a refrigerant cylinder connected to system except during charging operation. Failure to observe either of these precautions can result in transferring refrigerant from the system to the refrigerant cylinder, over-filling it, and possibly causing the cylinder to rupture because of pressure from expansion of the liquid refrigerant.

! CAUTION !**Operating Tips.**

- Make sure the machine is left running in the “Auto” position. This will assure a complete shutdown if a safety or overload is tripped.
- To initiate a harvest cycle, simply push the Manual Harvest push button (3PB).
- To interrupt the harvest cycle and revert to a freeze cycle, turn the Hand/Auto switch to “Hand” and back to “Auto”.
- Too much refrigerant in the condenser/receiver can contribute to high discharge pressure. Do not go above 13 1/2 inches from the center of the lower gage glass cock while in normal operation. A higher level can begin to cover the condenser tubes and reduce condenser efficiency.
- The circulating water overflow tubing will show that water is being slightly lifted up the tubing near the end of the freezing cycle. If this action ceases and water begins overflowing from the top water box, it is an indication that the tubes are freezing solid and the machine should begin a harvest cycle. It is best not to freeze the ice solid with no hole.
- To cease ice production manually, allow the machine to complete the harvest period and start the freeze period. When the “liquid feed” light comes on at the beginning of the freeze period, push the “Stop” button to cease ice production.

6. Electrical Controls

Your packaged Tube-Ice[®] machine is equipped with a compressor motor starter (1M) as required for your particular voltage and a transformer (if required) for the control circuit power. The motor starter and transformer are mounted on the machine front side (see Figures 1-1 or 1-4).

The control panel wiring schematic, FIGURE 6-3, illustrates these components as well as provisions for auxiliary equipment which may be incorporated by the customer such as:

- (FU1) Main power disconnect
- (5M) Conveyor motor starter and overload (5MOL)
- (6M) Tower fan starter and overload (6MOL)
- (7M) Condenser pump starter and overload (7MOL)

When adding motor starters for auxiliary equipment, be sure to incorporate the overload protection as indicated between terminals #12-#13 and remove the jumper wire. This will assure that the machine will shutdown when any auxiliary equipment fails.

Bin Level Control. Included in the wiring schematic is provision for a bin level control (BLC). The NC contacts of your control should be wired between terminals #8-#9 and the jumper wire removed as indicated. Installation in this manner will allow the machine to finish the harvest period before shutdown. However, the machine will still need to be manually started to resume production.

Safety Switches. The machine is also equipped with the following safeties and control switches, which are mounted to the frame near the compressor. Refer to the wiring schematic FIGURE 6-3 for their circuitry.

- High/Low dual pressure switch (1PS) to stop the machine if the compressor suction pressure goes too low (15 psi for R-22, or 25 psi for R-404a) or the compressor discharge pressure goes too high (300 psi for R-22, or 350 psi for R-404a). See “High/Low Pressure Switch”.
- Oil failure pressure switch (OPS) to stop the machine if the compressor oil pressure drops to 11 – 15 psi net (suction pressure minus oil pressure gage reading). See “Oil Pressure Switch”.

ELECTRICAL CONTROLS

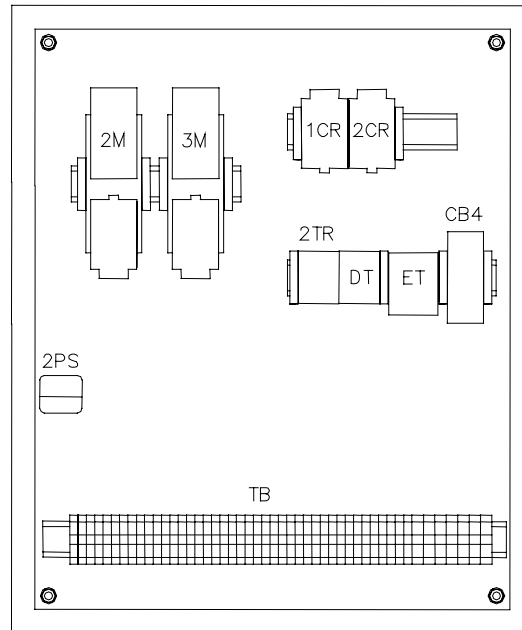


FIGURE 6-1
Lowside Control Panel (Door Opened)

1M (Not shown)	Compressor Motor Starter	Provides power to the compressor motor. Continuously energized during freezing and thawing with auxiliary hold contact and auxiliary contact to de-energize the compressor crankcase heater when the motor is running.
2M	Pump Motor Starter (Contactor & manual motor starter)	Provides power to the circulating water pump during the freezer period or when the Hand/Auto switch is in the "Hand" position to circulate water or ice machine cleaner, etc. Manual motor starter provides motor over-current and short circuit protection.
3M	Cutter Motor Starter (Contactor & manual motor starter)	Provides power to the cutter during the harvest period. Manual motor starter provides motor over-current and short circuit protection.
1CR	Control Relay With Pneumatic Timer	For making and breaking various circuits during freezing and thawing period with pneumatic timer to delay the actual thawing process. Energized during thawing.
2CR	Control Relay	For making and breaking circuits during freezing and thawing. Energized during freezing, thawing, and hand. Momentarily de-energized at the end of the harvest.
2TR	Thawing Timer	Controls the time of the harvest (thawing) period. Energized during the harvest period.
DT	Delay Timer	Allows the compressor to start unloaded by delaying the energizing of the "UR-SOL" (unloader solenoid) valve. This gives lower in rush amps and helps prevent belt slippage at start-up.
2PS	Freezer Pressure Switch	Controls the desired ice thickness (hole size) by sensing the freezer suction pressure and initiating the harvest period.
ET	Elapsed Time Indicator	Indicates total hours of machine operation. Is powered when the compressor is running.
CB4	Circuit Breaker	Overload and short circuit protection for crankcase heater and the control circuit.
TB	Terminal Block	Numbered for multiple wire connections and ease of troubleshooting.
DS2 (not shown)	CE panel-Lowside Disconnect	Used to disconnect power from panel when panel door opened.

TABLE 6-1
Description of Control Panel Parts (Inside)

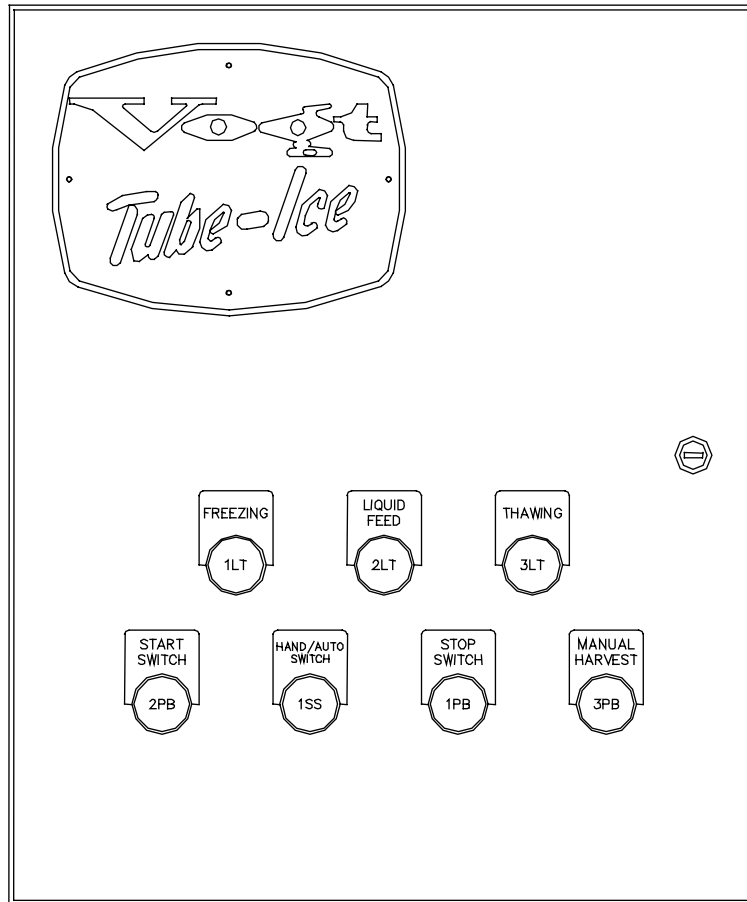


FIGURE 6-2
Lowside Control Panel (Hinged Door)

1LT	Amber Pilot Light - Freezing	Illuminated during the freeze period or whenever the circulating water pump is running.
2LT	Clear Pilot Light - Liquid Feed	Illuminated when the circulating water pump is running and the float switch (10) is closed. Indicates that the liquid line solenoid valve (20A) is opened.
3LT	Red Pilot Light - Thawing	Illuminated when the machine is in a harvest period.
2PB	Green Push Button - Start	For starting the compressor motor and ice production. (NO)
1PB	Red Push Button - Stop	For stopping the compressor motor and ice production. (NC)
3PB	White Push Button - Manual Harvest	For manually initiating a harvest cycle. (NO)
1SS	Selector Switch - Hand/Auto	“Hand” position for running the circulating water pump independently at start-up or for cleaning the freezer tubes and water tank. “Auto” position for provision of automatic system shutdown if there is a control circuit power interruption.

TABLE 6-2
Description of Control Panel Parts (Outer Door)

ELECTRICAL CONTROLS

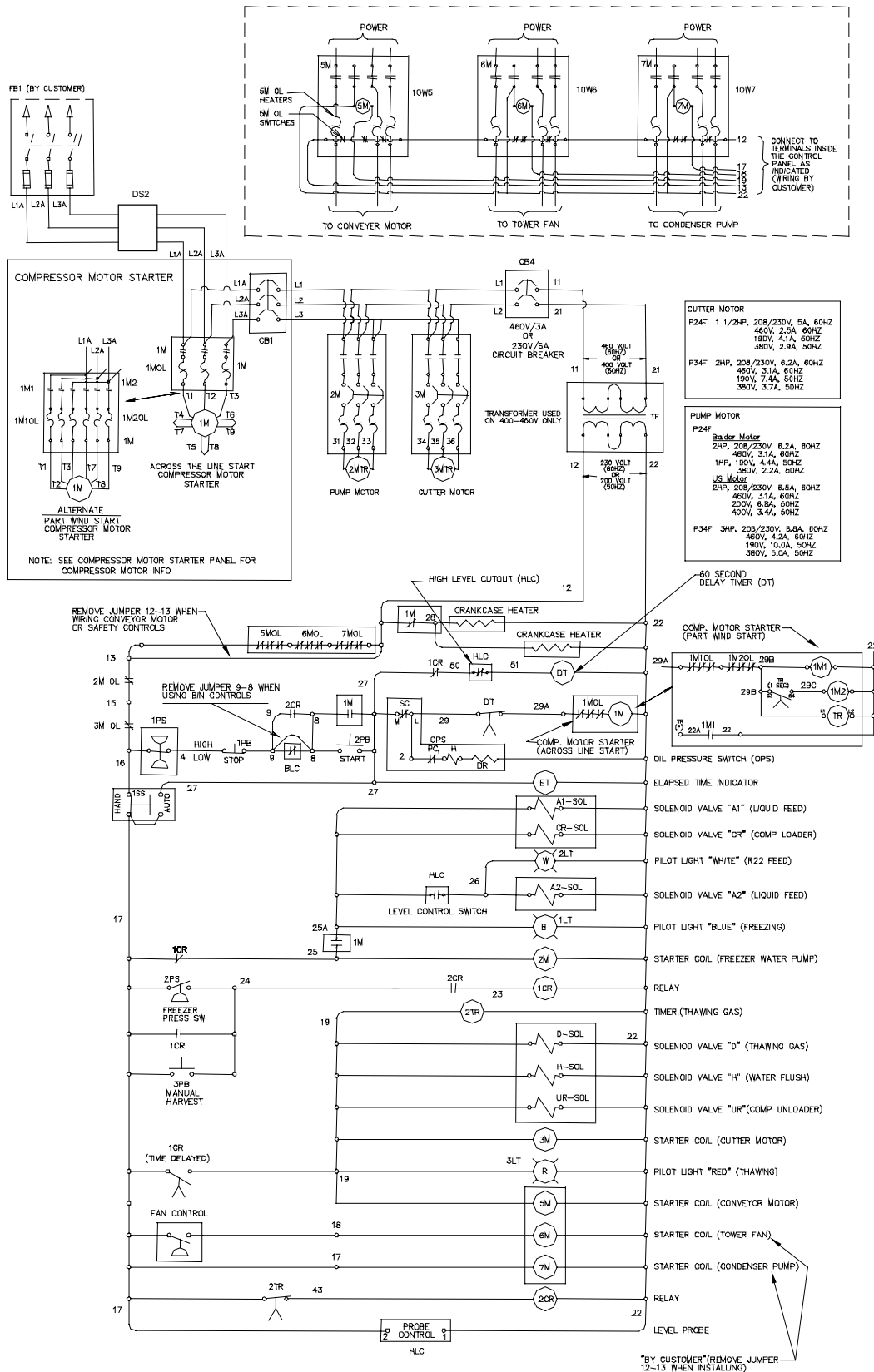


FIGURE 6-3
Electrical Schematic for P24F all Voltages, 50-60 Hz.

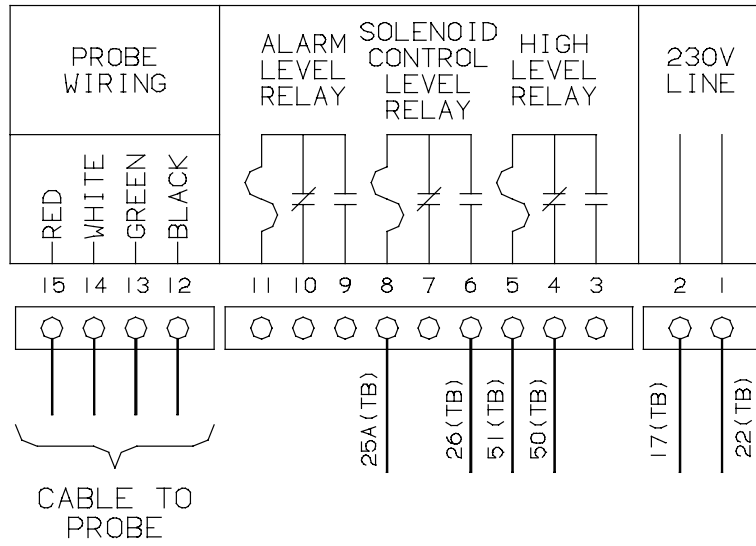


FIGURE 6-4
Level Column Wiring for P24F all Voltages, 50-60 Hz.

ELECTRICAL CONTROLS

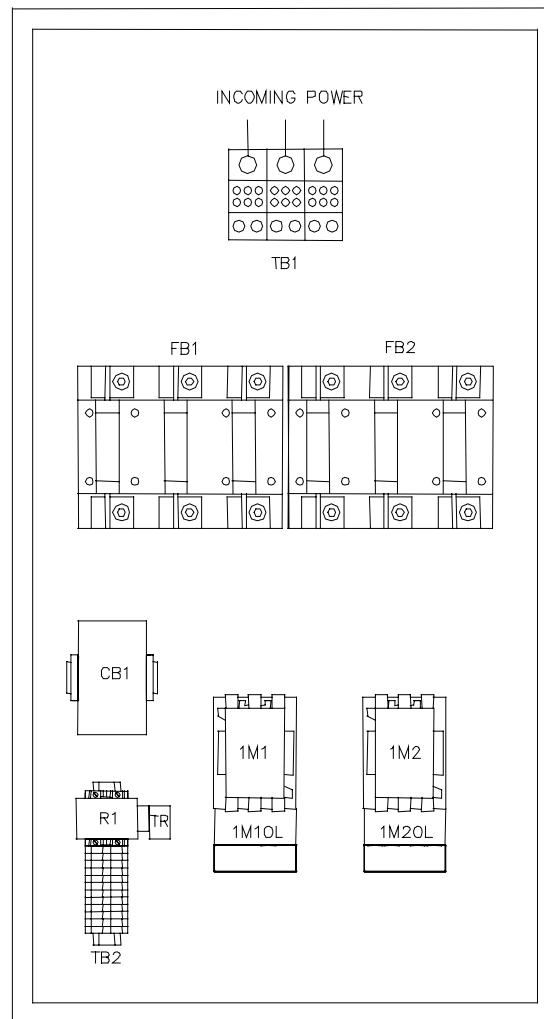


FIGURE 6-5
Part Wind Start Compressor Motor Starter

1M1	Motor Starter contactor #1	Used to start compressor motor. Energizes first.
1M1OL	Overload Relay #1	Provide over-current protection for one half of motor
1M2	Motor Starter contactor #1	Used to start compressor motor. Is energized approximately 1 second after 1M1 is energized.
1M2OL	Overload Relay #1	Provides over-current protection for one half of motor
CB1	Circuit Breaker – 3 pole	Provides short circuit protection and a disconnecting means to lowside control panel. Supplies power to lowside unit.
FB1	Fuse Block #1	Provides short circuit protection for one half of motor (3 fuses)
FB2	Fuse Block #2	Provides short circuit protection for one half of motor (3 fuses)
R1	Relay	Relay used to energize 1M2 contactor. Note: R1 is a control relay used on machines where contactor 1M2 is too large for TR to energize.
TB1	Terminal Block #1	Main Power connection.
TB2	Terminal Block #2	Secondary terminal block. Connections to Lowside panel.
TR	Delay Timer	Used to delay second motor starter (1M2). Timer either connected to R1 or 1M2 coil connection.
DS1 (not shown)	CE panel - Highside Disconnect	Used to disconnect power from panel when panel door opened.

TABLE 6-3
Description of Control Panel Parts

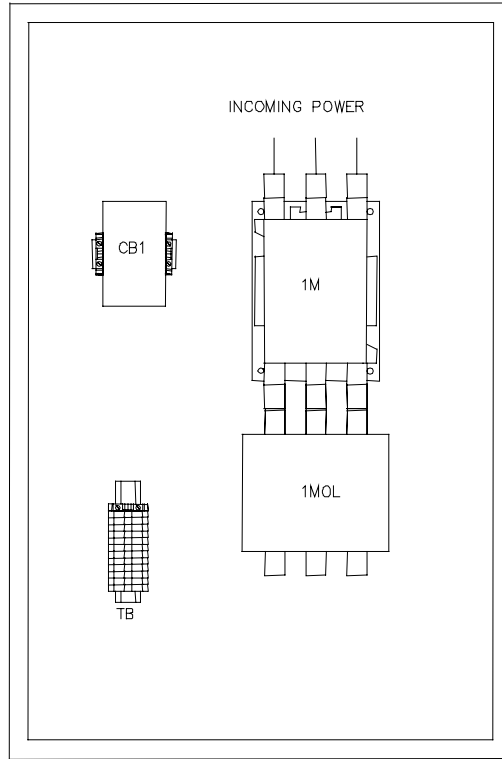


FIGURE 6-6
Across the Line Compressor Motor Starter

1M	Motor Starter contactor	Used to start compressor motor.
1MOL	Overload Relay	Provide over-current protection for compressor motor.
CB1	Circuit Breaker – 3 pole	Provides short circuit protection and a disconnecting means to lowside control panel. Supplies power to lowside unit.
TB	Terminal Block	Used for connections to Lowside panel.
DS1 (not shown)	CE panel - Highside Disconnect	Used to disconnect power from panel when panel door opened.

TABLE 6-4
Description of Control Panel Parts

ELECTRICAL CONTROLS

7. Maintenance

Preventative Maintenance. A careful inspection of the Tube-Ice[®] machine for leaks and correct operational functions at the time of installation and start-up will begin its long satisfactory life of service. In order to insure this degree of dependability, a systematic maintenance program is necessary. Therefore, the following schedule is suggested as a minimum.

A. Daily

- 1) Check operating pressures (suction, discharge, oil).
- 2) Check ice quality.
- 3) Check "ice out" time (maintain 30 seconds of continued harvest after last ice is out).
- 4) Check compressor oil level.
- 5) Check refrigerant operation level.
- 6) Check frost pattern on freezer shell and suction line.
- 7) Check make-up water float valve adjustment.

B. Weekly (in addition to daily checks)

- 1) Check all belts for proper tension. **Do not use belt dressings.**
- 2) **Check for leaks after 400 hours or four weeks of operation**

C. Monthly (in addition to weekly checks)

- 1) Check calibration and operation of all controls (high and low pressure switches, oil pressure switch, etc.)
- 2) Check cooling tower spray nozzles and pump suction screen for scaling and algae (consult water treatment suppliers for corrective measures).
- 3) Check water distributors in freezer for scale accumulation.
- 4) Check water tank for solids to be removed.
- 5) Check all motor drive units (compressor, cutter and pump motors, cooling tower fan, and pump, etc) for abnormal noise and/or vibrations.
- 6) Check oil level in gear reducer.
- 7) Check one complete freeze/thaw cycle, record data and compare with production check of Registration/Start-up Report.

D. Yearly (in addition to weekly and monthly)

- 1) Check entire system for leaks.
- 2) Drain water from condenser and cooling tower and check condenser tubes. Check closely for damage by corrosion or scale.
- 3) Remove all rust from all equipment, clean, and paint.
- 4) Check all motors for shaft wear and end play.
- 5) Check operation and general condition of all electrical controls, relays, motor starters, and solenoid valves.
- 6) Check freezing time, ice release time, and ice out time.
- 7) Change oil in gear reducer box once a year.
- 8) Lubricate compressor motor bearings.
- 9) Drain compressor oil, open compressor, inspect and clean inside crankcase. Change oil filter and add new oil. Inspect compressor suction strainer.

PREVENTATIVE MAINTENANCE FORM

This form can be removed and duplicated for record keeping.

Date: _____ Model #: _____ Serial #: _____

The following service performed and checked:

- Hour meter reading _____, Ambient temperature (inside) _____ °F
- Make-Up water float valve adjusted properly
- Water distributors clean and in place
- All drains freely draining
- Cleaned and flushed water tank
- Compressor oil changed
- Cleaned and inspected inside compressor crankcase
- Changed compressor oil filter
- Checked/adjusted compressor belt tension
- Lubricate compressor motor bearings
- Check/change cutter gear reducer oil
- Check/adjust cutter drive gear meshing
- Leak check entire system
- Check liquid refrigerant level in receiver
- Compressor crankcase heater working
- Compressor net oil pressure (gage reading less suction)

Motor amps: Compressor _____ Cutter _____ Pump _____
 Suction psig (end of freeze) _____ Discharge psig (end of freeze) _____
 Suction psig (end of thaw) _____ Discharge psig (end of thaw) _____
 Compressor water out _____ °F Tower fan cycles ___ On ___ Off

Production Check

Test Cycle	Make-up Water Temp	Freezing Time Min/Sec	Harvest Time Min/Sec	First Ice Out Min/Sec	All Ice Out Min/Sec	Avg. Hole Size	Ice lb. Per Harvest (est)	Ice lb. Per Day (est)
#1								
#2								
#3								
#4								

Comments: _____

Name: _____

Ice Making Section. The ice making section of the Tube-Ice® machine should be cleaned at least twice a year (more often if water conditions cause mineral build up). Use an approved food-grade ice machine cleaner. The water pump is used to circulate the cleaner through the system. For complete instructions, follow the “Cleaning Procedure” below.

Cleaning Procedure.

1. Stop the machine at the end of harvest.
2. Shut off make-up water supply.
3. Drain the water tank, flushing out any loose sediment.
4. Close the drain valve and fill the tank with warm water. Warm water promotes faster cleaning.
5. Cover the ice discharge opening to prevent contaminating any stored ice by splashing water out.
6. Add sufficient ice machine cleaner to the water tank.
P24 tank = 2.5 gallons water per inch of water height in tank, 13” = 32.5 gallons
Mix cleaning solution according to manufacturer’s recommendations.
7. Remove top water box cover, inspect distributors, remove any hard particles from orifices, and make sure all distributors are in place. Replace cover.
8. Turn Hand/Auto switch to “Hand” position and circulate the cleaning solution until deposits are dissolved or the solution is neutralized. After draining, the pump may have to be stopped and restarted to dispel air.
9. Turn switch to “Auto” position to stop the pump. Drain and flush the water tank. Repeat cleaning as necessary.
10. After cleaning, fill the tank with fresh water, start the pump again, and circulate for 15 minutes.
11. Stop the pump, drain and flush the tank and again refill with fresh water.
12. Remove the cover from the ice discharge opening, and clean any area that may have been splashed with solution during cleaning.
13. Make sure the make-up water float valve is adjusted properly and the drain valve is closed.
14. Start and stop the pump again to make sure it is circulating water and it is not air bound.

You are now ready to produce ice.

Water Distributors. The water distributors are located under the top freezer cover. These distributors are similar in design to those used in mid-size and small machines (i.e. P18F, P118, etc.) except they have a small vent tube. It is important that this plastic vent tube remain in place in each distributor. The distributors may require occasional or periodic cleaning to remove solids, foreign particles, or mineral deposit accumulated from the circulating make-up (ice making) water. The frequency of cleaning operation will depend on the characteristics of the water supply. The distributors need inspection when the inside diameter of a large portion of the ice becomes irregular (due to channeling of water), if some of the ice is opaque or if there is a noticeable decrease in ice capacity and quality.

Tube Size	1 1/2”	1 1/4”	1”
Number of Distributors	144	198	264

TABLE 7-1
Water Distributors

You may look through the plastic freezer cover to inspect the water distributors if the view is clear. For a closer inspection you should stop the unit, remove the nuts and retaining ring sections and lift off the top cover. Make sure the two orifices in the side of each distributor are open, the vent tubes are in place, and a distributor and vent tube assembly is installed firmly in each tube.

To remove the water distributors for cleaning:

1. Grip the top of the distributor body (not at the vent tube) with adjustable pliers.
2. Hold and twist the distributor while pulling upward.
3. Lift the distributor out of the hole.

To install the distributors:

1. Insert one in each tube hole and seat firmly by using a short piece of pipe or conduit.
2. Slide the pipe or conduit down over the vent tube and gently tap the distributor in place.
3. Do not allow the distributor to be recessed below the top of the tube sheet.

To replace the cover:

1. Replace water distributor box cover gasket.
2. Install the cover over the bolt studs.
3. Install the four (4) cover retaining rings sections and nuts.
4. Tighten the wing nuts firmly to prevent foreign materials from entering the water box.

Note: The freezer cover and gasket are not intended to hold the pressure of the circulating water in the event of a freeze up. Therefore every effort should be made to prevent the Tube-Ice[®] from freezing solid (with no hole).

Tube Size	1 1/2"	1 1/4"	1"
Hole Size	1/4"-3/8" Avg.	1/8"-3/16" Avg.	1/16"-1/8" Avg.

TABLE 7-2
Average Hole Size In Tube-Ice[®]

Water Tank. The production of opaque ice can indicate that the water in the water tank contains a concentrated amount of solids or salts. See Troubleshooting, "Poor Ice Quality".

To clean the water tank:

1. Stop the machine at the end of harvest.
2. Shut off the make-up water supply.
3. Open the drain valve and drain the tank.
4. Remove the water box cover and flush out any loose sediment from the tank. The wire mesh screen can be removed if necessary.
5. If further cleaning is needed, follow "Cleaning Procedure".
6. If further cleaning is not needed, close the drain valve and refill the tank with fresh water.
7. Make sure the float valve is adjusted properly and install the water box cover.
8. Start and stop the pump again to make sure it is circulating water and is not air bound.

Water Cooled Condenser Cleaning. As water evaporates from a cooling tower, the solid impurities remain and must be flushed from the system to prevent a scale build-up in the condenser and cooling tower. This can be accomplished by a continuous bleed off valve located in the pump discharge line. The valve should be adjusted to bleed off an equal amount of water that is evaporated. If water hardness is very high, a higher bleed off rate or chemical treatment may be required. Consult you local water treatment company for recommendations.

If after a period of time, scale has formed inside the tubes, mechanical cleaning may be necessary. See "Servicing Section--Condenser".

Cooling Tower/Evap Condenser. See Figure 3-4 for parts location.

1. Bleed off valve. The bleed off valve should be checked monthly to assure that it is not blocked and that water is flowing as required. If the unit is controlled by a water treatment system, the bleed off valve may not be required.
2. Strainer. The pan or sump strainer is located in the bottom of the sump at the suction connection to the pump. The strainer should be inspected monthly and kept clean. Do not operate the unit without the strainer in place.
3. Make-up water float valve. This valve should be checked monthly for proper operation and adjustment. It should be adjusted to maintain a water level below the overflow and high enough to prevent the pump from cavitating when the system is in operation.
4. Spray nozzles. The spray nozzles should be checked monthly to make sure none are restricted and the spray pattern is complete and even.
5. Pump motor and fan motor. The motors should be checked and/or lubricated every six months according to the motor manufacturer's recommendations.
6. Fan bearings. The fan bearings should be lubricated every six months. Make sure the proper grade of grease is used (normally conforms to NLCI-Grade 2). It is best to use a hand grease gun.
7. Fan belts. The fan belt tension should be checked weekly for the first two weeks of operation, then monthly during continuous use.

The best tension for a V-belt is the lowest tension at which the belt will not slip under its full load. Never use dressing on V-belts. Keep belts and grooves clean and free of oil, grease, and foreign material. Clean with non-flammable, non-toxic degreasing agent or commercial detergent and water.

! CAUTION !
Follow all lock-out and tag-out procedures before servicing any electrical equipment.
! CAUTION !

Service/Frequency	Start-Up	Monthly	Six Months	Shutdown
Clean debris from unit	X	X		X
Clean strainer and flush sump	X	X		X
Check fan and pump rotation	X			
Clean spray nozzles	X	X		
Check belt tension	X	X		
Check for noise/vibration	X	X		
Check/adjust make-up water valve	X	X		
Check/adjust bleed rate	X	X		
Check/lubricate fan bearings	X		X	
Lubricate motor base adj. screw	X		X	X
Drain sump and piping				X

TABLE 7-3
Cooling Tower Maintenance Schedule

Compressor. In starting and charging the unit, the oil sight glass should be continually checked to make sure an adequate oil level is maintained. The oil level should be 1/4-3/4 of the sight glass. If

the oil level drops below 1/4 of the glass, add refrigeration oil (Texaco WF32 or equivalent for R-22, Mobil EAL Arctic 22CC POE or equivalent for R-404a) as per the compressor manufacturer recommendations. Never allow the oil level to be out of sight, above or below the sight glass when the compressor is operating. The compressor contains approximately 5 gallons (22.7 liters) of refrigeration oil.

! CAUTION !
The crankcase heater should be energized for a minimum of four hours and the oil temperature should be 100°-110°F before attempting to start the compressor.
! CAUTION !

During operation, the specified net oil pressure should be maintained for proper lubrication and operation of the cylinder unloader mechanism.

Net oil pressure: 45-55 psig

Note: Net oil pressure is calculated by subtracting the compressor suction pressure from the oil pressure gage reading while the compressor is running.

Example: Oil pressure gage reading: 65 psig
 Suction pressure gage reading: 40 psig
 Net Oil Pressure: 25 psig

The compressor oil should be changed at close intervals during initial break-in operation and up to the first 1000 hours (see Table 7-4). Your machine was test operated at the factory and compressor oil was drained, crankcase cleaned, suction strainer sock cleaned, new oil filter installed (if applicable), and clean oil added prior to shipping.

Note: It is the owner’s responsibility to make sure normal maintenance is initiated to insure that the compressor is not subjected to premature wear or failure due to neglect or lack of sufficient maintenance and care.

	Frequency				
	1st	2nd	3rd	4th	Thereafter
Change oil and Filter	50 hr.	500 hr.	1500 hr.	4000 hr.	every 4000 hrs.
Clean suction strainer cloth	200 hr.	500 hr.	Remove if clogging is minimal		

TABLE 7-4
Compressor Maintenance

The above maintenance is only a guide. The compressor should be inspected anytime there is unusual noise, damage is suspected or the oil becomes discolored. The oil should be changed any time the compressor is opened. For specific recommendations and instructions, refer to the particular compressor manufacturer’s manual. See “Compressor Oil Changing and Inspection”

Cutter Gear Reducer. The oil level of the gear reducer should be checked monthly or when there is any evidence of leakage. The correct oil level is indicated by the pipe plug in the side of the gear

housing. The oil should run out of the hole when the plug is taken out. If low, add oil through one of the top plugged holes. A high grade lubricant such as Mobil 600W or SAE 140 gear oil should be used. The oil should be changed annually. Drain the oil and flush the gear case with mineral spirits. Drain the mineral spirits completely and refill with the proper oil.

Note: If a USDA high food grade lubricant is desired, use Chevron FM Lubricating Oil 460X.

! CAUTION !
Follow all lock-out and tag-out procedures before servicing any electrical equipment.
! CAUTION !

V-Belt Maintenance. Belts should be kept clean, free of oil and protected from sunlight as much as possible. To clean belts, wipe with a dry cloth. The safest way to remove dirt and grime is to wash the belt with soap and water and rinse well. **BELT DRESSING SHOULD NEVER BE USED ON A V-BELT DRIVE.**

The tension on a 5 rib, banded V-belt can be checked as follows:

1. Apply 50-75 pounds of deflection force uniformly across the belt, midway between the pulley centers. Lay a straight edge across the sheaves to measure the deflection. The deflection should be 5/8" to 3/4".
2. When installing a new belt, move the sheaves together to allow the belt to slide across the sheaves. Rotate the belt and sheaves to obtain proper seating. Remove the slack from the belt and measure the outside circumference to the nearest 1/4". Multiply this reading by .0075 and .001, add these amounts to the circumference reading. Elongate the belt to the new length.
Example: $105 \times .0075 = .7875$, $105 + .7875 = 105.7875 = 105 \frac{3}{4}$ " min.
 $105 \times .001 = 1.05$, $105 + 1.05 = 106.05 = 106 \frac{1}{16}$ " max.
3. Check Compressor sheave and motor sheave with a straight edge to be sure they are parallel and in the same plane.
4. The tension should be checked after 24 to 48 hours of operation to compensate for initial stretch and wear-in. Periodic checks should be made and tension restored as necessary.

General Rules:

1. The best tension for a V-belt drive is the lowest tension at which the belt will not slip under the highest load. Too much tension shortens belt and bearing life.
2. Check tension often during the first 48 hours of operation and periodically afterwards.
3. Keep belts and sheaves free of any foreign material which may cause slippage.
4. If a belt slips, tighten it.

8. Troubleshooting

Note: Your machine's electrical system has several built-in safety and overload protection features to stop operation when a single component fails, or there is a problem from an outside source such a power supply. Make sure all auxiliary equipment is connected to incorporate safety and overload circuits and protect all related equipment.

When the machine stops, it must be manually restarted by pushing the "Start" button. If it stopped while in a freeze cycle, it should be manually harvested to remove all ice from the freezer. This is done by pushing the white "Manual Harvest" button.

Always check the machine operation thoroughly after remedying the problem. Be sure to correct the source or cause of the problem to prevent the problem from occurring again.

<u>Symptom</u>	<u>Page</u>
Machine stopped	8-2
Freeze-up due to extended freeze period	8-4
Freeze-up due to ice failing to discharge	8-5
Low ice capacity	8-6
Poor ice quality	8-7
High discharge pressure	8-8
Low discharge pressure	8-9
High suction pressure	8-9
Compressor running unloaded during freeze	8-9
Compressor oil pressure low	8-10
Compressor loosing oil excessively	8-10
Machine short cycles	8-11
Shut down by oil pressure switch	8-11
High compressor discharge temperature	8-11
Suction line frosting to compressor	8-12

Notice: Opening the compressor for observation or determination of failure does NOT void the warranty.

Contact your distributor first for technical service assistance about operation problems not covered in this manual.

TROUBLESHOOTING

Symptom: Machine Stopped

Possible Cause	Possible Remedy
Power failure or interruption	Check fused disconnect or circuit breaker supplying power to the machine. If power has been off, make sure the crankcase heater is energized and there is no liquid refrigerant in the compressor crankcase prior to restarting the compressor. If ice is in the freezer, initiate a manual harvest.
Circuit breaker (CB4) for control circuit tripped	Check compressor crankcase heater, coils of relays, contactors, starters, solenoid valves, and thawing timer for a ground. Repair or replace any defective part and reset circuit breaker. Make sure there is no liquid refrigerant in the compressor crankcase prior to restarting the machine.
Compressor motor starter overload (1MOL) tripped	Check for a loose connection on all motor starter and motor terminals which could cause excessive amp draw. Reset overload and restart the machine, check amperage, power supply, and head pressure. (Check TR in part wind starts only).
Water pump, cutter motor, tower fan, tower pump, conveyor motor, overload tripped	Check for loose connection on all terminals which could cause excessive amp draw. Reset the overload and manually run that particular motor to check actual voltage and amperage against motor rating.
Freezer water pump motor overload (2MOL) tripped	Check for loose terminal connections and/or defective breaker (CB2), reset the overload and start the pump by turning the selector switch (1SS) to "Hand". Check voltage and amperage against motor rating. Confirm proper rotation.
Cutter motor overload (3MOL) tripped	Check for loose terminal connections and blown fuse, reset the overload. Clear all ice that may have jammed cutter. Turn the selector switch (1SS) to "Hand" and push the "Manual Harvest" button. Check voltage and amps against motor rating. If tripping repeats but ice is not jammed, check the gear reducer for resistance, cutter bearings for wear, drive gear and ring gear for proper engagement, and reducer motor for defect or single phasing.
Bin level control (optional) open	Adjust or replace control as required. If bin level control is not used, make sure jumper wire #8 and #9 is installed at of the terminal block.

Symptom: Machine Stopped (con't)

Possible Cause	Possible Remedy
High/Low pressure safety switch (1PS) tripped	<p>If the machine stops by low pressure cutout, the switch will reset automatically when the pressure raises to the “cut-in” setting. Check thaw gas valve (18) to make sure it opens during harvest time.</p> <p>If the machine stops by high pressure cutout, the switch will have to be manually reset after the pressure drops below the “cut-in” setting. Check the head pressure during the next freeze cycle. See FIGURE 9-2, Section 9 (High/Low Pressure Switch).</p>
Low oil pressure tripped (OPS)	<p>Manually reset the switch after the switch heater cools. Check the crankcase oil level (1/4-3/4 full). Add oil if below 1/4 glass before attempting to restart the machine.</p> <p>Restart the machine and check net oil pressure (net oil pressure = oil pump line pressure minus crankcase suction pressure). See FIGURE 9-4, Section 9 (Oil Pressure Switch). See “Low Compressor Oil Pressure”.</p> <p>Net oil pressure range: 45-55 psig</p>
Defective control panel component such as 1PB, 1SS, 1M contact, 2CR contact	See FIGURE 6-3, Wiring Schematic, and check for open circuit. Refer to FIGURES 6-1 and 6-2, Control Panel to identify parts. Check for loose wires. Replace defective part, restart machine, check power supply, and current draw.
Circuit breaker (CB2 or CB3) for pump or cutter motor tripped	Check for loose connection on all terminals, reset breaker and check amp draw against breaker rating. Check voltage and current unbalance, Section 3. Replace breaker if defective.
High refrigerant level in evaporator due to liquid feed valve “A1” leaking through	Check the manual opening stem to make sure it is in the automatic position (stem screwed out). Check for leakage by sound, temperature difference and frost during the freeze cycle. Leakage should stop by closing the hand stop valve downstream of thaw gas valve. Isolate and repair or replace the valve as needed.
High refrigerant level in evaporator due to level controller failure	Check liquid level control for proper operation and set-point. Replace defective part.

TROUBLESHOOTING

Symptom: Freeze-up due to extended freeze period

Possible Cause	Possible Remedy
Freezer pressure switch (2PS) set too low or defective	Adjust switch or replace if defective. See FIGURE 9-1.
Water tank drain valve, make-up water float valve or flushing valve stuck or opened	Close, repair, or replace valve as needed. The float valve should be adjusted low enough that water should not run out the tank overflow during the freeze cycle.
Thaw gas solenoid valve (18) leaking through during freeze	Check the manual opening stem to make sure it is in the automatic position (stem screwed in). Check for leakage by sound, temperature difference and frost during the freeze cycle. Leakage should stop by closing the hand stop valve downstream of thaw gas valve. Isolate and repair or replace the valve as needed.
Level control set to high	Check liquid level control for proper operation and set-point. Replace defective part.
Compressor running unloaded	<p>If the compressor is running unloaded, the motor amp draw will only be 60%-70% of the normal amp draw of a loaded compressor.</p> <p>Check the delay timer (DT) electrical circuit to make sure the "UR-SOL" coil is not energized.</p> <p>Refer to the compressor manual for normal oil pressure needed to load the compressor cylinders and any further procedures to check the mechanical function of the unloader mechanism.</p>

Symptom: Freeze-up due to ice failing to discharge

Possible Cause	Possible Remedy
Extended freeze period	Check freezer pressure switch (2PS) adjustment. See FIGURE 9-1 for adjustment and TABLE 7-2 for average hole size. Make sure all water distributors are in place (one in each tube).
Thaw time too short	Adjust thaw timer (2TR) to allow all ice to clear the cutter and ice discharge opening with at least 30 seconds to spare. Replace defective timer.
Insufficient heat for thawing due to low condensing pressure	The head pressure should be maintained from 175-200 psi for R-22 or 210-245 psi for R-404a, usually by a water regulating valve or fan cycling switch. Check to make sure these controls are working properly. Cold prevailing wind can also be a factor.
Insufficient heat due to non-condensables (usually air) in the system	If non-condensables are present with the refrigerant, the saturated temperature will not relate to the pressure reading at the receiver and the refrigerant will be cooler, although pressure will be high. Air can be purged from the system by following the procedure in the Section 9, "Purging Non-Condensables".
Insufficient heat due to water in the refrigeration system	If water is present in the refrigeration system, the ice will release, but discharge very slowly. Check the refrigerant for water content (purchased kit or freezer pump-down). Remove all water by following the procedure in Section 9, "Removing water".
Insufficient heat due to low refrigerant charge	The refrigerant level in the receiver should be near the operating mark at the end of a freezing cycle to provide enough volume of warm gas for harvesting. DO NOT OVERFILL RECEIVER.
Cutter or cutter disc does not turn	Check cutter gear reducer and drive gear for proper operation and alignment. Check for broken gear teeth or sheared shaft key. Replace defective parts.
Compressor not running unloaded during thaw cycle.	Check compressor motor Amp draw. During the thaw cycle, the compressor motor Amp draw should be 60 - 70% of normal amp draw during the freeze cycle. Check compressor unloader solenoid coil (UR) to make sure it is energized and the valve opening during the thaw cycle. Check oil pressure.

TROUBLESHOOTING

Symptom: Low ice capacity.

Suspicious of low ice capacity should be confirmed by accurate calculations of actual ice produced. Much weight can be lost by melting and fall off through augers and other ice handling equipment.

1. Time the total freeze and thaw cycle for the cycle which is to be caught and weighed.
2. Catch all the ice at the ice discharge opening of the machine.
3. Weight the total amount of ice caught.

Lbs. ice per cycle

Cycle time minutes X 1440 = _____ lbs. production per 24 hours

More than one cycle should be caught and weighed to get an accurate average.

Possible Cause	Possible Remedy
Inadequate water for ice making	Water pressure of 40 psig minimum is required to assure proper water supply. Check water pressure. Check for a restriction in the incoming line or at the make-up water float valve.
Water distributors may be stopped up	Check distributors and clean orifices as needed.
Freezer pressure switch or thaw timer out of adjustment	Check hole size in Tube-Ice (See TABLE 7-2). Crushed ice should be 3/16"-1/4" thick. Check and adjust thawing time. Thawing should be 30 seconds longer than it takes for all the ice to clear the freezer.
Excessive ice chips in the water tank, causing short cycling	Check incoming water temperature (45°F minimum). Check flushing valve to make sure ice chips are being melted and flowing out the tank overflow during the harvest cycle.
Compressor running unloaded or not pumping full volume	Check compressor motor amp draw. Check for belt slippage and tighten as needed. Check for leaking compressor suction or discharge valves. Refer to your compressor manual. See other related symptoms.
Restriction in the refrigerant liquid line or level controller not operating properly	Check for a partially closed valve or an obstruction at the filter drier, solenoid valve, or hand expansion valve. The liquid line will normally have frost on the downstream side of a restriction, especially as the suction pressure decreases. Check level controller set-point.
Low refrigerant charge, causing re-freeze	Check the receiver gage glass mark for the proper level. Check for and repair leaks. Add refrigerant.
Warm make-up water for ice making	Capacity of the machine is proportional to ice making water temperature. Warmer water will reduce the ice making capacity. Refer to Section 11, Capacity Table. Check float adjustment and water tank drain valve.

Symptom: Low ice capacity (cont.)

Possible Cause	Possible Remedy
Excessively high head pressure	Check cooling tower or evap condenser to make sure sufficient water is provided for cooling and the equipment is operational to cool the water. Also see "Symptom High Head Pressure".
Thawing gas solenoid valve (18) leaking through during freeze cycle	Check the manual opening stem to make sure it is in the automatic position (stem screwed in). Check for leak by sound, temperature difference and frost during a freeze cycle. Close the stop valve (90) to confirm suspicion of leakage. Repair or replace the valve.

Symptom: Poor ice quality

Possible Cause	Possible Remedy
Excessive concentration of solids in the water tank usually indicated by a build-up of mineral deposit on the sides and bottom of the tank and opaque ice production. Also, water distributors restricted.	Performing a cleaning procedure as well as removing the freezer cover and cleaning the water distributors. Make sure the flushing valve (63) is functioning and the tank overflow piping is not restricted.
Insufficient water supply indicated by a low level in the tank	Check water pressure, 40 psig is recommended minimum. Check for a water line restriction, partially closed valve, or defective make-up water float valve. Make sure the water tank drain is closed.
Water pump rotation wrong direction	Check rotation in relation with arrow on pump housing and reverse two wires at the motor if necessary.
Low refrigerant charge, causing an ice out problem and re-freeze	Check refrigerant level mark on the receiver and on the painted portion of the gage glass guard. Be sure to keep the gage glass cocks closed when finished checking the level.
Restriction in liquid line, causing short freeze cycle	Check for closed valve, defective solenoid valve (20), level controller defective or filter drier restricted. The liquid line will normally have frost on the down-stream side of a restriction, especially as the suction pressure decreases. Check level controller set-point.

TROUBLESHOOTING

Symptom: High discharge pressure (check gage accuracy)

Possible Cause	Possible Remedy
Insufficient water flow through the cooling tower or condenser	Check the condenser water pump to make sure it is pumping enough water as specified in TABLE 3-2. Check sump strainer screen and clean. Check condenser pump direction of rotation.
Fan control out of adjustment	Check adjustment. Refer to FIGURE 9-3, "Fan Control". Replace if defective.
Non-condensable in system.	If non-condensables are present with the refrigerant, the saturated temperature will not relate to the pressure reading at the receiver. The refrigerant will be cooler, although the pressure will be high.
Cooling tower or evap condenser in need of maintenance	Check fan motor and fan belts for proper operation and tension. Check spray nozzles, tubes, sump, and sump screen, for accumulation of mineral deposit and clean as required. Check tower blowdown and chemical treatment if applicable.
Dirty condenser tubes	Visually inspect the condenser tubes to see if there is any build-up of mineral deposits, which would reduce the cooling effect of the tubes and water. Clean chemically or mechanically as applicable.
Too much liquid in condenser/receiver covering tubes causing inefficiency	Remove refrigerant so all tubes will be above liquid refrigerant level.

Symptom: Low discharge pressure (check gage accuracy)

Possible Cause	Possible Remedy
Fan cycling switch out of adjustment or defective	Check adjustment. Refer to FIGURE 9-3, "Fan Control". Replace if defective.
Compressor running unloaded or not pumping efficiently	Check compressor motor amp. If the compressor is running unloaded, the amperage will only be approximately 60% of normal amp draw (FLA). Refer to the compressor manual.
Ambient temperature low and prevailing winds blowing through tower	Shield tower from prevailing winds to prevent excessive cooling. Install an indoor sump.
Too much cold water circulating through condenser	Install a water regulating valve in the water line from the condenser and control flow by receiver pressure.
Thaw gas valve #18 leaking through	Make sure manual opening stem is in the automatic (screwed in) position. Repair or replace defective parts.

Symptom: High suction pressure (check gage accuracy)

Possible Cause	Possible Remedy
Compressor running unloaded or not pumping efficiently	Check compressor motor amp. If the compressor is running unloaded, the amperage will only be approximately 60% of normal amp draw. Refer to the compressor manual.
Thaw gas valve #18 leaking through	Make sure manual opening stem is in the automatic (screwed in) position. Repair or replace defective parts.
Defective gage	Check pressure with accurate gage and replace as necessary.

Symptom: Compressor running unloaded during freeze

Possible Cause	Possible Remedy
Low oil pressure	Check compressor net oil pressure. Net oil pressure = oil pressure gage reading less suction pressure: 11 - 15 psi Refer to the compressor manual for "Oil Pressure Adjustment".
Unloader solenoid valve open	Check solenoid coil to make sure it is not energized. If valve is stuck open, replace valve.
Unloader mechanism not working properly	Refer to compressor manual for unloader information.

TROUBLESHOOTING

Symptom: Compressor oil pressure low (check gages)

See Section 7, for compressor oil pressure requirements.

Possible Cause	Possible Remedy
Oil diluted with refrigerant	Oil will be very foamy. Check liquid feed control for overfeed problem.
Oil pressure regulating valve out of adjustment	Adjust valve to increase oil pressure. Turn stem in to increase, out to decrease.
Compressor rotation incorrect	Check rotation direction by arrow indication. Reverse rotation, if necessary.
Restriction strainer, oil filter, pick-up tube or oil passage	Clean strainer or restriction in passage or replace filter.

Symptom: Compressor loosing oil excessively

Possible Cause	Possible Remedy
Non-effective oil separator or float	The oil separator will normally return a good portion of oil leaving the compressor, if it is working properly. Check the oil float and return line to see it is not restricted.
Liquid refrigerant in crankcase	Check liquid feed to make sure it is not overfeeding and that the solenoid valves #20A and #20B are not leaking through when the machine is stopped.
Compressor piston rings seized or broken	Check compressor efficiency. If rings are seized or broken, replace defective parts.
Leaking shaft seal	A few drops per minute is okay. If refrigerant is leaking, replace the seal.

Symptom: Machine short cycles

Possible Cause	Possible Remedy
Freezer pressure switch (2PS) set too low or defective	Adjust switch or replace if defective. See FIGURE 9-1.
Freeze-up	See “Freeze-up due to extended freezer period” and “Freeze-up due to ice failing to discharge”.
Clogged water distributors	Clean water distributors.
Lack of water for making ice	Check water tank for sufficient water level. Checks for restriction in water line, defective float valve, open drain valve, excessive ice chips or low water pressure and correct.
Lack of sufficient liquid refrigerant feed	Check liquid level controller, solenoid valves and coils #20A and #20B in liquid line, filter/drier, and refrigerant level in receiver.
Water pump rotation incorrect or pump defective	Check pump motor rotation. Check for leaking pump seal or defective motor and repair or replace as needed.

Symptom: Shut down by oil pressure switch

Possible Cause	Possible Remedy
Switch adjusted too high or defective	Check switch adjustment and cutout pressure activation against an accurate gage. Replace switch if defective. See Figure 9-4.
Oil pressure low	See “Compressor oil pressure low”.
Low oil level	Add oil.
Defective thawing timer causing long harvest cycle and oil dilution	Replace defective timer.

Symptom: High compressor discharge temperature

Possible Cause	Possible Remedy
High head pressure	Check gage accuracy and “High discharge pressure”.
Defective suction or discharge valves	Feel the compressor heads for hot spots or one head running hot. Replace worn or leaking valves.
Restriction in the discharge gas line	Check all hand and check valves to make sure they are fully opened and not stuck. Repair or replace as needed.
Internal relief valve leaking	Check the compressor manual to see if your compressor is so equipped. Replace accordingly.

TROUBLESHOOTING

Symptom: Suction line frosting to compressor

Possible Cause	Possible Remedy
Liquid refrigerant overfeed	Check liquid level controller to make sure it is functioning properly. Replace if defective. Check solenoid valves #20A and #20B to make sure they are not leaking through. Repair or replace if defective.
Refrigerant contaminated with water	Test refrigerant or oil for water contamination. Completely pump the freezer out (pumpdown) and pull vacuum on freezer. Refer to Service, Section 9 "Removing Water".

9. Servicing Operations

Automatic Blowdown (harvest cycle)

A feature of this machine is a solenoid activated flushing valve (63), which is provided to eliminate or reduce the necessity for frequent flushing or cleaning of the water tank. This flushing during the harvest cycle helps to remove salts or solids accumulated in the water as a result of the freezing action. It also helps melt ice chips that fall into the water tank during harvest. The flushing valve is opened (energized) during each thaw cycle when the water pump stops and the water in the freezer tubes returns to the water tank. If water quality is superior, the blowdown can be reduced by installing a smaller reducer bushing in the outlet elbow.

The flushing action carries accumulated salts, solids, and ice chips (fines) out through the water tank overflow pipe. This overflow should be kept open at all times to allow the water to drain freely and keep the water level below the cutter disc and ice discharge opening. If the flushing solenoid valve leaks through during the freeze cycle, it can be disassembled and cleaned, then reassembled.

Cleaning Ice Making Section

Refer to Section 7, Maintenance for instructions for cleaning the circulating water tubes, water distributors, and water tank.

Float valve (make-up water)

The make-up water float valve (12) maintains the proper pumping level in the water tank for ice making. The valve should be set to maintain a water level in the water tank during the freezing period, so that there will be a quantity of blowdown only during the thaw mode. The water level during the freeze cycle should always be below the overflow piping to prevent excessive waste of cold water, resulting in loss of ice capacity.

If it should become necessary to clean the float valve, close the stop valve in the make-up water line to the machine and remove the float valve. After the valve has been cleaned and reinstalled, check to ascertain if the proper water level is being maintained. After the machine is stopped and the water in the tank seeks its normal level, there should be no water flow through the float valve or out the overflow.

It is advisable to install a large area strainer in the water supply line to protect the float valve from dirt or solids in the water that would necessitate frequent cleaning. A strainer of 40 mesh screen is usually satisfactory.

Capacitive Level Control

The control unit houses the "brains" of the Vari-Level[®], its digital readout, knobs for adjusting set points and differentials, and the relays themselves. Because the signal from the probe is unique, it requires the control unit to interpret and convert it to an understandable signal and display.

The control unit, which has a watertight enclosure, is mounted in an accessible area away from the movement of material and equipment. **CAUTION: Do not install conduit connections into top of control unit; water can condense in conduit and drip down on control unit electronics, causing failure.**

SERVICING OPERATIONS

See Section 6 of this manual for control unit electrical wiring diagram. Before connecting electrical power, check the voltage on the control unit nameplate and the power supply at the wire leads to be sure that they are the same. Supply voltage must be within +10% or -15% of listed voltage. Connect power supply leads to the quick disconnect plug (Terminals 1 & 2) and secure into the appropriate marked socket.

The probe is the device that actually measures the liquid level. It accomplishes this by sending a small, specialized signal out into the refrigerant liquid and vapor. This signal returns via the level column back to electronics inside probe housing. The strength of the returning signal is measured to determine level. This information is continuously sent to the control unit through the control cable.

When installing the probe, match its serial number with the control unit. Remove the probe from the packing crate, being careful not to bend or whip the probe. Use nonelectrically isolating pipe thread sealant (**do not use Teflon[®] tape**) on the 3/4" MPT fitting on the probe and insert in top of the level column. Tighten probe on hex; do not grip probe housing flats or electrical box. Pressure test for leaks.

Probes are supplied from the factory with 50 feet of shielded control cable. If the control unit is located less than 50 feet from probe, trim the control unit end of the cable as necessary. Securely place the control cable quick disconnect plug into the appropriate marked socket inside the control unit.

Setpoint and Operation. The level set point adjustment control is a slide knob with a scale in percentage of active probe length. The percentage relates to the liquid level in the column between the 3% level point and the 100% level point, as measured from the probe bottom end. The level set point has a level differential adjustment control which is a rotating knob scaled in percentage of active probe length from 2% to 20%. These percentages relate to the number of percentage points above or below the set point at which the particular relay position will change, as detailed in the next three paragraphs.

LOW LEVEL ADJUSTMENT—Not used on the P24F.

CONTROL LEVEL ADJUSTMENT

This set point is intended to maintain the level inside the vessel via a liquid refrigerant supply solenoid valve, "A1". The control level set point is the level at which make-up liquid will start to feed into the vessel. The level in the P24F should be between 20% and 40% and is dependent on make-up water and ambient temperatures. The differential adjustment control should be set at 2%. The filling indicator light (green) will be on when the relay is energized.

HIGH LEVEL ADJUSTMENT

This set point is intended to signal that the liquid level is becoming too high. The high level set point is the highest level that the liquid should ever reach before a compressor cutout occurs. The level in the P24F should be 70%. The differential adjustment control should be set at 2%. The high level indicator light (red) will be on when the relay is de-energized.

SIMULATION

The purpose of the built-in level simulator is to enable the level set points and differentials to be very accurately set and to be checked for proper system operation. Before entering the simulation mode, be aware of the following:

IMPORTANT: Control devices (solenoid valves, contactors, etc.) can operate while in the simulation mode. For calibration and electrical checkout, disconnect the main circuits of the compressor motor, pump motor, etc., where necessary to prevent damage, or remove the relay quick disconnect plug in control unit.

To enter simulation mode, depress and hold the simulation button; the amber simulation mode light will be on. When in simulation mode, the digital readout displays the simulated (pretend) liquid level. While continuing to depress the simulation button, use a small screwdriver in the other hand to rotate the level simulation adjustment screw to change the simulated liquid level and display. Observe the operation of the indicator lights. If necessary, make adjustments to level set point and differential knobs.

When the relay level set points and differentials are properly set, return the simulated level to a percentage value between the control and high level settings. This prevents the unexpected operation of relays during the next simulation. Simply release the simulation button to return to normal operation; the operation mode light (green) will come on. The value displayed on the readout will now become that of the actual liquid level in the level column and the relay positions will respond to this level.

RECALIBRATION

Control units are accurately factory precalibrated to a 3" level column for the specified refrigerant and the supplied probe. Recalibration may be necessary when a replacement probe or control unit is installed, especially if not "factory matched" by serial number. However, the zero point and at least one other point should be checked at the operating refrigerant temperature for the highest level of accuracy. It is ultimately the responsibility of the installer to ensure proper calibration for the specific application. If the control unit appears to be out of calibration, check for possible causes in the trouble-shooting guide on before attempting to change the calibration.

If recalibration is ever required, only two points need to be checked, typically the 0% and sight glass at 50% level point. Recalibration must be done in the order specified below.

To check the proper calibration at the 0% level, the level column should be free of liquid to below the probe bottom end. This can be accomplished by pumping the P24F down. With the probe end free of liquid, the control unit's digital readout should display -00%. If not, remove the seal on the low level calibration screw and adjust with a small screwdriver until the readout indicates -00%; replace seal.

The level column standard sight glass location is at 30%. Raise or lower the liquid level so that it is centered in the sight glass. The digital readout on the Vari-Level[®] control unit should display the same level as the sight glass, 30 % level. If not, remove the seal on the high level calibration screw and adjust until the digital readout displays the calculated sight glass, 30% level; replace seal. For greatest accuracy, recheck 0% calibration and readjust if necessary.

SERVICING OPERATIONS

Problem	Cause	Action
Digital readout and indicator lights do not display	<ol style="list-style-type: none"> 1. No power to control unit or wrong voltage. 2. Moisture in control unit or probe housing. 	<ol style="list-style-type: none"> 1. Check Voltage at terminals 1 and 2 in the control unit. 2. See Note 1 below.
Digital readout does not indicate level changes	<ol style="list-style-type: none"> 1. Fault in control cable. 2. No continuity between probe and level column. 3. Moisture in control unit or probe housing. 4. Probe wire loose. 	<ol style="list-style-type: none"> 1. See Note 2 below 2. Check for Teflon tape or other non-conductive pipe sealant at probe to column connection; replace sealant 3. See Note 1 below. 4. Open probe housing cover and check connection of probe wire (single wire lead) from probe center to terminal connection.
Solenoid valve (#20A) does not respond.	Blown fuse in control unit. Fuses located just above quick disconnect terminal strip.	Find reason for electrical fault and correct. Replace blown fuses.
Digital readout indicates too low a level compared to sight glass	<ol style="list-style-type: none"> 1. Control unit and probe serial numbers do not match. 2. Fault in control cable. 3. Moisture in control unit or probe housing. 4. Calibration not correct. 5. Calibrated for different refrigerant. 6. Insulating resistance of teflon enclosed probe rod is too low. 	<ol style="list-style-type: none"> 1. Contact factory if mate is not available. 2. See Note 2 below. 3. See Note 1 below. 4. See re-calibration instructions. 5. Contact factory for replacement. 6. See Note 3 below.
Digital readout indicates too high a level compared to sight glass	<ol style="list-style-type: none"> 1. Control unit and probe serial numbers do not match. 2. Fault in control cable. 3. Moisture in control unit or probe housing. 4. Calibration not correct. 5. Calibrated for different refrigerant. 6. Oil rich mixture in level column. 	<ol style="list-style-type: none"> 1. Contact factory if mate is not available. 2. See Note 2 below. 3. See Note 1 below. 4. See re-calibration instructions. 5. Contact factory for replacement. 6. Check for excessive oil carry over from compressor.
Intermittent high level.	<ol style="list-style-type: none"> 1. Rapid suction pressure pull down results in excessive boiling and liquid surging. 2. High level alarm point has been positioned too close to operating set point. 3. Moisture in control unit or probe housing. 	<ol style="list-style-type: none"> 1. Check time delay timer "DT" for proper operation. 2. Lower operating set point or raise high level set point. 3. See Note 1 below.
Occasional erratic level displayed on digital readout without actual changes in level.	<ol style="list-style-type: none"> 1. Moisture in control unit or probe housing. 2. Radio Frequency Interference (RFI) 	<ol style="list-style-type: none"> 1. See Note 1 below. 2. Find source of interference, such as mobile radios or transmitters, and disable. If unable, contact factory for arrestor device.

Note 1.

MOISTURE IN CONTROL UNIT OR PROBE HOUSING. Dry out control unit or probe housing. If appearance is dry, look for signs of moisture damage, such as white residue. Check cover gaskets, watertight cable connectors, and other water sealing joints, replace if worn. If a conduit connection is on top of the probe, carefully seal the inside to prevent condensation migration into the housing. Relocate any conduit connections on top of the control unit to the bottom, or seal the connections.

Note 2.

FAULT IN CONTROL CABLE. A symptom can be the digital readout display above 100% or below 0%. Check wires and matching color dots on quick disconnect plugs at the probe and control unit for proper connection. See page 9 for probe wiring diagram. Wires should be securely fastened and not frayed. Also check for continuity in the wiring.

Note 3.

INSULATION VALUE OF PROBE. The following procedure is only required if probe integrity is questioned. With the probe wire removed from its socket, check the insulating resistance of the Teflon[®]-enclosed probe rod using a 500V "Megger". Connect the positive side to the probe wire, the negative side to the probe housing. The result should be over 1000 Mega Ohms; halocarbon probes should be over 50 Mega Ohms. If not, contact the factory.

Trouble-shooting Guide for level controller

Hand Expansion Valve

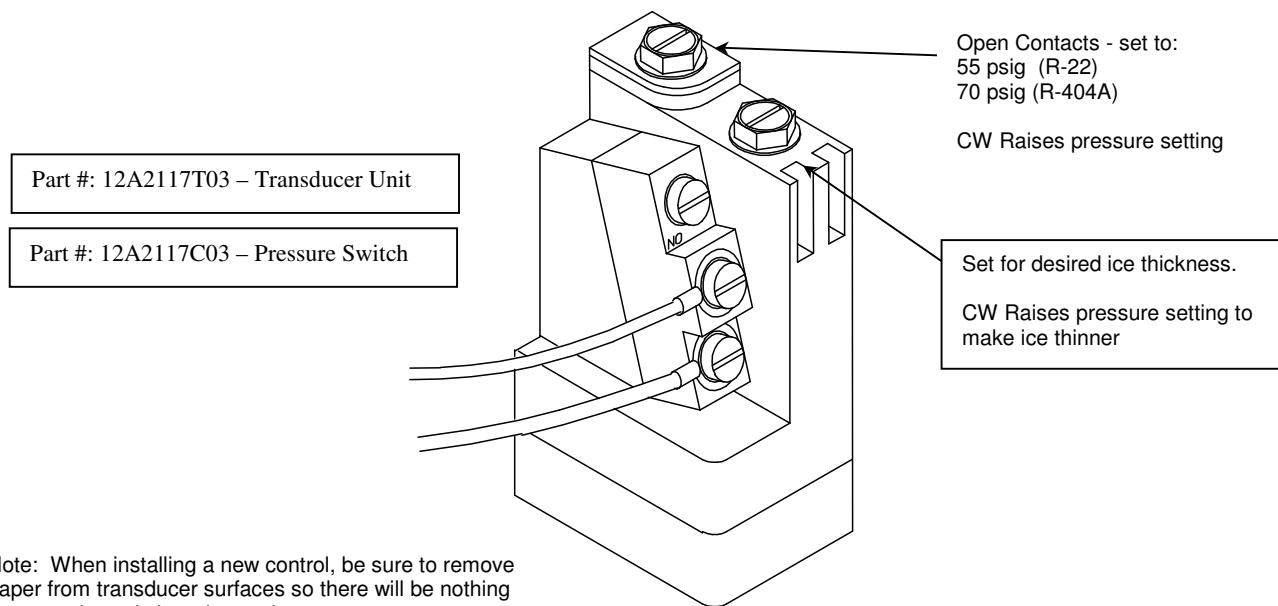
The hand expansion valve is located directly after the “#20A” solenoid valve. This valve should be set at a point where the float switch is open for a length of time approximately equal to the time it is closed.

Freezer Pressure Switch

The freezing time period for producing ice of a desired thickness is controlled by the freezer pressure switch (2PS), Figure 9-1, located inside the control panel.

The original switch was set at the factory to produce ice of recommended thickness. Look at the “Certificate of Test” which was provided with the machine for a sample set of pressure readings with corresponding time periods and water temperatures. Also see TABLE 11-5A, Operating Vitals for typical settings. When making adjustments, allow two ice discharging cycles between adjustments. Switch adjustment is as follows: See Figure 9-1.

1. Turn the low signal adjustment nut CCW until low signal setting indicator is fully down. Turn the high signal adjustment nut until high signal setting indicator is slightly beyond the actuation setting of 55 psig for R-22 or 70 psig for R-404a.
2. Starting with the pressure above the actuation pressure, reduce the pressure to desired actuation pressure of 55 psig for R-22 or 70 psig for R-404a, contact opens.
3. Advance the low signal adjusting nut until the switch actuates and contact closes.



Note: When installing a new control, be sure to remove paper from transducer surfaces so there will be nothing between the switch and transducer.

FIGURE 9-1
ASCO Freezer Pressure Switch (2PS)

It is preferable that the freezing cycle be such that a small diameter hole remain in the center of the ice cylinder (1/16” diameter for 7/8” diameter ice, 1/8” diameter for 1 1/8” diameter ice, 1/4” diameter for 1 3/8” diameter ice). This insures that the freezing cycle is not extended unnecessarily and eliminates a possible opaque core in the center of the ice, as well as a loss of production.

SERVICING OPERATIONS

High-Low Pressure Switch

The high-low pressure switch (1PS), Figure 9-2, is a two-pole dual function switch mounted to the frame near the compressor. It protects the machine from possible damage due to abnormal pressure during operation.

! CAUTION !
When this switch causes the machine to stop, the cause should be identified and corrected before resuming normal operation.
! CAUTION !

The LOW pressure cut-in should be set at 40 psig (R-22) / 55 psig (R-404a) and the cut-out set at 20 psig (R-22) / 35 psig (R-404a). After tripping at the cut-out setting, the switch will reset automatically when the pressure rises to the cut-in setting.

Loss of water pressure will cause frequent cut-out, also check freezer pressure switch operation.

The HIGH pressure cut-out should be set at 300 psig (R-22) / 300 psig (R-404a). After tripping, the switch must be reset manually. Lack of condenser water pressure or fouled condenser is generally the cause of a high pressure trip.

Note: Do not rely on the switch calibration for accuracy. For accurate adjustment, check settings with a test gage.

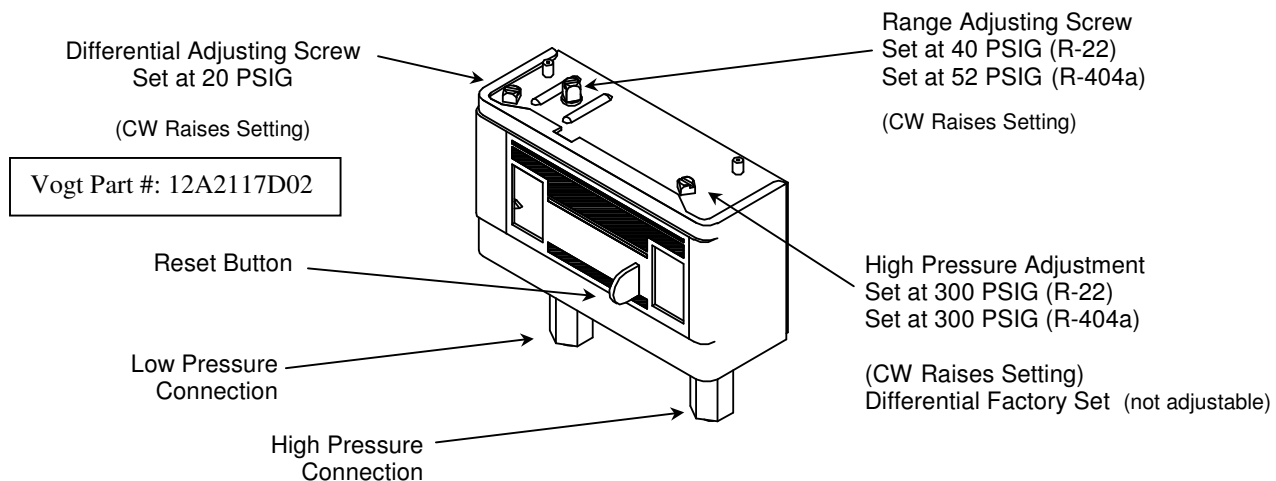


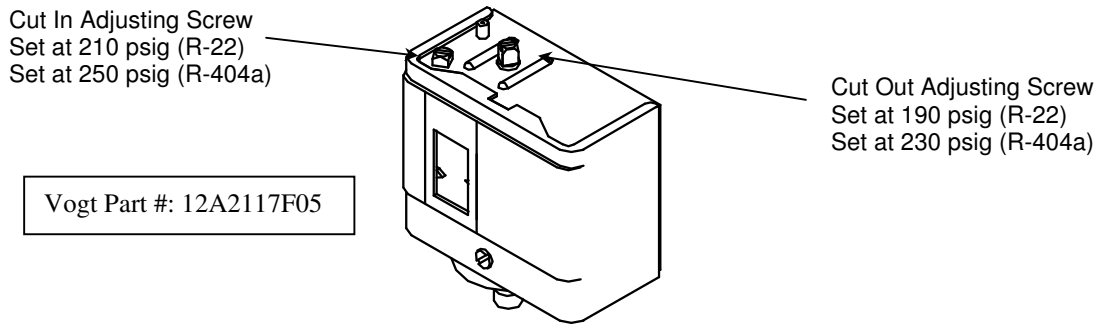
FIGURE 9-2
High-Low Pressure Switch (1PS)

Compressor Crankcase Heater

When electrical power is supplied to terminals 12 and 22 of the control panel (see Figure 6-3), the crankcase heater is energized when the compressor is not running. It is deenergized when the compressor is operating. The heater is designed to maintain a temperature of the oil in the crankcase at 100-110°F (38-43°C) when the compressor is not running. This will prevent the migration of refrigerant to the compressor during off periods.

Fan Control (cooling tower)

The fan control switch is used to cycle the cooling tower fan on and off, thereby maintaining the proper operating head pressure. This switch is mounted on the frame of your machine and should be adjusted to maintain a head pressure between 190-210 psig (R-22) / 230-250 psig (R-404a). The fan control supplies power to the starter coil for the tower fan motor(s) (6M not furnished by Vogt). See FIGURE 9-3 for adjustment instructions.



**FIGURE 9-3
Fan Control Switch**

Oil Pressure Switch

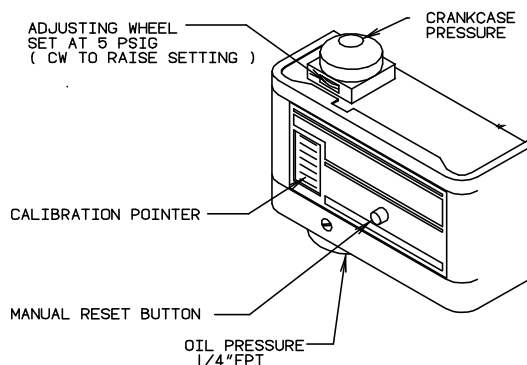
The compressor is protected by a manual reset type low oil pressure safety switch which is set at 15 psig. The oil pressure switch has a built-in 60-second time delay. If the net oil pressure (pump pressure minus suction pressure) falls below the switch setting for a time period of 60 seconds and the pressure does not increase at least 5 psi above the setting during that 60 seconds, the switch contact will open and stop the machine. After a period of time, as the delay heater cools, the switch can be manually reset and the machine restarted. The compressor should not be operated under low oil pressure or low oil level conditions.

If oil is added to the compressor crankcase to resume operation after a loss of oil, be sure to observe several cycles to make sure the oil level remains stable. See “Troubleshooting”, “Low Oil Pressure Switch Tripped”.

! CAUTION !

When this switch causes the machine to stop, the cause should be identified and corrected before resuming operation.

! CAUTION !



**FIGURE 9-4
Oil Pressure Switch**

SERVICING OPERATIONS

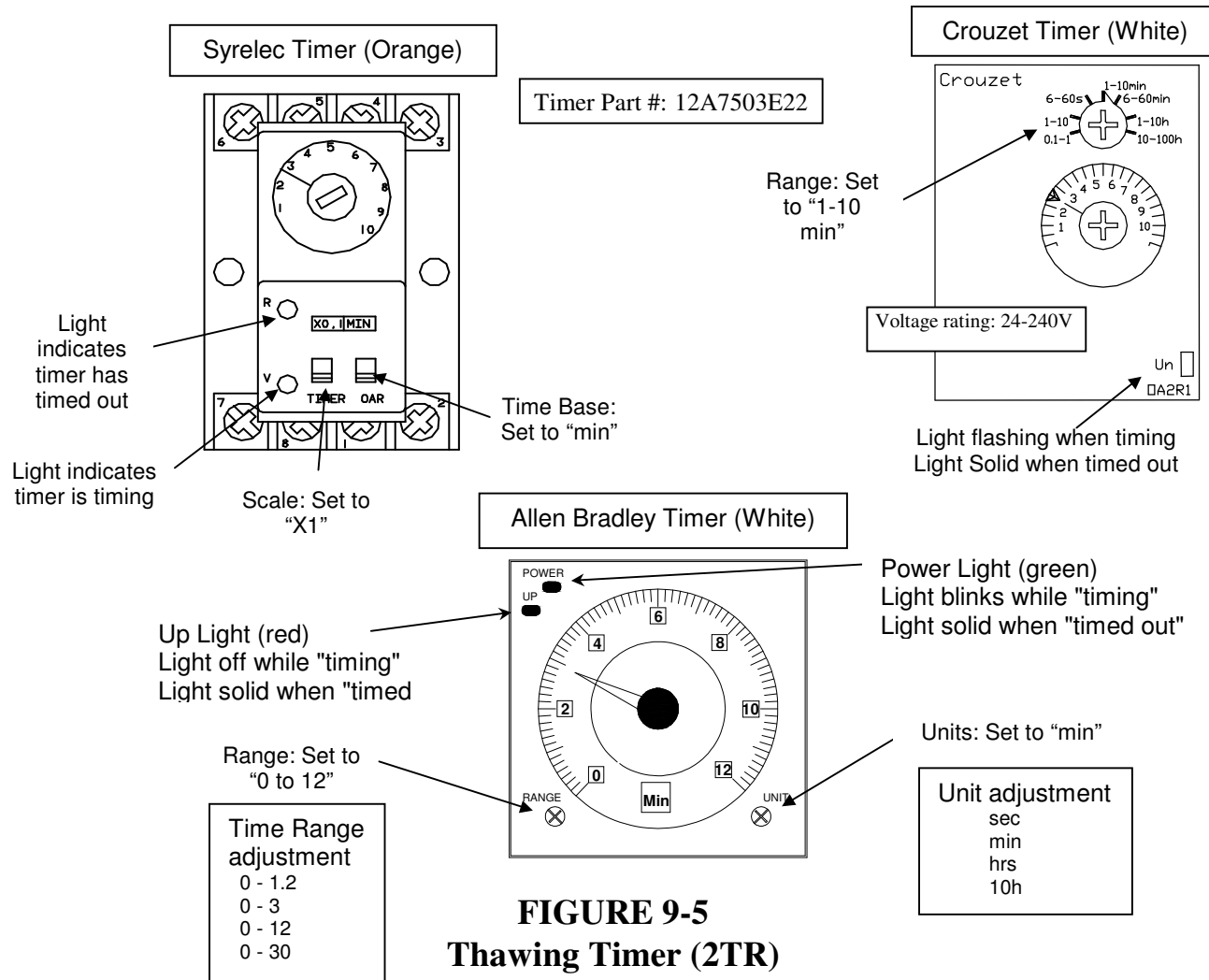
Control Circuit Protection

The electrical control circuit of the machine is protected by a 6 amp circuit breaker (CB4). If this breaker trips, the machine will immediately stop. Before resetting the circuit breaker, open the disconnect switch and lock-out all power to the control panel. Reset CB4 and restore power. Check circuitry with a voltmeter. If the machine was off for an extended time, the crankcase heater must be energized for a minimum of four (4) hours and no liquid refrigerant in the crankcase before restarting the machine. When ready to restart the machine, depress the "Start" button. As usual, initiate a harvest cycle if there is ice remaining in the freezer. Check Amp draw through the breaker for excessive load or unbalance.

Thawing Timer

The thawing timer (2TR), Figure 9-5, governs the ice thawing period. It is located inside the control panel (FIGURE 6-1). It is started by action of the freezer pressure switch (2PS) which energizes the "1CR" relay. This timer is set prior to shipment for approximately a three minute period. To replace the timer, simply pull the timer from its base and plug in another, set to "X1" and "Min" and set the thawing period for at least 30 seconds longer than the time required to harvest the entire discharge of ice. If it should be necessary to change the setting of the timer, turn the adjustment dial clockwise to increase the time or counter-clockwise to decrease the time. Check thaw time after each adjustment.

Note: Thicker ice may require a longer thaw period, due to slower ice release time.



Condenser Cleaning

There are 124 - 1 1/4" OD x 84" long steel tubes in the P24F condenser/ receiver. These tubes are approximately 1 1/32" inside diameter. Any brush or cleaning tool should be sized accordingly so as not to damage the tubes during cleaning. The cleaning tools should be rotated at the specified speed for the particular tool used. The tubes should be kept wet during cleaning. After cleaning, the tubes should be flushed thoroughly and all foreign material removed. Contact your distributor or Vogt's Service Department to obtain the proper cleaning tools.

The following is the condenser cleaning procedure:

1. Refer to the space diagrams, Section 2, to make sure ample room is provided for removing the condenser heads and using the mechanical cleaning equipment.
2. Order replacement cover gaskets for use at the time of reassembly.
3. Disconnect and lock-out power to the ice machine and auxiliary equipment.
4. Disconnect water piping and drain the condenser. Loosening the cover (heads) hex nuts and separating the covers from the condenser end will drain additional water.
5. Remove the heads, stud bolts, and gasket completely.
6. Inspect the tubes for excessive corrosion and possible refrigerant leaks. Determine whether or not further cleaning is feasible.
7. Clean the inside of each tube as well as possible, being careful not to damage the tube. Follow the instructions for the particular tool being used.
8. Flush each tube with water to remove all loose material and prevent contamination of the cooling tower and sump.
9. Clean the ends of the tube sheets, so the new gasket will seal properly.
10. Insert the stud bolts to the proper depth and install the replacement gasket. Make sure the gasket does not cover the extended tube ends.
11. Install the end covers (heads) and fasten securely in place with the hex nuts.
12. Reconnect the water piping and turn on the power. Check for leaks by turning the Hand-Auto switch to Hand allowing the condenser pump to run.
13. Turn the switch back to Auto and wait for the crankcase heater to warm-up compressor before starting the machine.

SERVICING OPERATIONS

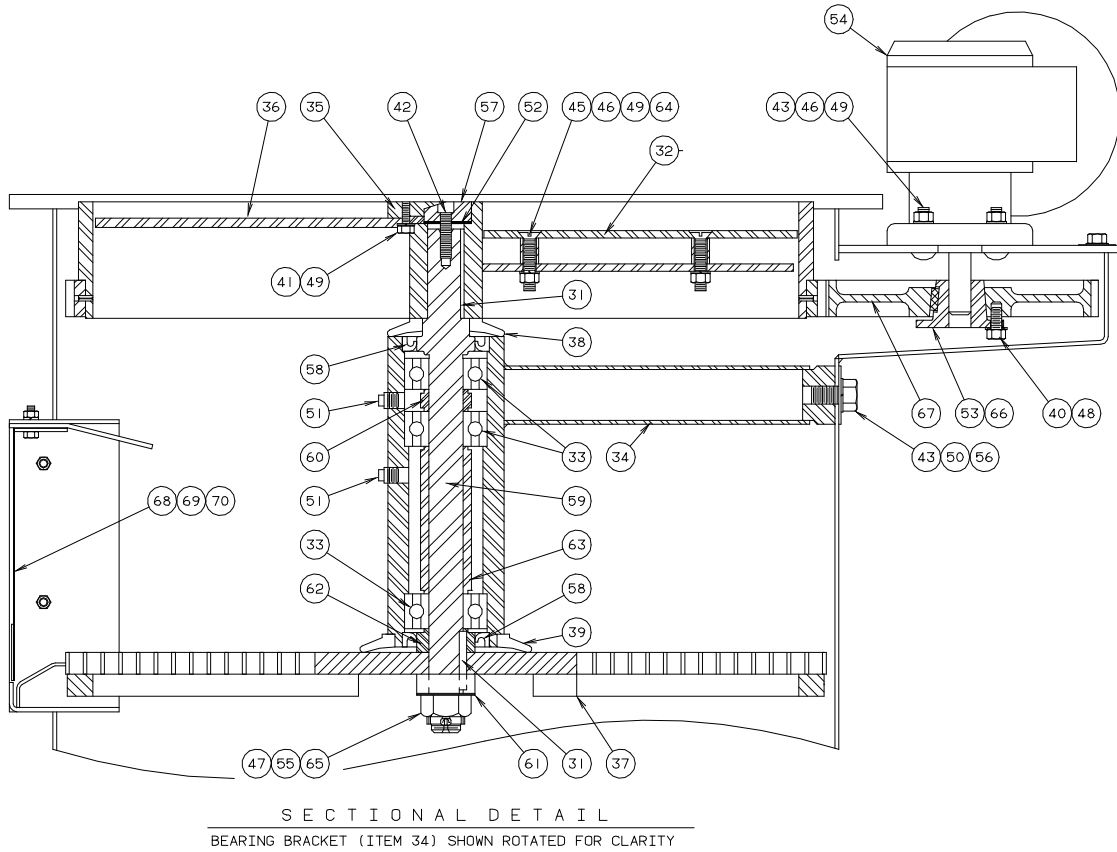


Figure 9-5A
P24F Cutter Assembly

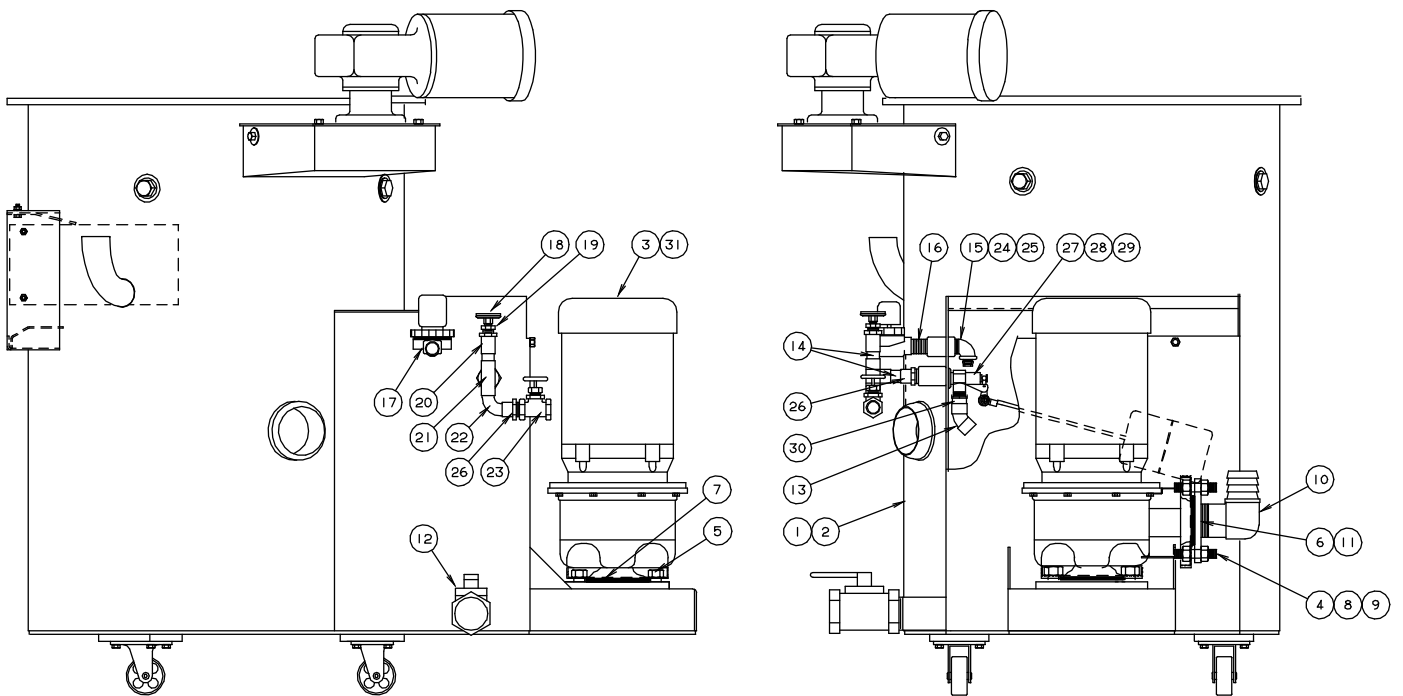


Figure 9-5B
P24F Water Tank Assembly

SERVICING OPERATIONS

Item #	Description	Vogt Part #
1	Water Tank Assembly	19T4500S24
2	Water Box Cover (Not Shown)	19T2150C01
3	Water Pump	See Pump Model #
4	5/8"-11 NC x 3" Long S.S. Stud	12A2222L1119
5	5/8"-11 NC x 2" Long S.S. Stud	12A2222L1115
6	2" Red Rubber Gasket	12A2600R07
7	2 1/2" Red Rubber Gasket	12A2600R08
8	5/8" S.S. Hex Nut (8)	12A2240A113
9	5/8" S. S. Lock Washer (8)	12A2250B113
10	PVC Ell 2" MPT x Insert	12A2450E12
11	2" PVC Round Flange	12A2535F0706
12	2" FPT Valve	12A4200G1401
13	WC 45° Ell 7/8" ODC	12A2409W0006
14	7/8" OD Copper Tubing	12A4180A0008
15	3/4" MPT x FPT PVC 90° Ell	12A2450E07
16	3/4" S.S. Pipe Nipple	12A3050S0401
17	3/4" FPT Solenoid	12A4200A0607
18	Thermometer	12A4170T01
19	1/2" MPT x 1/4" Brass Bushing	12A2451B03
20	1/2" FPT x 7/8" ODC Adapter	12A2401W012
21	WC Tee 7/8" ODC	12A2422W0009
22	WC 90° Ell 7/8" ODC	12A2417W0004
23	3/4" Brass Service Valve	12A4205G0601
24	3/4" MPT x 1/2" PVC Bushing	12A2450B04
25	1/2" MPT x 1/4" PVC Bushing	12A2450B05
26	3/4" MPT x 7/8" ODC Adapter	12A2400W0023
27	3/4" MPT Float Valve	12A4200H0601
28	Float Valve Stem	12A4200HP01
29	Valve Float	12A4200HP02
30	WC 3/4" FPT x 7/8" ODC Adapt.	12A2401W0007
31	Key 1/4" x 1/4" x 3 3/16" S.S.	12A2785S04
32	Cutter Adapter Plate	19T2010A11
33	Bearing	12A2020M02
34	Bearing Bracket	19T2025B0105
35	Cutter Blade	19T2035B01
36	Breaker Cutter Assembly	19T2160C0401
37	Tines Disc Assembly	19T2163D0302

Item #	Description	Vogt Part #
38	Top Excluder	12A2210E01
39	Bottom Excluder	12A2210E04
40	Cap Screw, 5/16-18 x 1" S.S. (4)	12A2215G111
41	Cap Screw, 3/8-16 x 1" S.S. (8)	12A2215H111
42	Cap Screw, 3/8-16 x 1"	12A2215H611
43	Cap Screw, 5/8-11 x 1 1/2" S.S. (4)	12A2215L1113
44	Carriage Bolt, 3/8-16x1 1/4" (4)	12A2218H1112
45	Mach Screw 3/8"-16 x 2" Flat (8)	12A2226H1115
46	Hex Nut, 3/8-16 S.S. (12)	12A2240A1309
47	Slotted Nut, 1-14 NF S.S.	12A2240E1216
48	Lock washer 5/16" S.S.	12A2250B108
49	Lock washer 3/8" S.S.	12A2250B109
50	Lock washer 5/8" S.S.	12A2250B113
51	1/4" S.S. Sq. Head Pipe Plug (2)	12A2475T0001
52	Gasket, 3/4" OD x 7/16" ID	12A2600R02
53	Key, 3/8" x 5/16" x 3/4" S.S.	12A2785S01
54	Cutter Motor / Gear Reducer Combo	12A2900M0704
	Gear Reducer only	12A4030R1
	Cutter Motor only	12A2900M0705
55	Cotter Pin, 3/16" x 1 1/2" S.S.	12A3040S06
56	Cutter Support Washer	19T4001S0224
57	Retainer	19T4065R0100
58	Seal	12A4080S02
59	Cutter Shaft	19T4090S0300
60	Upper Bearing Spacer	19T4130C0100
61	Tines Disc Spacer	19T4130C0200
62	Seal Spacer	19T4130C0300
63	Lower Bearing Spacer	19T4130C0400
64	Spacer, 5/8" OD x 7/8" Long (8)	19T4130T0400
65	Disc Spring	12A4138S01
66	Split Taper Bushing	12B2060B04
67	Drive Gear	12B2615D03
68	Splash Curtain Holder	19T4001S0162
69	Splash Curtain Bottom Plate	19T4001S0415
70	Splash Curtain	12A4078C03

SERVICING OPERATIONS

Cutter Gear Reducer

The cutter motor and gear reducer (54), Figure 9-5A, drive the ring gear of the cutter assembly. It is important that the teeth of the drive gear and the ring gear mesh properly both vertically and horizontally. The drive gear and hub can be raised or lowered on the gear reducer shaft to obtain maximum vertical tooth engagement and the reducer assembly can be moved in or out horizontally to obtain the proper tooth depth for maximum gear life.

Note: The motor and gear reducer are an integral unit. Only qualified personnel should attempt to disassemble and repair this unit.

Drive Gear Replacement

1. Disconnect and lock-out all power to the machine.
2. Remove the top and side bolts holding the mounting plate to the support bracket. Lift the plate and gear reducer from the bracket and rest the assembly on a stable work table sitting next to the tank. Leave the electrical conduit connected to the gear reducer motor.
3. Inspect the drive gear teeth for proper vertical alignment and wear pattern.
4. If the wear pattern indicates less than a full width of tooth engagement, measure the difference and make a note to correct at the time of reassembly.
5. Measure and record the dimension from the drive gear to the bottom side of the mounting plate.
6. Remove the three or four cap screws holding the drive gear to the split taper bushing.
7. Using two of the same cap screws in the threaded holes of the bushing, jack the gear off the bushing and remove both from the gear reducer shaft.
8. Clean the split bushing and tapered hole of the new drive gear and insert the bushing into the drive gear making sure the tapers match.
9. Slide the split hub and gear onto the keyed shaft with the key in place, positioning the hub (by measurement previously recorded) so the full width of the gear teeth will engage when assembled and tightened.
10. Tighten the cap screws (three or four) progressively and uniformly around the hub and recheck the location measurement. If it is not correct, loosen the cap screws, hub and gear assembly and make correction. Then retighten the cap screws.
11. Install the reducer and mounting plate assembly on the water tank bracket and fasten in place with the side and top cap screws.
12. Rotate the cutter and disc assembly by hand and stop at the point where you feel the least amount of backlash between the gear teeth.
NOTE: There should be only a slight amount of backlash (more specifically “tooth tip clearance”). Too much clearance will cause premature wear and possible tooth damage. When the cutter runs under a no load condition, it should have a smooth uniform sound. For lubrication, see Section 7, Maintenance.
13. If the tooth tip clearance needs adjusting, loosen the four hex nuts holding the reducer to the mounting plate and move the reducer as required for proper tooth engagement. Tighten the hex nuts securely and recheck backlash.

Gear Reducer Replacement

1. Disconnect and lock out all power to the machine.
2. Disconnect electrical wires and conduit from the motor.
3. Remove the top and side bolts holding the mounting plate to the support bracket and lift the plate and gear reducer assembly from the tank bracket.
4. Inspect the drive gear teeth for proper vertical alignment and wear pattern. If the wear pattern indicates less than a full width of tooth engagement, measure the distance so correction can be made at the time of reassembly.
5. Measure and record either the distance of the drive gear from the mounting plate or the split hub from the shaft end for future reference when reassembling.
6. Remove the three or four cap screws from the split taper bushing.
7. Use two of the cap screws in the threaded holes of the bushing as jacking screws for pushing the drive gear from the hub.
8. Drive a wedge in the split of the hub (bushing) and slide both the hub and gear from the shaft.
9. Remove the four hex nuts and lock washers from the carriage bolts around the reducer base and mounting plate and separate the plate and reducer.
10. Install the replacement gear reducer and motor onto the mounting plate using the carriage bolts, lock washers, and hex nuts. Tighten the nuts snug only for later adjustment.
11. Clean the split hub and drive gear, insert the hub into the gear, making sure the tapers of the two match and slide the hub and gear onto the shaft.
12. Position the hub on the shaft (note measurements previously taken) so the full width of the gear teeth will engage when assembled and tightened.
13. Tighten the cap screws (three or four) progressively and uniformly around the hub, checking the measurements and adjusting as necessary.
14. Install the reducer and mounting plate assembly on the water tank bracket and fasten in place with the side and top cap screws.
15. Rotate the cutter and disc assembly by hand and stop at the point where you feel the least amount of backlash between the gear teeth.
16. If the gear tooth tip clearance needs adjusting, loosen the four hex nuts around the reducer base and move the reducer as required for proper tooth clearance. Tighten the hex nuts securely and recheck for backlash.
17. Reconnect the electrical wires and conduit to the motor.
18. Check cutter rotation and correct as necessary.
NOTE: When the cutter runs under a “no-load” condition, it should have a smooth uniform sound.

The weights listed in TABLE 9-1 will give you an idea of manpower or equipment needed when servicing and handling the various parts of the water tank and cutter. Be sure to use safe lifting and handling practices to prevent bodily injury and/or damage to parts. If additional information is needed, you should contact your distributor or the factory.

SERVICING OPERATIONS

To inspect the cutter assembly and make repairs or replace parts, it will be necessary to lower and remove the water tank from its mounting to the bottom of the freezer. The water tank has metal casters allowing it to be rolled out from under the freezer for inspection and servicing.

Description	P24 Weight (lbs.)
Water tank (bare)	333
Bearing bracket assembly and cutter disc	106
Cutter assembly and ring gear	89
Water tank and cutter assembly	528
Cutter disc	57
Cutter drive gear	8
Gear reducer and motor	56
Water pump	85

TABLE 9-1
Water Tank and Cutter Parts Weights

Water Tank Removal

1. Disconnect and lock-out all power to the machine.
There should be ample space to roll the water tank from under the machine. It may be necessary to provide a flat level surface such as a sheet of plywood sufficiently supported to hold the weight of the tank and cutter assembly. See TABLE 9-1.
2. Turn off water supply, drain water, and disconnect water and drain lines from the tank.
3. Remove the overflow tubing from the water tank and remove the circulating water tubing from the pump.
4. Disconnect the ice discharge chute or hopper from the ice discharge opening of the water tank, making sure the tank is free to be moved.
5. Remove the mounting bolts from around the flange of the tank, allowing the tank to be lowered to rest on its casters.
6. Roll the water tank from under the freezer, turning it as you go to clear the gear reducer and motor. It is now accessible for inspecting and/or repair of the cutter assembly.

Cutter Assembly Removal and Installation

1. Follow water tank removal instructions, Steps 1-7. See Figure 9-5B.
2. Remove the socket head cap screw from the center of the cutter shaft and lift out retainer and gasket.
3. Lift the cutter straight up and off the shaft, taking care to catch the shaft key as it is removed.
4. To install the cutter, lower it down onto the shaft, allowing the ring gear to mesh with the drive gear.
5. Rotate the cutter, aligning the shaft and hub key way, and inserting the key to its full depth.
6. Install the gasket, retainer, and socket head cap screw and tighten to approx. 15 ft.-lb. torque.
7. Check and adjust the cutter height per "Cutter Height Adjustment" instructions.

Bearing Bracket and Cutter Disc Removal

1. Remove the cutter assembly per instructions.
2. Match mark the bearing bracket support arms with the water tank for reassembly reference.
3. Remove the splash shield and ice deflector plate from the ice discharge opening.
4. Support the bearing bracket to keep it from falling in the tank. Loosen and remove the four cap screws and lock washers from the ends of the bearing bracket support arms.
5. Lift the bracket and cutter disc from the tank. Be sure the support arms are match marked for reassembly. You may have to gently drive the support arms up or down to release them from the tank walls.
6. With the bracket and disc assembly turned upside down, remove the cotter pin from the shaft.
7. Loosen and remove the slotted hex nut, spring washer, and spacer.
8. Lift the cutter disc from the keyed shaft, being careful not to loose the shaft key.

The cutter shaft and bearings are sealed in the bearing bracket assembly. The cavity between the bearings has been filled with a food-grade grease to prevent the presence of moisture and prolong the life of the unit. If there is any vertical or side movement of the shaft or if the bearings feel rough or tight when turning the shaft, the assembly should be dismantled and rebuilt. Refer to the cutter tank assembly drawing, Figure 9-5B, for parts location and identification.

Cutter Shaft and Bearing Removal

Note: Use only a soft mallet or other soft tool for fitting all parts into place.

1. With the bearing bracket assembly removed from the tank, press the shaft out of the housing from the bottom up.
Note: The two top bearings may come out with the shaft along with the upper seal and excluder.
2. Turn the bracket over and press the bottom bearing out the bottom, along with the lower seal.
3. There are three spacers on the shaft that should be removed and labeled as to their location. Remove them as they are made accessible.
4. Clean and inspect all parts for wear or damage. Discard all parts showing any indication of damage.

SERVICING OPERATIONS

Cutter Shaft and Bearing Installation

1. Clean the inside of the bearing housing of grease or foreign matter. Further clean the top bearing housing with pro-lock cleaner and primer (or a suitable substitute) and remove the pipe plugs from the side of the housing.
2. Apply a thin coat of Loctite[®] RC/609 retainer (or a suitable substitute) to the inner surface and bearing shoulder of the top of the bearing bracket.
3. Insert a bearing in the top housing and set it in place.
4. Clean the cutter shaft and press the top bearing onto the shaft.
5. Slide the upper bearing spacer on the shaft and begin driving the shaft down through the middle bearing of the housing. Do not start the top shaft bearing in the housing.
6. Partially fill the housing with grease (MPG-2 or a USDA approved grease). Use enough to fill the area between the two upper bearings, forcing some out the pipe plug hole when the shaft and top bearing are seated.
7. Finish driving the shaft and bearing into the housing until it is firmly seated.
8. Turn the bracket and shaft upside down and fill the housing around the shaft with MPG-2 (or suitable substitute) grease.
9. Slide the lower bearing spacer over the shaft and into the housing.
10. With the top end of the shaft supported, install the lower bearing on the shaft driving it down into the housing firmly against the housing shoulder.
11. Slide the seal spacer (ridged end in, flat end out) and seal (open face out) onto the shaft together.
12. Uniformly tap the seal into the housing against its shoulder.
NOTE: The purpose of the seals and excluders are to prevent moisture from entering the housing area not to hold the grease in.
13. Wipe off excess grease and install the two pipe plugs.
14. Install the largest excluder on the bracket as illustrated by the assembly drawing.
15. Install the tines disc, the 1/4 x 1/4 key, spacer, spring washer, castle nut, and cotter pin.
16. Turn the assembly right side up and install it in the water tank, locating the support arms as they were match marked when removed, and secure in place using the 5/8" stainless steel cap screw and lock washer (maximum torque should be 90 ft. lbs).
17. Install the top seal (open side facing out*), tapping it uniformly into the housing until it seats.
18. Install the top water excluder.
19. Install the splash shield and ice deflector plate in the ice discharge opening.
20. Install the cutter assembly, using the 1/4" X 1/4" X 3 3/16" lg. stainless steel key to align the key ways and lock the cutter and shaft together.
21. Install the red rubber gasket, retainer, and 3/8" stainless steel socket head cap screw. Tighten to approximately 15 ft. lbs.
22. Check and adjust the cutter height per "Cutter Height Adjustment" instructions.

Cutter Height Adjustment

The height of the cutter can be adjusted by the four bolts holding the bearing bracket assembly in place. These bolts are threaded into holes in the end of each arm through holes in the water tank. The current design has these washers welded in place after the cutter height is properly adjusted. This helps to insure proper adjustment during servicing. Using a true straight edge long enough to reach across the top flange of the water tank (30" for P24 and 40" for P34), the top of the cutter rim and blade should be $1/8" \pm 1/16"$ below the top of the water tank flange.

Keep one end of the straight edge at the same point and swing the other end across the tank at various points to check the clearance.

Also, rotate the cutter to check all points. If adjustment is necessary, loosen the four side bolts and raise or lower each arm as needed. Tighten the bolts securely to approximately 90 ft. lb.

Water Tank Installation

1. Place the $3/16"$ thick gum rubber gasket on the top of the tank flange. It can be held in place with narrow strips of tape through the bolt holes.
2. Push the water tank in and under the freezer aligning the bolt holes and installing the mounting bolts around the flange and tightening the nuts securely.
3. Reconnect the discharge chute or hopper to the ice discharge opening.
4. Mount the water pump (P34 only) and attach the circulating water tubing and overflow tubing.
5. Reconnect all water piping such as drain, overflow, and make-up water lines. Turn water on and check for leaks.
6. Fill the water tank with water and make sure the drain valve is closed.

When ready, turn the power "On" to the machine, but don't operate the compressor until the oil is warm and there is no liquid refrigerant in the crankcase.

SERVICING OPERATIONS

Cutter Ring Gear Replacement

1. Remove the water tank assembly (see water tank removal).
2. Remove the cutter assembly from the cutter shaft.
3. Remove the (6) 3/16" drive pins that hold the ring gear to the cutter bank.
4. The ring gear is a shrink fit onto the cutter bank and therefore will have to be driven off. It should be driven off progressively and uniformly around its circumference to avoid binding.
5. Inspect and clean the cutter band, removing any burrs, scale, or dirt.
6. Attempt to put the new gear onto the cutter and check for fit. If it will not fit, it will have to be expanded by heat.
7. Move the ring gear away from the cutter and heat the gear uniformly to 300-400°F (150-205°C). This can be done by passing a hand/held oxy/acetylene torch uniformly over the entire ring gear. **DO NOT HEAT THE CUTTER.**
8. Align the valley of the ring gear teeth with the existing drive pin holes and carefully set the ring gear onto the cutter. Make sure it is fully seated all the way against the machined shoulder of the cutter bank.
9. After the gear has cooled, drill 3/16" holes in the valley (between the teeth) of the ring gear and install the drive pins. Make sure the drive pins do not protrude and interfere with the engagement of the drive gear.
10. Install the cutter assembly onto the shaft.
11. Check and adjust cutter height and meshing of the gear teeth.
12. Install the water tank assembly.

Cutter Blade Replacement

The cutter blades are designed to give many years of satisfactory service and rarely need to be replaced. If they become damaged, they can be replaced by the following procedure.

1. Disconnect and lock-out all power and remove the water tank assembly so the cutter assembly is accessible. (See water tank removal).
2. Remove the 3/8" cap screws holding the blades to the cutter plate and remove the blades.
3. Set the new blades in place and install the cap screws and washers but do not tighten.
4. Refer to FIGURE 9-6, adjust each blade to dimension "A" and lock the blade in position by tightening the 3/8" cap screws. Note: Use a 90° square (as illustrated) to obtain the proper blade clearance required for satisfactory ice discharge. Dimension "A" is critical and should be measured at both ends of the blade. Note: 3/8" x 1" cap screw must be flush with cutter blade.
5. Make sure all bolts and nuts are tightened securely then reinstall the tank assembly.

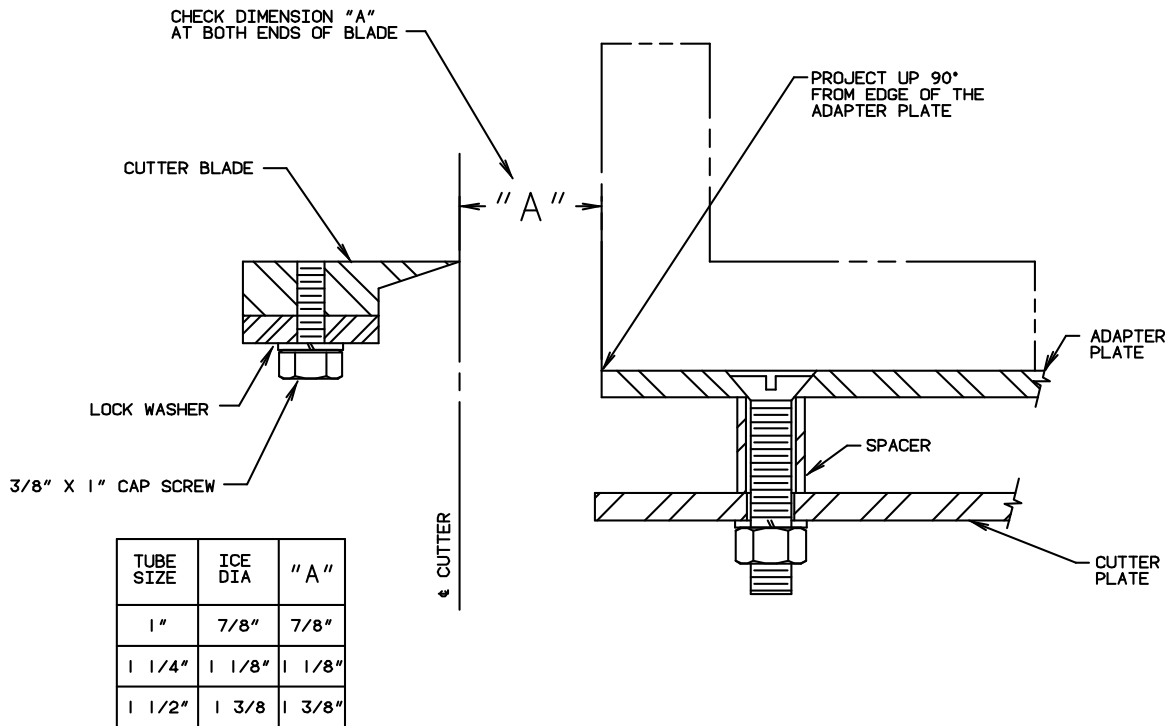


Figure 9-6
Cutter Blade and Adapter Plate Adjustment

Cutter Adapter Plate Installation

1. Disconnect and lock-out all power to the machine and remove the water tank assembly so the cutter is accessible (see water tank removal).
2. Locate the new adapter plate, holding the correct dimension "A" from the edge of the plate to the edge of the blade. See Figure 9-6.
3. Using two C-clamps to hold the adapter plate securely in place, drill four 7/16" diameter holes through the adapter plate and through the cutter plate at the same time so they will adjoined properly.
4. Countersink the holes in the adapter plate to make the bolt heads flush with the plate.
5. Install bolts and spacers as illustrated and tighten securely. Note: the length of ice is determined by the spacer length. Refer to "Ice Length" for details.
6. Install the water tank assembly to the machine.
Note: Length of cylinder ice can be changed. See Section 10.

SERVICING OPERATIONS

Pumpdown

The function of the pumpdown is to transfer the liquid refrigerant from the freezer (evaporator) into the receiver. Pumpdown should only be performed when the freezer is clear of ice. Its main purposes are:

1. To check the total refrigerant charge.
2. To perform service or repair work on the machine.
3. To winterize the machine.
4. To remove excess water from the refrigerant.
5. To prepare the machine for disconnection or moving.

To perform a pumpdown, follow this procedure:

1. With the machine running, close the liquid feed stop valve (58) nearest the receiver.
2. Open the water tank drain valve partially to allow a continuous flow of warm make-up water into the water tank and still maintain a good level in the tank. An auxiliary supply of warm water (not to exceed 100°F) may be used if available. Warmer water affords a more complete pumpdown.
3. Allow the machine to operate and complete two freeze and harvest cycles.
4. After the second harvest cycle, unplug the harvest timer.
5. Let machine run until machine shuts off on the compressor low pressure switch at approximately 15 psig. Lower pressure can be obtained by lowering the setpoint on the switch (see Figure 9-2). Do not operate the machine below 2 psig. This could cause non-condensables to be drawn into the machine if a vacuum is achieved.
6. When the desirable pumpdown is obtained, close the thawing gas stop valve, #90, and the discharge line stop valve, #55. Other valves may also be closed to isolate a particular area, which may require attention.
7. To perform a total pumpdown, it may be necessary to apply heat directly to the bottom of the freezer in order to boil off the liquid refrigerant and oil mixture.

Removal of Refrigerant from the Machine

Liquid refrigerant can be removed from the machine through the receiver drain valve, #44. Refer to Sections 1, 2, and Appendix "A" for special warnings and instructions regarding the handling of refrigerant. Make sure you are familiar with and technically qualified to handle R-22 or R-404a refrigerant.

! WARNING !
It is not recommended that refrigerant to be transferred from a refrigeration system directly into a cylinder. If such a transfer is made, the refrigerant cylinder must be an approved, CLEAN cylinder--free of any contaminants or foreign materials--and must be weighed continuously to assure contents do not exceed net weight specified by cylinder manufacturer of any applicable code requirements.
! WARNING !

Note: Observe all local codes when handling R-22 or R-404a refrigerant.

Refrigerant Leaks

Refrigerant leaks can be detected by an electronic leak detector. Apply a solution of soap and water with a narrow brush or spray bottle to all joints, welds, or areas of suspicion. The solution will form bubbles if there is a leak.

Non-condensable Gasses

Satisfactory operation of the machine is not possible if non-condensable gases (usually air) are present in the system. Excessive condensing pressure is an indication of such gases. Excessive condensing pressure in water-cooled condensers may also be due to the accumulation of scale in the cooling coil or due to insufficient cooling water or excessive water temperature. See “Water-Cooled Condensers”, Section 7. and Section 9 “Condenser Cleaning”.

Non-condensable gas effects are:

1. Higher condensing pressure than desired.
2. Greater electrical power consumption.
3. Reduced refrigeration capacity.
4. Longer than normal compressor running time.
Slow ice release and long thaw cycle.

Air collects mostly in high pressure condensers, receivers, and other high-pressure components. It collects mostly in the coolest, lowest-velocity area of these components.

Water Contamination of R-22 or R-404a Refrigerants

Water in the refrigerant can cause a slow ice discharge, erratic operation, and dilution of the oil. This can result in freeze-up, refrigerant carry-over and compressor failure. This condition should not go uncorrected, and the water should be immediately removed. There are two options for water removal from the refrigeration system. The first and best alternative is removal of all refrigerant and oil from the system, followed by vacuuming and recharging according to the procedure outlined in Section 5. The second is reclaiming and reconditioning the refrigerant and oil.

Circulating Water Pump Motor

The motor bearings are prelubricated and sealed. They require no further lubrication. The pump should operate with the water level above the impeller housing.

The pump is equipped with a mechanical seal that is self-adjusting and requires no lubrication. However, the pump should not be operated with no water in the water tank. The pump manufacturer recommends that a mechanical seal be kept as a spare. When ordering a seal, specify pump size, type, serial number, and manufacturer's name as indicated on the nameplate.

SERVICING OPERATIONS

Solenoid Valves

The P24F is equipped with several solenoid valves that perform various functions during the ice producing process.

The Thaw Gas Solenoid Valve

This valve opens during the thaw cycle to allow warm gas to pass from the receiver to the freezer. Repair or replace as follows:

1. With the receiver pressure higher than the freezer pressure, manually open the valve by turning the manual stem in until you hear gas passing through the valve.
2. Close the two hand stop valves (#90) tight on either side of solenoid valve when there is vapor only in that part of the line.
3. Loosen the 1/4" tubing compression nut at the strainer slightly to reclaim that section of the thaw gas line and continue to reclaim until all pressure is relieved.
4. Repair or replace the valve as needed making sure all connections are tight.
5. With the valve manually opened (stem in), open slightly only one stop valve #90 and purge air from the line through the 1/4" tubing compression nut at the strainer. Then close that valve #90 and open the other #90 valve to purge air from that section of the line.
6. When reclaiming is complete, tighten the compression nut, and manually close the solenoid valve.
7. Reopen stop valves #90 and check for leaks.
8. Assure that the pressure is 65-70 psig (R-22) / 82-89 psig (R-404a) in the freezer during harvest.

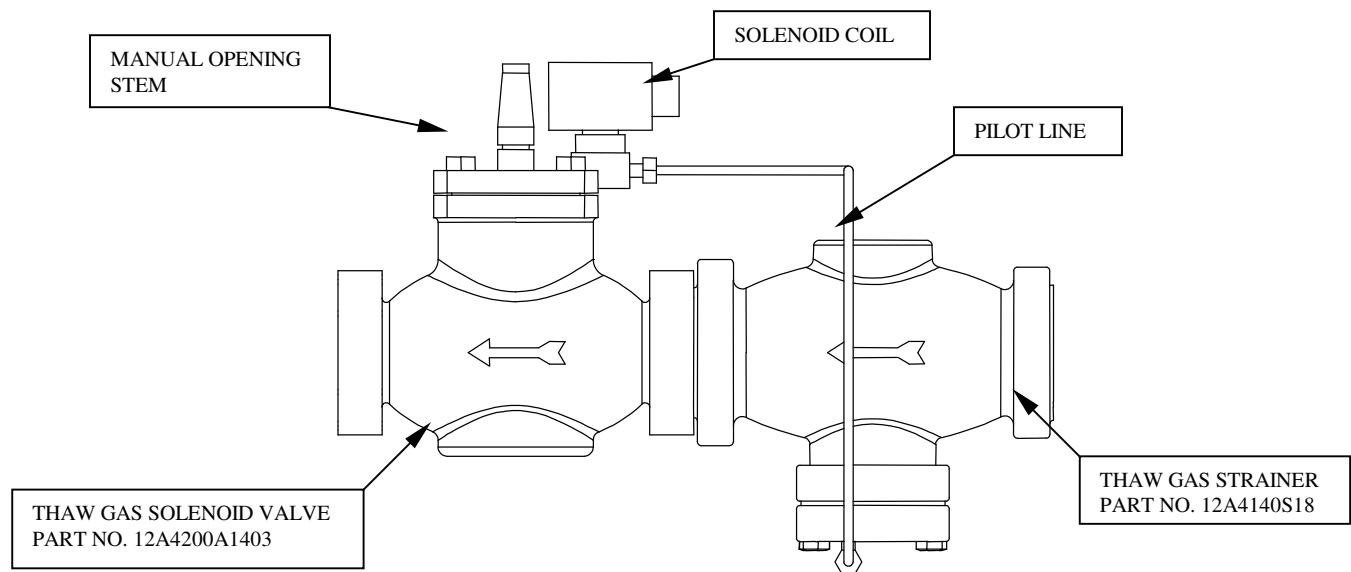


FIGURE 9-7
Thaw Gas Solenoid Valve

The Liquid Feed A1 and A2 Solenoid Valves (20A and 20B)

A1 (20A) solenoid is opened and closed during the freeze cycle by the float switch #10, in order to maintain the proper freezer refrigerant level. The smaller A2 (20B) solenoid valve is a by-pass valve that is opened continuously during the freeze cycle, to assist the A1 solenoid during pulldown. Both valves are closed when the machine is off and in harvest to prevent liquid flow from the receiver to the freezer.

Repair or replace as follows:

1. With the receiver pressure higher than the freezer pressure close the hand stop valve #58 (upstream) in the liquid line between the receiver and liquid feed solenoid valve.
2. Manually open (screw stem in) and allow the liquid to flow to the freezer and clear this part of the line of liquid, leaving only vapor.
3. Close the other hand stop valve #29 (downstream). This will isolate the solenoid valve.
4. Reclaim the remaining refrigerant from this line through the charging valve #28.
5. Repair or replace the valve as needed, making sure all connections are tight.
6. Evacuate air from this isolated part of the liquid line through the charging valve #28.

After evacuating, manually close (screw stem out) the solenoid valve and open stop valves #29 and #58, check for leaks.

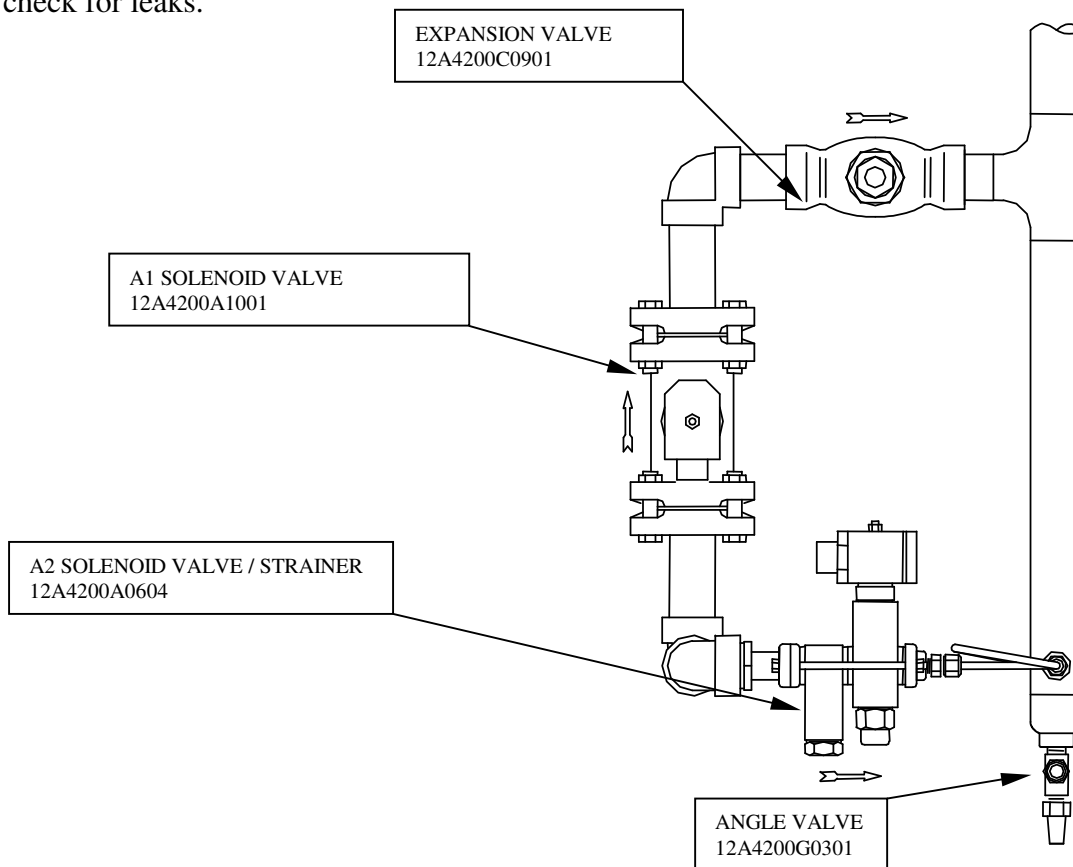


FIGURE 9-8
Liquid Line Solenoid Valve

SERVICING OPERATIONS

Water Flush Solenoid Valve (63) is opened during the thaw (harvest) cycle, to flush out impurities from the water in the tank, thereby improving the ice quality. Repair or replace as follows:

1. Turn off the water supply to this valve.
2. Dismantle the valve and inspect for dirt and wear. Reverse osmosis water can cause premature wear and erosion of the brass parts of this valve. You may want to consider replacing it with a stainless steel valve.
3. Repair or replace the valve as needed.
4. Turn on the water supply and check for leaks.

Compressor Oil Changing

See Table 7-4 for frequency recommendations

1. Turn off power to the machine and make sure the compressor crankcase heater is not energized.
2. Drain the oil through the oil drain valve located at the base of the compressor.
3. When all oil is drained, new oil of the required specifications can be pumped into the crankcase to the proper level.
4. Turn the power on and allow the crankcase heater to warm the oil prior to start-up. Be sure to confirm sufficient oil pressure at start-up.
5. Restore power to the crankcase heater allowing time to warm the oil. Be sure to confirm sufficient oil pressure at start-up.

Compressor Inspection

1. Close the compressor suction valve and allow the machine to stop by low pressure cut-out.
2. Close the compressor discharge valve and oil return stop valve. Disconnect and lock-out all power to the machine.
3. Drain the oil through the oil drain valve located at the base of the compressor and reclaim the compressor until all pressure is relieved.
4. Remove the compressor side cover (handhole cover), being careful to protect the gasket and surface from damage.
5. Inspect the crankcase inside for foreign material such as sludge, metal flakes, burrs, or anything that may look unusual, indicating excessive wear or damage.
6. Remove all remaining oil and wipe out the compressor with a lint-free cloth. The extent of internal inspection should be dependent on the degree of evidence of wear.
7. Inspect and clean the oil strainer. Cleaning can be accomplished with light oil, diesel fuel or mineral spirits. Make sure excess cleaning agents are removed prior to closing the crankcase.
8. Clean the oil sight glass and install the side cover plate using a new gasket if necessary. Torque down bolts to the correct specification.
9. Evacuate the compressor and add new oil to the crankcase.
10. Restore power to the crankcase heater allowing time to warm the oil.
11. Open the suction valve, discharge valve, oil return valve, and any other valves which may have been closed for servicing and check for leaks.
12. Check and confirm sufficient oil pressure as you witness at least one complete cycle when operation is resumed.

Belt Tension

New belts should be checked after the first day running, after the first week for tension, then at regular intervals for tension, alignment, and wear.

1. Always use matched sets or banded belts for multiple belt applications.
2. Too much tension shortens belt life and motor bearing life.
3. Never use a petroleum base belt dressing.
4. The proper tension is just enough to prevent slipping.

Reasons for premature wear.

1. Pulley misalignment
2. Belts not matched
3. Dirt or foreign material present
4. Excessive slipping (loose tension)

Belt Replacement

Belts, which are worn, cracked, frayed, or over stretched, should be replaced.

1. Remove the belt guard and loosen motor hold-down bolts.
2. Move the motor and sheave closer to the compressor until there is enough slack to remove the old belts.
3. Remove the old belts and clean the sheave groove if necessary with non-flammable, non-toxic degreasing agent or commercial detergent.
4. Install new belts by rotating the belt and sheaves to obtain seating in the grooves.
Note: on drives having more belt grooves in the sheaves than needed, use the grooves closest to the motor and compressor. Make sure that the belts are all slack on the same side of the drive, preferably the bottom, prior to tightening.
5. Move the sheaves apart until the belts are snug.
6. Check the motor and compressor shafts to make sure they are parallel, and check the flywheel and motor sheave with a straight edge, string, or wire to make sure they are parallel and in the same plane. Make adjustment as required.
7. Adjust tension following these guidelines:
 - a) Best tension is the lowest tension at which the belts will not slip under the highest load condition.
 - b) Check tension after the first two to four hours and again after 24 to 48 hours of operation, then periodically thereafter.
 - c) If a belt slips, tighten it.
8. Retighten motor hold-down bolts after each adjustment.

Compressor Servicing

Refer to your compressor manual for specific instructions regarding repair and servicing of internal parts. It is important to be familiar with the operation and function of your equipment so you can provide the best possible service.

SERVICING OPERATIONS

11. Tables & Charts

TABLES & CHARTS

P24F SPECIFICATIONS, 400/460 Volt-3 Phase- 50/60Hz

Tube Size	inches (cm)	1 (2.54)	1 1/4 (3.17)	1 1/2 (3.81)
Nominal Capacity⁽¹⁾	Tons/day (M Tons/day)	22.8 (20.6)	23.8 (21.5)	23.1 (20.8)
Overall Dimensions (LxWxH)	Feet (meters)	7.5x8x14.5 (2.3x2.4x4.4)	7.5x8x16 (2.3x2.4x4.8)	7.5x8x16 (2.3x2.4x4.8)
Shipping Weight	lbs (Kg)	12,300 (5,580)	12,700 (5,760)	12,500 (5,670)
Operating Weight	lbs (Kg)	14,190 (6,440)	14,800 (6,720)	14,700 (6,670)
Refrigerant Charge	lbs (Kg)	1200 (544.3)	1200 (544.3)	1200 (544.3)
Total FLA Water Cooled⁽²⁾		99.1	99.1	99.1
Maximum Fuse		225	225	225
Minimum Ampacity		125.4	125.4	125.4
Water Requirements				
-makeup⁽³⁾	gpm (m³/Hr)	4.76 (1.1)	4.98 (1.1)	4.81 (1.1)
-condenser⁽⁴⁾	gpm (m³/Hr)	196 (45.7)	196 (45.7)	196 (45.7)
Connection Sizes				
-makeup water	FPT	3/4"	3/4"	3/4"
-tank drain	FPT	2"	2"	2"
-tank overflow	FPT	3"	3"	3"
-flush water	FPT	3/4"	3/4"	3/4"
-compressor cooling	FPT	1"	1"	1"
-condenser water inlet	FPT	3"	3"	3"
-condenser water outlet	FPT	3"	3"	3"
Compressor (HP-FLA) 50/60Hz		(75 – 120)/(75 – 95)	(75 – 120)/(75 – 95)	(75 – 120)/(75 – 95)
Water Pump (HP-FLA) 50/60Hz		(2 – 3.4)/(2 – 3.1)	(2 – 3.4)/(2 – 3.1)	(2 – 3.4)/(2 – 3.1)
Cutter Motor (HP-FLA) 50/60Hz		(1.5 - 2.9)/(1.5 – 2.5)	(1.5 - 2.9)/(1.5 – 2.5)	(1.5 - 2.9)/(1.5 – 2.5)
THR	Btu/hr (kW)	1,031,625 (302.5)	1,031,625 (302.5)	1,031,625 (302.5)
Marley Cooling Tower⁽⁵⁾				
-dim. (LxWxH)	ft (meters)	4x6.5x7.8 (1.2x2.0x2.4)	4x6.5x7.8 (1.2x2.0x2.4)	4x6.5x7.8 (1.2x2.0x2.4)
-shipping weight	lbs (Kg)	1410 (639)	1410 (639)	1410 (639)
-operating weight	lbs (Kg)	2960 (1,342)	2960 (1,342)	2960 (1,342)
-fan (HP-FLA)		(2 - 3.2)	(2 - 3.2)	(2 - 3.2)
Tower Pump				
-flow	gpm (m³/Hr)	195 (44.2)	195 (44.2)	195 (44.2)
-TDH minimum	ft (m)	55 (16.7)	55 (16.7)	55 (16.7)
-HP-FLA		7.5 – 11	7.5 – 11	7.5 – 11
-connections (inlet x outlet)	FPT	NA	NA	NA
-shipping weight	lbs (Kg)	110 (50.0)	110 (50.0)	110 (50.0)

(1) Nominal capacity is based on 70°F makeup water, 100°F condensing temperature, 70°F ambient, and 25% blowdown.

(2) FLA for 460 volt models is approximately 1/2 that of 230 volt models. Total FLA does not include cooling tower.

(3) Makeup water is maximum value and includes 25% blowdown, each cycle

(4) Condenser flow rate is for 85°F entering water temperature and 100°F condensing.

(5) Tower sized for 75°F wet bulb temperature.

Vogt reserves the right to change designs and specifications without notice.

Table 11-1

P24F Capacity Ratings

Makeup Water Temp. Deg. F	Rated Capacity (lbs/day)											
	60Hz						50Hz					
	Cylinder			Crushed			Cylinder			Crushed		
	1"	1 1/4"	1 1/2"	1"	1 1/4"	1 1/2"	1"	1 1/4"	1 1/2"	1"	1 1/4"	1 1/2"
45	52,000	54,600	53,000	53,924	56,620	54,961	52,000	54,600	53,000	53,924	56,620	54,961
46	51,720	54,280	52,680	53,634	56,288	54,629	51,720	54,280	52,680	53,634	56,288	54,629
47	51,440	53,960	52,360	53,343	55,957	54,297	51,440	53,960	52,360	53,343	55,957	54,297
48	51,160	53,640	52,040	53,053	55,625	53,965	51,160	53,640	52,040	53,053	55,625	53,965
49	50,880	53,320	51,720	52,763	55,293	53,634	50,880	53,320	51,720	52,763	55,293	53,634
50	50,600	53,000	51,400	52,472	54,961	53,302	50,600	53,000	51,400	52,472	54,961	53,302
51	50,360	52,720	51,120	52,223	54,671	53,011	50,360	52,720	51,120	52,223	54,671	53,011
52	50,120	52,440	50,840	51,974	54,380	52,721	50,120	52,440	50,840	51,974	54,380	52,721
53	49,880	52,160	50,560	51,726	54,090	52,431	49,880	52,160	50,560	51,726	54,090	52,431
54	49,640	51,880	50,280	51,477	53,800	52,140	49,640	51,880	50,280	51,477	53,800	52,140
55	49,400	51,600	50,000	51,228	53,509	51,850	49,400	51,600	50,000	51,228	53,509	51,850
56	49,120	51,320	49,720	50,937	53,219	51,560	49,120	51,320	49,720	50,937	53,219	51,560
57	48,840	51,040	49,440	50,647	52,928	51,269	48,840	51,040	49,440	50,647	52,928	51,269
58	48,560	50,760	49,160	50,357	52,638	50,979	48,560	50,760	49,160	50,357	52,638	50,979
59	48,280	50,480	48,880	50,066	52,348	50,689	48,280	50,480	48,880	50,066	52,348	50,689
60	48,000	50,200	48,600	49,776	52,057	50,398	48,000	50,200	48,600	49,776	52,057	50,398
61	47,760	49,920	48,360	49,527	51,767	50,149	47,760	49,920	48,360	49,527	51,767	50,149
62	47,520	49,640	48,120	49,278	51,477	49,900	47,520	49,640	48,120	49,278	51,477	49,900
63	47,280	49,360	47,880	49,029	51,186	49,652	47,280	49,360	47,880	49,029	51,186	49,652
64	47,040	49,080	47,640	48,780	50,896	49,403	47,040	49,080	47,640	48,780	50,896	49,403
65	46,800	48,800	47,400	48,532	50,606	49,154	46,800	48,800	47,400	48,532	50,606	49,154
66	46,560	48,560	47,160	48,283	50,357	48,905	46,560	48,560	47,160	48,283	50,357	48,905
67	46,320	48,320	46,920	48,034	50,108	48,656	46,320	48,320	46,920	48,034	50,108	48,656
68	46,080	48,080	46,680	47,785	49,859	48,407	46,080	48,080	46,680	47,785	49,859	48,407
69	45,840	47,840	46,440	47,536	49,610	48,158	45,840	47,840	46,440	47,536	49,610	48,158
70	45,600	47,600	46,200	47,287	49,361	47,909	45,600	47,600	46,200	47,287	49,361	47,909
71	45,400	47,360	45,960	47,080	49,112	47,661	45,400	47,360	45,960	47,080	49,112	47,661
72	45,200	47,120	45,720	46,872	48,863	47,412	45,200	47,120	45,720	46,872	48,863	47,412
73	45,000	46,880	45,480	46,665	48,615	47,163	45,000	46,880	45,480	46,665	48,615	47,163
74	44,800	46,640	45,240	46,458	48,366	46,914	44,800	46,640	45,240	46,458	48,366	46,914
75	44,600	46,400	45,000	46,250	48,117	46,665	44,600	46,400	45,000	46,250	48,117	46,665
76	44,360	46,160	44,760	46,001	47,868	46,416	44,360	46,160	44,760	46,001	47,868	46,416
77	44,120	45,920	44,520	45,752	47,619	46,167	44,120	45,920	44,520	45,752	47,619	46,167
78	43,880	45,680	44,280	45,504	47,370	45,918	43,880	45,680	44,280	45,504	47,370	45,918
79	43,640	45,440	44,040	45,255	47,121	45,669	43,640	45,440	44,040	45,255	47,121	45,669
80	43,400	45,200	43,800	45,006	46,872	45,421	43,400	45,200	43,800	45,006	46,872	45,421
81	43,200	44,960	43,600	44,798	46,624	45,213	43,200	44,960	43,600	44,798	46,624	45,213
82	43,000	44,720	43,400	44,591	46,375	45,006	43,000	44,720	43,400	44,591	46,375	45,006
83	42,800	44,480	43,200	44,384	46,126	44,798	42,800	44,480	43,200	44,384	46,126	44,798
84	42,600	44,240	43,000	44,176	45,877	44,591	42,600	44,240	43,000	44,176	45,877	44,591
85	42,400	44,000	42,800	43,969	45,628	44,384	42,400	44,000	42,800	43,969	45,628	44,384
86	42,240	43,800	42,600	43,803	45,421	44,176	42,240	43,800	42,600	43,803	45,421	44,176
87	42,080	43,600	42,400	43,637	45,213	43,969	42,080	43,600	42,400	43,637	45,213	43,969
88	41,920	43,400	42,200	43,471	45,006	43,761	41,920	43,400	42,200	43,471	45,006	43,761
89	41,760	43,200	42,000	43,305	44,798	43,554	41,760	43,200	42,000	43,305	44,798	43,554
90	41,600	43,000	41,800	43,139	44,591	43,347	41,600	43,000	41,800	43,139	44,591	43,347

Capacity rating based on 70°F ambient conditions, 100°F SDT temperature.
 Capacity rating is average for the model. Individual machines may vary up to 5% above or below.
 Capacity rating is for clear ice production with makeup water containing no more than 200ppm total dissolved solids.

Table 11-2

TABLES & CHARTS

Condensing Temp. °F	Entering Water Temp. °F	Leaving Water Temp. °F	Water Flow gpm	Pressure Drop psig	Average Total Heat of Rejection BTU/HR
100	50	95	44	1	1,031,625
100	55	95	49	1	1,031,625
100	60	95	56	1	1,031,625
100	65	95	65	2	1,031,625
100	70	95	78	2	1,031,625
100	75	95	98	4	1,031,625
100	80	95	131	7	1,031,625
100	85	95	196	15	1,031,625

Table 11-3
P24F Condenser Water Usage

Make-Up Water Temp. °F	Cylinder Ice			Crushed Ice		
	Tube Size			Tube Size		
	1"	1 1/4"	1 1/2"	1"	1 1/4"	1 1/2"
40	5.58	5.87	5.70	6.90	7.33	7.12
50	5.28	5.53	5.37	6.60	6.91	6.71
60	5.00	5.23	5.07	6.25	6.53	6.33
70	4.76	4.95	4.81	5.95	6.18	6.01
80	4.53	4.71	4.57	5.66	5.88	5.71
90	4.33	4.48	4.36	5.41	5.60	5.45

Includes 25% blowdown per cycle

Table 11-4
P24F Make-Up Water Usage (gpm)

			Suction Pressure (psig) R404a		Discharge Pressure (psig) R404a		Harvest Times (secs)			Ice per cycle Average (lbs)	Freeze Time (minutes)				
			End of Freeze	End of Thaw	End of Freeze	End of Thaw	First Ice	All Ice Out	Total Harvest		Water Temperature (deg. F)				
										90	80	70	60	50	
60 HZ	C	1"	38	88	229	99	28	100	130	450	15.2	13.9	12.6	11.3	10.0
	Y	1 1/4"	35	81	235	90	47	135	165	650	20.5	18.3	17.4	16.5	15.0
	L	1 1/2"	30	78	230	106	80	150	180	750	22.0	19.3	18.5	17.7	17.0
	C	1"	48	88	229	99	11	191	212	260	8.7	7.9	7.0	6.1	5.6
	R	1 1/4"	46	81	235	90	13	211	234	375	9.3	8.31	7.5	6.8	6.1
	U	1 1/2"	42	88	233	106	14	226	250	433	12.9	12.0	11.2	10.4	9.4
50 HZ	C	1"	38	88	229	99	28	100	130	450	15.2	13.9	12.6	11.3	10.0
	Y	1 1/4"	35	81	235	90	47	135	165	650	20.5	18.3	17.4	16.5	15.0
	L	1 1/2"	30	78	230	106	80	150	180	750	22.0	19.3	18.5	17.7	17.0
	C	1"	48	88	229	99	11	191	212	260	8.7	7.9	7.0	6.1	5.6
	R	1 1/4"	46	81	235	90	13	211	234	375	9.3	8.31	7.5	6.8	6.1
	U	1 1/2"	42	88	233	106	14	226	250	433	12.9	12.0	11.2	10.4	9.4

Table 11-5A
P24F Normal Operating Vitals For R-404a

			Suction Pressure (psig) R22		Discharge Pressure (psig) R22		Harvest Times (secs)			Ice per cycle Average (lbs)	Freeze Time (minutes)				
			End of Freeze	End of Thaw	End of Freeze	End of Thaw	First Ice	All Ice Out	Total Harvest		Water Temperature (deg. F)				
										90	80	70	60	50	
60 HZ	C	1"	32	70	190	80	28	100	130	450	15.2	13.9	12.6	11.3	10.0
	Y	1 1/4"	30	65	195	73	47	135	165	650	20.5	18.3	17.4	16.5	15.0
	L	1 1/2"	27	70	194	85	80	150	180	750	22.0	19.3	18.5	17.7	17.0
	C	1"	37	70	190	80	11	191	212	260	8.7	7.9	7.0	6.1	5.6
	R	1 1/4"	34	65	195	73	13	211	234	375	9.3	8.31	7.5	6.8	6.1
	U	1 1/2"	31	70	194	85	14	226	250	433	12.9	12.0	11.2	10.4	9.4
50 HZ	C	1"	32	70	190	80	28	100	130	450	15.2	13.9	12.6	11.3	10.0
	Y	1 1/4"	30	65	195	73	47	135	165	650	20.5	18.3	17.4	16.5	15.0
	L	1 1/2"	27	70	194	85	80	150	180	750	22.0	19.3	18.5	17.7	17.0
	C	1"	37	70	190	80	11	191	212	260	8.7	7.9	7.0	6.1	5.6
	R	1 1/4"	34	65	195	73	13	211	234	375	9.3	8.31	7.5	6.8	6.1
	U	1 1/2"	31	70	194	85	14	226	250	433	12.9	12.0	11.2	10.4	9.4

Table 11-5B
P24F Normal Operating Vitals For R-22

TABLES & CHARTS

RECOMMENDED SPARE PARTS LIST**Vogt Model P24F Tube-Ice[®] Machine**

QTY	P24F PART NO.	DESCRIPTION
1	12A7503E22	Thaw timer 208/230
1	12A2590G10	Suction pressure gage 30"-150# / R22
1	12A2590G11	Discharge pressure gage 30"-400# / R22
1	12A4200H0601	Roberts float valve 3/4"
1	12A4200HP01	10" float valve stem
1	12A4200HP02	Float for Roberts 6"
1	12A2600G08	Freezer cover gasket (P24-27" o.d., P34-37" o.d.)
1	12A2600G09	Water tank gasket (P24-30" o.d.,P34-40" o.d.)
1	12A2625G05	Gage glass 1/2" x 29" lg.
2	12A4199V26	Gage glass O-ring
1	12A2117C03	Freezer pressure switch Asco #PA16A
1	12A2117T03	Transducer for above control Asco RE10A44
1	12A7515E22	Control Circuit Breaker (190/208/230V-50/60Hz)
1	12A7515E21	Control Circuit Breaker (380/460V-50/60Hz)
1	12A7515E08	Circuit Breaker 15 amp.
144	12B2185V31	Water distributors 1 1/2" (P34-306 Req'd)
198	12B2185V21	Water distributors 1 1/4" (P34-420 Req'd)
264	12B2185V12	Water distributors 1" (P34-564 Req'd)
as req'd	126531RED	Red vent tubes (one per water distributor)
1	12A4200A0607	Flush valve Sporlan 3/4" FPT solenoid
1	12B2615D03	P24 drive gear--aluminum, bronze
2	12A7503E22	Timer (delay on make)
2	12A7503E39	Timer Base
1	12A7530E56	Cutter Motor Starter (190/208/230V-50/60Hz)
1	12A7530E55	Cutter Motor Starter (380/460V-50/60Hz)
1	12A7530E56	Pump Motor Starter (190/208/230V-50/60Hz)
1	12A7530E54	Pump Motor Starter (380V-50Hz)
1	12A7530E55	Pump Motor Starter (460V-60Hz)
2	12A7517E27	Relay
1	12B7503E20	Elapsed Timer (50Hz)
1	12B7503E21	Elapsed Timer (60Hz)
1	12B2060B01	Hub for drive gear

TO ORDER SPARE PARTS, PLEASE CONTACT YOUR DISTRIBUTOR.

**TEMPERATURE - PRESSURE CHART
FOR COMMON REFRIGERANTS (°F-psig)**

Deg F	R-12	R-22	R-502	R-134a	R-404A	R-717	MP-39	Deg F	R-12	R-22	R-502	R-134a	R-404A	R-717	MP-39
-50	-7.6	-3.0	0.2	-9.0	0.0	-7.0	-9.1	50	46.7	84.0	97.4	45.5	102.9	74.2	45.3
-48	-7.2	-2.4	0.7	-8.7	0.8	-6.5	-8.7	52	48.8	87.3	101.0	47.7	109.0	77.7	60.0
-46	-6.8	-1.7	1.5	-8.3	1.6	-6.0	-8.3	54	51.0	90.8	104.8	50.1	113.0	81.3	62.0
-44	-6.3	-1.0	2.3	-8.0	2.5	-5.4	-7.9	56	53.2	94.3	108.6	52.3	117.0	84.9	65.0
-42	-5.8	-0.2	3.2	-7.6	3.4	-4.9	-7.4	58	55.4	97.9	112.4	55.0	121.0	88.7	68.0
-40	-5.4	0.5	4.1	-7.1	5.5	-4.3	-7.1	60	57.7	101.6	116.4	57.5	125.0	92.6	70.0
-38	-4.9	1.3	5.0	-6.7	6.5	-3.6	-6.6	62	60.1	105.4	120.4	60.1	130.0	96.6	73.0
-36	-4.4	2.2	6.0	-6.3	7.5	-3.0	-6.1	64	62.5	109.3	124.6	62.7	134.0	100.7	76.0
-34	-3.8	3.0	7.0	-5.8	8.6	-2.3	-5.6	66	65.0	113.2	128.8	65.5	139.0	104.9	79.0
-32	-3.3	4.0	8.1	-5.3	9.7	-1.6	-5.2	68	67.6	117.3	133.2	68.3	144.0	109.3	82.0
-30	-2.7	4.9	9.2	-4.8	10.8	-0.8	-4.4	70	70.2	121.4	137.6	71.2	148.0	113.7	85.0
-28	-2.1	5.9	10.3	-4.2	12.0	0.0	-4.1	72	72.9	125.7	142.2	74.2	153.0	118.3	89.0
-26	-1.5	6.9	11.5	-3.8	13.2	0.8	-3.4	74	75.6	130.0	146.8	77.2	158.0	123.1	92.0
-24	-0.8	7.9	12.7	-3.0	14.5	1.7	-2.9	76	78.4	134.5	151.5	80.3	164.0	127.9	95.0
-22	-0.1	9.0	14.0	-2.4	15.8	2.6	-2.2	78	81.3	139.0	156.3	83.5	169.0	132.8	99.0
-20	0.6	10.1	15.3	-1.8	17.1	3.5	-1.7	80	84.2	143.6	161.2	86.8	174.0	137.9	102.0
-18	1.3	11.3	16.7	-1.1	18.5	4.5	-1.0	82	87.2	148.4	166.2	90.2	180.0	143.2	106.0
-16	2.1	12.5	18.1	-0.4	20.0	5.6	-0.2	84	90.2	153.2	171.4	93.6	185.0	148.5	109.0
-14	2.8	13.8	19.5	0.3	21.5	6.7	0.4	86	93.3	158.2	176.6	97.1	191.0	154.1	113.0
-12	3.7	15.1	21.0	1.1	23.0	7.8	1.4	88	96.5	163.2	181.9	100.7	197.0	159.7	117.0
-10	4.5	16.5	22.6	1.9	24.6	8.9	2.2	90	99.8	168.4	187.4	104.4	203.0	165.5	121.0
-8	5.4	17.9	24.2	2.8	26.3	10.2	3.1	92	103.1	173.7	192.9	108.2	209.9	171.4	125.0
-6	6.3	19.3	25.8	3.6	28.0	11.4	3.9	94	106.5	179.1	198.6	112.1	215.0	177.5	129.0
-4	7.2	20.8	27.5	4.5	29.8	12.8	4.8	96	110.0	184.6	204.3	116.1	222.0	183.7	133.0
-2	8.2	22.4	29.3	5.5	31.6	14.2	5.7	98	113.5	190.2	210.2	120.1	229.0	190.1	138.0
0	9.2	24.0	31.1	6.5	33.5	15.6	6.7	100	117.2	195.9	216.2	124.3	235.0	196.1	142.0
2	10.2	25.6	32.9	7.5	35.6	17.1	7.7	102	120.9	201.8	222.3	128.5	242.0	203.3	146.0
4	11.2	27.3	34.9	8.5	37.4	18.6	8.8	104	124.7	207.7	228.5	132.9	249.0	210.2	151.0
6	12.3	29.1	36.9	9.6	39.4	20.3	9.9	106	128.5	213.8	234.9	137.3	256.0	217.2	156.0
8	13.5	30.9	38.9	10.8	41.6	21.9	11.0	108	132.4	220.0	241.3	142.8	264.0	224.4	160.0
10	14.6	32.8	41.0	12.0	43.9	23.7	12.2	110	136.4	226.4	247.9	146.5	271.0	231.7	165.0
12	15.8	34.7	43.2	13.1	46.0	25.4	13.4	112	140.5	232.8	254.6	151.3	279.0	239.2	170.0
14	17.1	36.7	45.4	14.4	48.3	27.4	14.6	114	144.7	239.4	261.5	156.1	286.0	246.9	175.0
16	18.4	38.7	47.7	15.7	50.7	29.3	15.9	116	148.9	246.1	268.4	161.1	294.0	254.8	180.0
18	19.7	40.9	50.0	17.0	53.1	31.3	17.2	118	153.2	252.9	275.5	166.1	302.0	262.8	185.0
20	21.0	43.0	52.5	18.4	55.6	33.3	18.6	120	157.7	259.9	282.7	171.3	311.0	271.0	191.0
22	22.4	45.3	54.9	19.9	58.2	35.5	20.0	122	162.2	267.0	290.1	176.6	319.0	279.4	196.0
24	23.9	47.6	57.5	21.4	59.9	37.7	21.5	124	166.7	274.3	297.6	182.0	328.0	288.0	202.0
26	25.4	49.9	60.1	22.9	63.6	40.0	23.0	126	171.4	281.6	305.2	187.5	336.0	296.7	207.0
28	26.9	52.4	62.8	24.5	66.5	42.4	24.6	128	176.2	289.1	312.9	193.1	345.0	305.7	213.0
30	28.5	54.9	65.6	26.1	69.4	44.8	26.2	130	181.0	296.8	320.8	198.9	354.0	314.8	219.0
32	30.1	57.5	68.4	27.8	72.3	47.4	27.9	132	185.9	304.6	328.9	204.7	364.0	324.2	225.0
34	31.7	60.1	71.3	29.5	75.4	50.0	29.6	134	191.0	312.5	337.1	210.7	373.0	333.7	231.0
36	33.4	62.8	74.3	31.3	78.5	52.7	31.3	136	196.2	320.6	345.4	216.8	383.0	343.4	237.0
38	35.2	65.6	77.4	33.2	81.8	55.5	33.2	138	201.3	328.9	353.9	223.0	392.0	353.4	243.0
40	36.9	68.5	80.5	35.1	85.1	58.4	35.0	140	206.6	337.3	362.6	229.4	402.0	363.5	250.0
42	38.8	71.5	83.8	37.0	88.5	61.3	37.0	142	212.0	345.8	371.4	235.8	412.0	373.8	256.0
44	40.7	74.5	87.0	39.1	91.9	64.4	39.0	144	217.5	354.5	380.4	242.4	423.0	384.4	263.0
46	42.7	77.6	90.4	42.0	95.5	67.6	41.0	146	223.1	363.4	389.5	249.2	434.0	395.2	269.0
48	44.7	80.7	93.9	43.3	99.2	70.8	43.1	148	228.8	372.3	398.9	256.0	444.0	406.1	277.0
50	46.7	84.0	97.4	45.5	102.9	74.2	45.3	150	234.6	381.5	408.4	263.0	449.0	432.0	283.0

TABLE 11-6
All pressures are in lbs/in² gage (psig).

TABLES & CHARTS

REFERENCE INFORMATION**CONVERSION FACTORS: English to Metric**

To Convert	From	To	Multiply by
Area	ft ²	m ²	9.2903e-2
	in ²	m ²	6.416 e-4
Energy	BTU	Joule (J)	1054.48
	hp	BTU/Hr	2546.2
	kW	hp	1.34
Length	ft.	m.	0.3048
	in.	m.	0.0254
Pressure	lbf/ft ²	Paschals	47.88
	lbf/in ² (psi)	Paschals	6894.76
	in. Hg	psi	0.491
	in H ₂ O	psi	0.03612
Temperature	°F	°C	$T_C = 5/9 * (T_F - 32)$
	°C	°F	$T_F = (9/5 * T_C) + 32$
Volume	ft ³	m ³	2.8317e-2
	gal(U.S.)	m ³	3.7854e-3
	ft ³	gal(U.S.)	7.48

TABLE 11-7**CONSTANTS**

Specific heat of Water	1 BTU/(lbm °F)
Specific heat of Air	4.19 kJ/(kg °C) 0.24 BTU/(lbm °F)
Tube-Ice Density	32-35 lbs/ft ³
Ice Latent Heat	144 BTU/hr
Water Sensible Heat	1 BTU/(lb °F)
Ice Melting Effect (IME) 1 Ton Refrigeration	12,000 BTU/hr
Atmospheric pressure	14.7 psia
Weight of Water	62.4 lbs/ft ³ 8.33 lbs/gal
1 gpm water	12013 lb/day
Weight of air	0.0749 lbs/ft ³ 0.0100 lbs/gal
1 Horsepower	2545.6 BTU/hr
1 Kilowatt	1.34 horsepower
Gravitational accel.	9.81 m ² /sec

TABLE 11-8

Appendix A



The MSDS format adheres to the standards and regulatory requirements of the United States and may not meet regulatory requirements in other countries.

DuPont
Material Safety Data Sheet

Page 1

"FREON" 22
2008FR Revised 5-OCT-1996

CHEMICAL PRODUCT/COMPANY IDENTIFICATION

Material Identification

Corporate MSDS Number : DU000025
Formula : CHClF2
Molecular Weight : 86.47
CAS Name : "FREON" 22

Tradenames and Synonyms

Freon 22
CHLORODIFLUOROMETHANE
HCFC-22
CC0335
Dymel 22

Company Identification

MANUFACTURER/DISTRIBUTOR
DuPont Fluoroproducts
1007 Market Street
Wilmington, DE 19898

PHONE NUMBERS

Product Information : 1-800-441-7515 (outside the U.S.
302-774-1000)
Transport Emergency : CHEMTREC 1-800-424-9300 (outside U.S.
703-527-3887)
Medical Emergency : 1-800-441-3637 (outside the U.S.
302-774-1000)

COMPOSITION/INFORMATION ON INGREDIENTS

Components

Material	CAS Number	%
*"FREON" 22 METHANE, CHLORODIFLUORO-	75-45-6	100

* Disclosure as a toxic chemical is required under Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR part 372.

HAZARDS IDENTIFICATION

Potential Health Effects

Inhalation of high concentrations of vapor is harmful and may cause heart irregularities, unconsciousness or death. Intentional misuse or deliberate inhalation may cause death without warning. Vapor reduces oxygen available for breathing and is heavier than air. Liquid contact can cause frostbite.

HUMAN HEALTH EFFECTS:

Skin contact with the liquid may include frostbite. Prolonged overexposure may cause defatting or dryness of the skin. Eye contact with liquid may include eye irritation with discomfort, tearing, or blurring of vision.

Inhalation may include temporary nervous system depression with anesthetic effects such as dizziness, headache, confusion, incoordination, and loss of consciousness.

Higher exposures may lead to temporary alteration of the heart's electrical activity with irregular pulse, palpitations, or inadequate circulation. Fatality may occur from gross overexposure.

Individuals with preexisting diseases of the central nervous or cardiovascular system may have increased susceptibility to the toxicity of excessive exposures.

Carcinogenicity Information

None of the components present in this material at concentrations equal to or greater than 0.1% are listed by IARC, NTP, OSHA or ACGIH as a carcinogen.

FIRST AID MEASURES

First Aid

INHALATION

If inhaled, immediately remove to fresh air. Keep person calm. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.

SKIN CONTACT

In case of contact, flush area with lukewarm water. Do not use hot water. If frostbite has occurred, call a physician.

EYE CONTACT

(FIRST AID MEASURES - Continued)

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Call a physician.

INGESTION

Ingestion is not considered a potential route of exposure.

Notes to Physicians

Because of possible disturbances of cardiac rhythm, catecholamine drugs, such as epinephrine, should only be used with special caution in situations of emergency life support.

FIRE FIGHTING MEASURES

Flammable Properties

Flash Point : Will not burn
Autodecomposition : 632 C (1170 F)

Other burning materials may cause "FREON" 22 to burn weakly.

Chlorodifluoromethane is not flammable at ambient temperatures and atmospheric pressure. However, chlorodifluoromethane has been shown in tests to be combustible at pressures as low as 60 psig at ambient temperature when mixed with air at concentrations of 65 volume % air. Experimental data have also been reported which indicate combustibility of "FREON" 22 in the presence of certain concentrations of chlorine.

Fire and Explosion Hazards:

Cylinders may rupture under fire conditions. Decomposition may occur.

Extinguishing Media

As appropriate for combustibles in area. Extinguishant for other burning material in area is sufficient to stop burning.

Fire Fighting Instructions

Use water spray or fog to cool containers. Self-contained breathing apparatus (SCBA) is required if cylinders rupture or contents are released under fire conditions. Water runoff should be contained and neutralized prior to release.

ACCIDENTAL RELEASE MEASURES

Safeguards (Personnel)

NOTE: Review FIRE FIGHTING MEASURES and HANDLING (PERSONNEL) sections before proceeding with clean-up. Use appropriate PERSONAL PROTECTIVE EQUIPMENT during clean-up.

Accidental Release Measures

Ventilate area, especially low or enclosed places where heavy vapors might collect. Remove open flames. Use self-contained breathing apparatus (SCBA) for large spills or releases.

HANDLING AND STORAGE

Handling (Personnel)

Use with sufficient ventilation to keep employee exposure below recommended limits. "FREON" 22 should not be mixed with air for leak testing. In general, it should not be used or allowed to be present with high concentrations of air above atmospheric pressure. Contact with chlorine or other strong oxidizing agents should also be avoided.

Storage

Clean, dry area. Do not heat above 52 C (125 F).

EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls

Normal ventilation for standard manufacturing procedures is generally adequate. Local exhaust should be used when large amounts are released. Mechanical ventilation should be used in low or enclosed places.

Personal Protective Equipment

Impervious gloves and chemical splash goggles should be used when handling liquid. Under normal manufacturing conditions, no respiratory protection is required when using this product. Self-contained breathing apparatus (SCBA) is required if a large release occurs.

Exposure Guidelines

Exposure Limits

"FREON" 22

PEL (OSHA)	: None Established
TLV (ACGIH)	: 1,000 ppm, 3,540 mg/m ³ , 8 Hr. TWA, A4
AEL * (DuPont)	: None Established

* AEL is DuPont's Acceptable Exposure Limit. Where governmentally imposed occupational exposure limits which are lower than the AEL are in effect, such limits shall take precedence.

PHYSICAL AND CHEMICAL PROPERTIES

Physical Data

Boiling Point	: -40.8 C (-41.4 F)
Vapor Pressure	: 151 psig @ 25 C (77 F)
Vapor Density	: 3.03 (Air=1.0) @ 25 C (77 F)
% Volatiles	: 100 WT%
Evaporation Rate	: >1 (CCl ₄ =1.0)
Solubility in Water	: 0.3 WT% @ 25 C (77 F)
pH	: Neutral
Odor	: Slight ethereal
Form	: Liquified Gas.
Color	: Clear, Colorless.
Liquid Density	: 1.194 g/cm ³ @ 25 C (77 F)

STABILITY AND REACTIVITY

Chemical Stability

Material is stable. However, avoid open flames and high temperatures.

Incompatibility with Other Materials

Incompatible with alkali or alkaline earth metals--powdered Al, Zn, Be, etc.

Decomposition

Decomposition products are hazardous. "FREON" 22 can be decomposed by high temperatures (open flames, glowing metal surfaces, etc.) forming hydrochloric and hydrofluoric acids, and possibly carbonyl halides. These materials are toxic and irritating. Contact should be avoided.

Polymerization

Polymerization will not occur.

TOXICOLOGICAL INFORMATION

Animal Data

INHALATION:

4 hour, LC50, rat: 220,000 ppm.

The compound is a skin irritant and a slight eye irritant, but is not a skin sensitizer in animals.

Effects from single high exposures include central nervous system depression, anesthesia, rapid breathing, lung congestion and microscopic liver changes. Cardiac sensitization occurred in dogs at 50,000 ppm or greater from the action of exogenous epinephrine.

No toxic effects or abnormal histopathological observations occurred in rats repeatedly exposed to concentrations ranging from 10,000 to 50,000 ppm (v/v). Long-term exposures to 50,000 ppm (v/v) of vapors produced organ weight increases and a decrease in body weight gain, but no increased mortality or adverse hematological effects. In chronic inhalation studies, "FREON" 22, at a concentration of 50,000 ppm (v/v), produced a small, but statistically significant increase of late-occurring tumors involving salivary glands in male rats, but not female rats or male or female mice. In the same studies, no increased incidence of tumors was seen in either species at concentrations of 10,000 ppm or 1,000 ppm (v/v).

Long-term administration in corn oil produced no effects on body weight or mortality.

"FREON" 22 was mutagenic in some strains of bacteria in bacterial cell cultures, but not mammalian cell cultures or animals. It did not cause heritable genetic damage in mammals.

A slight, but significant increase in developmental toxicity was observed at high concentrations (50,000 ppm) of "FREON" 22, a concentration which also produced toxic effects in the adult animal. Based on these findings, and other negative developmental studies, "FREON" 22 is not considered a unique hazard to the conceptus. Studies of the effects of "FREON" 22 on male reproductive performance have been negative. Specific studies to evaluate the effect on female reproductive performance have not been conducted, however, limited information obtained from studies on developmental toxicity do not indicate adverse effects on female reproductive performance at concentrations up to 50,000 ppm.

ECOLOGICAL INFORMATION

Ecotoxicological Information

Aquatic Toxicity:

"FREON" 22

48 hour EC50 - Daphnia magna: 433 mg/L
-----DISPOSAL CONSIDERATIONS

Waste Disposal

Comply with Federal, State, and local regulations. Reclaim by distillation or remove to a permitted waste disposal facility.

-----TRANSPORTATION INFORMATION

Shipping Information

DOT/IMO
Proper Shipping Name : CHLORODIFLUOROMETHANE
Hazard Class : 2.2
UN No. : 1018
DOT/IMO Label : NONFLAMMABLE GAS

Shipping Containers

Tank Cars.
Tank Trucks.
Cylinders.

-----REGULATORY INFORMATION

U.S. Federal Regulations

TSCA Inventory Status : Reported/Included.

TITLE III HAZARD CLASSIFICATIONS SECTIONS 311, 312

Acute : Yes
Chronic : No
Fire : No
Reactivity : No
Pressure : Yes

HAZARDOUS CHEMICAL LISTS

SARA Extremely Hazardous Substance: No
CERCLA Hazardous Substance : No

(REGULATORY INFORMATION - Continued)

SARA Toxic Chemical - See Components Section

OTHER INFORMATION

NFPA, NPCA-HMIS

NPCA-HMIS Rating
Health : 1
Flammability : 0
Reactivity : 1

Personal Protection rating to be supplied by user depending on use conditions.

The data in this Material Safety Data Sheet relates only to the specific material designated herein and does not relate to use in combination with any other material or in any process.Responsibility for MSDS : MSDS Coordinator
> : DuPont Fluoroproducts
Address : Wilmington, DE 19898
Telephone : (800) 441-7515

Indicates updated section.

This information is based upon technical information believed to be reliable. It is subject to revision as additional knowledge and experience is gained.

End of MSDS



The MSDS format adheres to the standards and regulatory requirements of the United States and may not meet regulatory requirements in other countries.

DuPont
Material Safety Data Sheet

Page 1

6002FR "SUVA" HP62 (R404A)
Revised 29-AUG-2001

CHEMICAL PRODUCT/COMPANY IDENTIFICATION

Material Identification

"SUVA" is a registered trademark of DuPont.

Corporate MSDS Number : DU005612

Company Identification

MANUFACTURER/DISTRIBUTOR

DuPont Fluoroproducts
1007 Market Street
Wilmington, DE 19898

PHONE NUMBERS

Product Information : 1-800-441-7515 (outside the U.S.
302-774-1000)
Transport Emergency : CHEMTREC 1-800-424-9300 (outside U.S.
703-527-3887)
Medical Emergency : 1-800-441-3637 (outside the U.S.
302-774-1000)

COMPOSITION/INFORMATION ON INGREDIENTS

Components

Material	CAS Number	%
PENTAFLUOROETHANE (HFC-125)	354-33-6	44
ETHANE, 1,1,1-TRIFLUORO- (HFC-143a)	420-46-2	52
ETHANE, 1,1,1,2-TETRAFLUORO- (HFC-134a)	811-97-2	4

HAZARDS IDENTIFICATION

Potential Health Effects

Inhalation of high concentrations of vapor is harmful and may cause heart irregularities, unconsciousness, or death. Intentional misuse or deliberate inhalation may cause death without warning. Vapor reduces oxygen available for breathing and is heavier than air. Liquid contact can cause frostbite.

HUMAN HEALTH EFFECTS:

Overexposure to the vapors by inhalation may include temporary nervous system depression with anesthetic effects

(HAZARDS IDENTIFICATION - Continued)

such as dizziness, headache, confusion, incoordination, and loss of consciousness. Higher exposures to the vapors may cause temporary alteration of the heart's electrical activity with irregular pulse, palpitations, or inadequate circulation; or fatality from gross overexposure. Contact with the liquid may cause frostbite.

Individuals with preexisting diseases of the central nervous or cardiovascular system may have increased susceptibility to the toxicity of increased exposures.

Carcinogenicity Information

None of the components present in this material at concentrations equal to or greater than 0.1% are listed by IARC, NTP, OSHA or ACGIH as a carcinogen.

FIRST AID MEASURES

First Aid

INHALATION

If inhaled, immediately remove to fresh air. Keep person calm. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.

SKIN CONTACT

Flush area with lukewarm water. Do not use hot water. If frostbite has occurred, call a physician.

EYE CONTACT

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Call a physician.

INGESTION

Not a probable route. However, in case of accidental ingestion, call a physician.

Notes to Physicians

THIS MATERIAL MAY MAKE THE HEART MORE SUSCEPTIBLE TO ARRHYTHMIAS. Catecholamines such as adrenaline, and other compounds having similar effects, should be reserved for emergencies and then used only with special caution.

FIRE FIGHTING MEASURES

Flammable Properties

Flash Point : No flash point

Flammable Limits in Air, % by Volume:

LEL : None per ASTM E681

UEL : None per ASTM E681

Autoignition: Not determined

Fire and Explosion Hazards:

Cylinders may rupture under fire conditions. Decomposition may occur.

Contact of welding or soldering torch flame with high concentrations of refrigerant can result in visible changes in the size and color of torch flames. This flame effect will only occur in concentrations of product well above the recommended exposure limit, therefore stop all work and ventilate to disperse refrigerant vapors from the work area before using any open flames.

R-404A is not flammable in air at temperatures up to 100 deg C (212 deg F) at atmospheric pressure. However, mixtures of R-404A with high concentrations of air at elevated pressure and/or temperature can become combustible in the presence of an ignition source. R-404A can also become combustible in an oxygen enriched environment (oxygen concentrations greater than that in air). Whether a mixture containing R-404A and air, or R-404A in an oxygen enriched atmosphere becomes combustible depends on the inter-relationship of 1) the temperature 2) the pressure, and 3) the proportion of oxygen in the mixture. In general, R-404A should not be allowed to exist with air above atmospheric pressure or at high temperatures; or in an oxygen enriched environment. For example: R-404A should NOT be mixed with air under pressure for leak testing or other purposes.

Experimental data have also been reported which indicate combustibility of HFC-134a, a component in this blend, in the presence of chlorine.

Extinguishing Media

As appropriate for combustibles in area.

Fire Fighting Instructions

Cool cylinder with water spray or fog. Self-contained breathing apparatus (SCBA) is required if cylinders rupture and contents are released under fire conditions. Water runoff should be contained and neutralized prior to release.

ACCIDENTAL RELEASE MEASURES

Safeguards (Personnel)

NOTE: Review FIRE FIGHTING MEASURES and HANDLING (PERSONNEL) sections before proceeding with clean-up. Use appropriate PERSONAL PROTECTIVE EQUIPMENT during clean-up.

Accidental Release Measures

Ventilate area using forced ventilation, especially in low or enclosed places where heavy vapors might collect. Remove open flames. Use self-contained breathing apparatus (SCBA) for large spills or releases.

HANDLING AND STORAGE

Handling (Personnel)

Avoid breathing vapor. Avoid liquid contact with eyes and skin. Use with sufficient ventilation to keep employee exposure below recommended limits. Contact with chlorine or other strong oxidizing agents should also be avoided. See Fire and Explosion Data section.

Storage

Clean, dry area. Do not heat above 52 deg C (125 deg F).

EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls

Avoid breathing vapors. Avoid contact with skin or eyes. Use with sufficient ventilation to keep employee exposure below the recommended exposure limit. Local exhaust should be used if large amounts are released. Mechanical ventilation should be used in low or enclosed places.

Refrigerant concentration monitors may be necessary to determine vapor concentrations in work areas prior to use of torches or other open flames, or if employees are entering enclosed areas.

Personal Protective Equipment

Impervious gloves should be used to avoid prolonged or repeated exposure. Chemical splash goggles should be available for use as needed to prevent eye contact. Under normal manufacturing conditions, no respiratory protection is required when using this product. Self-contained breathing apparatus (SCBA) is required if a large release occurs.

(EXPOSURE CONTROLS/PERSONAL PROTECTION - Continued)

Exposure Guidelines

Applicable Exposure Limits

PENTAFLUOROETHANE (HFC-125)

PEL (OSHA) : None Established
TLV (ACGIH) : None Established
AEL * (DuPont) : 1000 ppm, 8 & 12 Hr. TWA
WEEL (AIHA) : 1000 ppm, 4900 mg/m3, 8 Hr. TWA

ETHANE, 1,1,1-TRIFLUORO- (HFC-143a)

PEL (OSHA) : None Established
TLV (ACGIH) : None Established
AEL * (DuPont) : 1000 ppm, 8 & 12 Hr. TWA
WEEL (AIHA) : 1000 ppm, 8 Hr. TWA

ETHANE, 1,1,1,2-TETRAFLUORO- (HFC-134a)

PEL (OSHA) : None Established
TLV (ACGIH) : None Established
AEL * (DuPont) : 1000 ppm, 8 & 12 Hr. TWA
WEEL (AIHA) : 1000 ppm, 8 Hr. TWA

* AEL is DuPont's Acceptable Exposure Limit. Where governmentally imposed occupational exposure limits which are lower than the AEL are in effect, such limits shall take precedence.

PHYSICAL AND CHEMICAL PROPERTIES

Physical Data

Boiling Point : -46.7 C (-52.1 F) Average
Vapor Pressure : 182.1 psia at 25 deg C (77 deg F)
% Volatiles : 100 WT%
Evaporation Rate : (CL4 = 1)
Greater than 1
Solubility in Water : Not determined
Odor : Slight ethereal
Form : Liquefied gas
Color : Clear, colorless
Specific Gravity : 1.05 @ 25C (77F)

STABILITY AND REACTIVITY

Chemical Stability

Material is stable. However, avoid open flames and high temperatures.

Incompatibility with Other Materials

Incompatible with active metals, alkali or alkaline earth metals--powdered Al, Zn, Be, etc.

(STABILITY AND REACTIVITY - Continued)

Decomposition

Decomposition products are hazardous. This material can be decomposed by high temperatures (open flames, glowing metal surfaces, etc.) forming hydrofluoric acid and possibly carbonyl fluoride.

These materials are toxic and irritating. Contact should be avoided.

Polymerization

Polymerization will not occur.

TOXICOLOGICAL INFORMATION

Animal Data

The blend is untested.

HFC-125

Inhalation 4 hour ALC: > 709,000 ppm in rats

Single, high inhalation exposures caused lethargy, decreased activity, labored breathing and weight loss. Weak cardiac sensitization effect, a potentially fatal disturbance of heart rhythm caused by a heightened sensitivity to the action of epinephrine. Lowest-Observed-Adverse-Effect-Level for cardiac sensitization: 100,000 ppm.

Repeated exposure caused: No significant toxicological effects. No-Observed-Adverse-Effect-Level (NOAEL): 50,000 ppm

No animal data are available to define carcinogenic, developmental or reproductive hazards. In animal testing this material has not caused developmental toxicity. HFC-125 does not produce genetic damage in bacterial or mammalian cell cultures or when tested in animals (not tested for heritable genetic damage).

HFC-134a

Inhalation 4-hour LC50: 567,000 ppm in rats

Single exposure caused: Cardiac sensitization, a potentially fatal disturbance of heart rhythm associated with a heightened sensitivity to the action of epinephrine. Lowest-Observed-Adverse-Effect-Level for cardiac sensitization: 75,000 ppm. Single exposure caused: Lethargy. Narcosis. Increased respiratory rates. These effects were temporary. Single exposure to near lethal doses caused: Pulmonary edema. Repeated exposure caused: Increased adrenals, liver, spleen weight. Decreased uterine, prostate

(TOXICOLOGICAL INFORMATION - Continued)

weight. Repeated dosing of higher concentrations caused: the following temporary effects - Tremors. Incoordination.

CARCINOGENIC, DEVELOPMENTAL, REPRODUCTIVE, MUTAGENIC EFFECTS:

In a two-year inhalation study, HFC-134a, at a concentration of 50,000 ppm, produced an increase in late-occurring benign testicular tumors, testicular hyperplasia and testicular weight. The no-effect-level for this study was 10,000 ppm. Animal data show slight fetotoxicity but only at exposure levels producing other toxic effects in the adult animal. Reproductive data on male mice show: No change in reproductive performance. Tests have shown that this material does not cause genetic damage in bacterial or mammalian cell cultures, or in animals. In animal testing, this material has not caused permanent genetic damage in reproductive cells of mammals (has not produced heritable genetic damage).

HFC-143a

Inhalation 4-hour LC50: >540,000 ppm in rats

Single exposures by inhalation to 500,000 ppm caused anesthesia but no mortality at 540,000 ppm. Cardiac sensitization occurred in dogs at 300,000 ppm following an intravenous challenge with epinephrine. Two, 4-week inhalation have been conducted. In the first study, pathological changes in the testes were observed at all exposure concentrations; no effects were observed in females. The testicular effect was considered related to the method used to expose the rats to HFC-143a. In the second study using the same exposure concentrations, no effects were noted in males at any concentration. Data from a 90-day study revealed no effects in male or female rats at exposures up to 40,000 ppm. Long-term exposure caused significantly decreased body weights in male rats fed 300 mg/kg for 52 weeks, but there was no effect on mortality. Tests in rats demonstrated no carcinogenic activity when administered orally 300 mg/kg/day for 52 weeks and observed for an additional 73 weeks. Tests in bacterial cell cultures demonstrated mutagenic activity, but the compound did not induce transformation of mammalian cells in culture or in the whole animal. Tests in animals demonstrate no developmental toxicity.

ECOLOGICAL INFORMATION

Ecotoxicological Information

Aquatic Toxicity

HFC 143a

96-hour LC50, Rainbow trout: >40 mg/L

HFC-134a

48-hour EC50, Daphnia magna: 980 mg/L

96-hour LC50, Rainbow trout: 450 mg/L
-----DISPOSAL CONSIDERATIONS

Waste Disposal

Comply with Federal, State, and local regulations. Reclaim by distillation or remove to a permitted waste disposal facility.

-----TRANSPORTATION INFORMATION

Shipping Information

DOT/IMO/IATA

Proper Shipping Name : Refrigerant Gas R-404A

Hazard Class : 2.2

UN No. : 3337

Label(s) : Nonflammable Gas

Shipping Containers

Tank Cars.

Cylinders

Ton Tanks
-----REGULATORY INFORMATION

U.S. Federal Regulations

TSCA Inventory Status : Reported/Included.

TITLE III HAZARD CLASSIFICATIONS SECTIONS 311, 312

Acute : No
Chronic : No
Fire : No
Reactivity : No
Pressure : Yes

(REGULATORY INFORMATION - Continued)

LISTS:

SARA Extremely Hazardous Substance	-No
CERCLA Hazardous Material	-No
SARA Toxic Chemicals	-No

OTHER INFORMATION

NFPA, NPCA-HMIS

NPCA-HMIS Rating	
Health	: 1
Flammability	: 0
Reactivity	: 1

Personal Protection rating to be supplied by user depending on use conditions.

The data in this Material Safety Data Sheet relates only to the specific material designated herein and does not relate to use in combination with any other material or in any process.

Responsibility for MSDS	: MSDS Coordinator
>	: DuPont Fluoroproducts
Address	: Wilmington, DE 19898
Telephone	: (800) 441-7515

Indicates updated section.

This information is based upon technical information believed to be reliable. It is subject to revision as additional knowledge and experience is gained.

End of MSDS

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11. Tables & Charts

TABLES & CHARTS

P24F SPECIFICATIONS, 400/460 Volt-3 Phase- 50/60Hz

Tube Size	inches (cm)	1 (2.54)	1 1/4 (3.17)	1 1/2 (3.81)
Nominal Capacity⁽¹⁾	Tons/day (M Tons/day)	22.8 (20.6)	23.8 (21.5)	23.1 (20.8)
Overall Dimensions (LxWxH)	Feet (meters)	7.5x8x14.5 (2.3x2.4x4.4)	7.5x8x16 (2.3x2.4x4.8)	7.5x8x16 (2.3x2.4x4.8)
Shipping Weight	lbs (Kg)	12,300 (5,580)	12,700 (5,760)	12,500 (5,670)
Operating Weight	lbs (Kg)	14,190 (6,440)	14,800 (6,720)	14,700 (6,670)
Refrigerant Charge	lbs (Kg)	1200 (544.3)	1200 (544.3)	1200 (544.3)
Total FLA Water Cooled⁽²⁾		99.1	99.1	99.1
Maximum Fuse		225	225	225
Minimum Ampacity		125.4	125.4	125.4
Water Requirements				
-makeup⁽³⁾	gpm (m³/Hr)	4.76 (1.1)	4.98 (1.1)	4.81 (1.1)
-condenser⁽⁴⁾	gpm (m³/Hr)	196 (45.7)	196 (45.7)	196 (45.7)
Connection Sizes				
-makeup water	FPT	3/4"	3/4"	3/4"
-tank drain	FPT	2"	2"	2"
-tank overflow	FPT	3"	3"	3"
-flush water	FPT	3/4"	3/4"	3/4"
-compressor cooling	FPT	1"	1"	1"
-condenser water inlet	FPT	3"	3"	3"
-condenser water outlet	FPT	3"	3"	3"
Compressor (HP-FLA) 50/60Hz		(75 – 120)/(75 – 95)	(75 – 120)/(75 – 95)	(75 – 120)/(75 – 95)
Water Pump (HP-FLA) 50/60Hz		(2 – 3.4)/(2 – 3.1)	(2 – 3.4)/(2 – 3.1)	(2 – 3.4)/(2 – 3.1)
Cutter Motor (HP-FLA) 50/60Hz		(1.5 - 2.9)/(1.5 – 2.5)	(1.5 - 2.9)/(1.5 – 2.5)	(1.5 - 2.9)/(1.5 – 2.5)
THR	Btu/hr (kW)	1,031,625 (302.5)	1,031,625 (302.5)	1,031,625 (302.5)
Marley Cooling Tower⁽⁵⁾				
-dim. (LxWxH)	ft (meters)	4x6.5x7.8 (1.2x2.0x2.4)	4x6.5x7.8 (1.2x2.0x2.4)	4x6.5x7.8 (1.2x2.0x2.4)
-shipping weight	lbs (Kg)	1410 (639)	1410 (639)	1410 (639)
-operating weight	lbs (Kg)	2960 (1,342)	2960 (1,342)	2960 (1,342)
-fan (HP-FLA)		(2 - 3.2)	(2 - 3.2)	(2 - 3.2)
Tower Pump				
-flow	gpm (m³/Hr)	195 (44.2)	195 (44.2)	195 (44.2)
-TDH minimum	ft (m)	55 (16.7)	55 (16.7)	55 (16.7)
-HP-FLA		7.5 – 11	7.5 – 11	7.5 – 11
-connections (inlet x outlet)	FPT	NA	NA	NA
-shipping weight	lbs (Kg)	110 (50.0)	110 (50.0)	110 (50.0)

(1) Nominal capacity is based on 70°F makeup water, 100°F condensing temperature, 70°F ambient, and 25% blowdown.

(2) FLA for 460 volt models is approximately 1/2 that of 230 volt models. Total FLA does not include cooling tower.

(3) Makeup water is maximum value and includes 25% blowdown, each cycle

(4) Condenser flow rate is for 85°F entering water temperature and 100°F condensing.

(5) Tower sized for 75°F wet bulb temperature.

Vogt reserves the right to change designs and specifications without notice.

Table 11-1

P24F Capacity Ratings

Makeup Water Temp. Deg. F	Rated Capacity (lbs/day)											
	60Hz						50Hz					
	Cylinder			Crushed			Cylinder			Crushed		
	1"	1 1/4"	1 1/2"	1"	1 1/4"	1 1/2"	1"	1 1/4"	1 1/2"	1"	1 1/4"	1 1/2"
45	52,000	54,600	53,000	53,924	56,620	54,961	52,000	54,600	53,000	53,924	56,620	54,961
46	51,720	54,280	52,680	53,634	56,288	54,629	51,720	54,280	52,680	53,634	56,288	54,629
47	51,440	53,960	52,360	53,343	55,957	54,297	51,440	53,960	52,360	53,343	55,957	54,297
48	51,160	53,640	52,040	53,053	55,625	53,965	51,160	53,640	52,040	53,053	55,625	53,965
49	50,880	53,320	51,720	52,763	55,293	53,634	50,880	53,320	51,720	52,763	55,293	53,634
50	50,600	53,000	51,400	52,472	54,961	53,302	50,600	53,000	51,400	52,472	54,961	53,302
51	50,360	52,720	51,120	52,223	54,671	53,011	50,360	52,720	51,120	52,223	54,671	53,011
52	50,120	52,440	50,840	51,974	54,380	52,721	50,120	52,440	50,840	51,974	54,380	52,721
53	49,880	52,160	50,560	51,726	54,090	52,431	49,880	52,160	50,560	51,726	54,090	52,431
54	49,640	51,880	50,280	51,477	53,800	52,140	49,640	51,880	50,280	51,477	53,800	52,140
55	49,400	51,600	50,000	51,228	53,509	51,850	49,400	51,600	50,000	51,228	53,509	51,850
56	49,120	51,320	49,720	50,937	53,219	51,560	49,120	51,320	49,720	50,937	53,219	51,560
57	48,840	51,040	49,440	50,647	52,928	51,269	48,840	51,040	49,440	50,647	52,928	51,269
58	48,560	50,760	49,160	50,357	52,638	50,979	48,560	50,760	49,160	50,357	52,638	50,979
59	48,280	50,480	48,880	50,066	52,348	50,689	48,280	50,480	48,880	50,066	52,348	50,689
60	48,000	50,200	48,600	49,776	52,057	50,398	48,000	50,200	48,600	49,776	52,057	50,398
61	47,760	49,920	48,360	49,527	51,767	50,149	47,760	49,920	48,360	49,527	51,767	50,149
62	47,520	49,640	48,120	49,278	51,477	49,900	47,520	49,640	48,120	49,278	51,477	49,900
63	47,280	49,360	47,880	49,029	51,186	49,652	47,280	49,360	47,880	49,029	51,186	49,652
64	47,040	49,080	47,640	48,780	50,896	49,403	47,040	49,080	47,640	48,780	50,896	49,403
65	46,800	48,800	47,400	48,532	50,606	49,154	46,800	48,800	47,400	48,532	50,606	49,154
66	46,560	48,560	47,160	48,283	50,357	48,905	46,560	48,560	47,160	48,283	50,357	48,905
67	46,320	48,320	46,920	48,034	50,108	48,656	46,320	48,320	46,920	48,034	50,108	48,656
68	46,080	48,080	46,680	47,785	49,859	48,407	46,080	48,080	46,680	47,785	49,859	48,407
69	45,840	47,840	46,440	47,536	49,610	48,158	45,840	47,840	46,440	47,536	49,610	48,158
70	45,600	47,600	46,200	47,287	49,361	47,909	45,600	47,600	46,200	47,287	49,361	47,909
71	45,400	47,360	45,960	47,080	49,112	47,661	45,400	47,360	45,960	47,080	49,112	47,661
72	45,200	47,120	45,720	46,872	48,863	47,412	45,200	47,120	45,720	46,872	48,863	47,412
73	45,000	46,880	45,480	46,665	48,615	47,163	45,000	46,880	45,480	46,665	48,615	47,163
74	44,800	46,640	45,240	46,458	48,366	46,914	44,800	46,640	45,240	46,458	48,366	46,914
75	44,600	46,400	45,000	46,250	48,117	46,665	44,600	46,400	45,000	46,250	48,117	46,665
76	44,360	46,160	44,760	46,001	47,868	46,416	44,360	46,160	44,760	46,001	47,868	46,416
77	44,120	45,920	44,520	45,752	47,619	46,167	44,120	45,920	44,520	45,752	47,619	46,167
78	43,880	45,680	44,280	45,504	47,370	45,918	43,880	45,680	44,280	45,504	47,370	45,918
79	43,640	45,440	44,040	45,255	47,121	45,669	43,640	45,440	44,040	45,255	47,121	45,669
80	43,400	45,200	43,800	45,006	46,872	45,421	43,400	45,200	43,800	45,006	46,872	45,421
81	43,200	44,960	43,600	44,798	46,624	45,213	43,200	44,960	43,600	44,798	46,624	45,213
82	43,000	44,720	43,400	44,591	46,375	45,006	43,000	44,720	43,400	44,591	46,375	45,006
83	42,800	44,480	43,200	44,384	46,126	44,798	42,800	44,480	43,200	44,384	46,126	44,798
84	42,600	44,240	43,000	44,176	45,877	44,591	42,600	44,240	43,000	44,176	45,877	44,591
85	42,400	44,000	42,800	43,969	45,628	44,384	42,400	44,000	42,800	43,969	45,628	44,384
86	42,240	43,800	42,600	43,803	45,421	44,176	42,240	43,800	42,600	43,803	45,421	44,176
87	42,080	43,600	42,400	43,637	45,213	43,969	42,080	43,600	42,400	43,637	45,213	43,969
88	41,920	43,400	42,200	43,471	45,006	43,761	41,920	43,400	42,200	43,471	45,006	43,761
89	41,760	43,200	42,000	43,305	44,798	43,554	41,760	43,200	42,000	43,305	44,798	43,554
90	41,600	43,000	41,800	43,139	44,591	43,347	41,600	43,000	41,800	43,139	44,591	43,347

Capacity rating based on 70°F ambient conditions, 100°F SDT temperature.
 Capacity rating is average for the model. Individual machines may vary up to 5% above or below.
 Capacity rating is for clear ice production with makeup water containing no more than 200ppm total dissolved solids.

Table 11-2

TABLES & CHARTS

Condensing Temp. °F	Entering Water Temp. °F	Leaving Water Temp. °F	Water Flow gpm	Pressure Drop psig	Average Total Heat of Rejection BTU/HR
100	50	95	44	1	1,031,625
100	55	95	49	1	1,031,625
100	60	95	56	1	1,031,625
100	65	95	65	2	1,031,625
100	70	95	78	2	1,031,625
100	75	95	98	4	1,031,625
100	80	95	131	7	1,031,625
100	85	95	196	15	1,031,625

Table 11-3
P24F Condenser Water Usage

Make-Up Water Temp. °F	Cylinder Ice			Crushed Ice		
	Tube Size			Tube Size		
	1"	1 1/4"	1 1/2"	1"	1 1/4"	1 1/2"
40	5.58	5.87	5.70	6.90	7.33	7.12
50	5.28	5.53	5.37	6.60	6.91	6.71
60	5.00	5.23	5.07	6.25	6.53	6.33
70	4.76	4.95	4.81	5.95	6.18	6.01
80	4.53	4.71	4.57	5.66	5.88	5.71
90	4.33	4.48	4.36	5.41	5.60	5.45

Includes 25% blowdown per cycle

Table 11-4
P24F Make-Up Water Usage (gpm)

			Suction Pressure (psig) R404a		Discharge Pressure (psig) R404a		Harvest Times (secs)			Ice per cycle Average (lbs)	Freeze Time (minutes)				
			End of Freeze	End of Thaw	End of Freeze	End of Thaw	First Ice	All Ice Out	Total Harvest		Water Temperature (deg. F)				
											90	80	70	60	50
60 HZ	C	1"	38	88	229	99	28	100	130	450	15.2	13.9	12.6	11.3	10.0
	Y	1 1/4"	35	81	235	90	47	135	165	650	20.5	18.3	17.4	16.5	15.0
	L	1 1/2"	30	78	230	106	80	150	180	750	22.0	19.3	18.5	17.7	17.0
	C	1"	48	88	229	99	11	191	212	260	8.7	7.9	7.0	6.1	5.6
	R	1 1/4"	46	81	235	90	13	211	234	375	9.3	8.31	7.5	6.8	6.1
	U	1 1/2"	42	88	233	106	14	226	250	433	12.9	12.0	11.2	10.4	9.4
50 HZ	C	1"	38	88	229	99	28	100	130	450	15.2	13.9	12.6	11.3	10.0
	Y	1 1/4"	35	81	235	90	47	135	165	650	20.5	18.3	17.4	16.5	15.0
	L	1 1/2"	30	78	230	106	80	150	180	750	22.0	19.3	18.5	17.7	17.0
	C	1"	48	88	229	99	11	191	212	260	8.7	7.9	7.0	6.1	5.6
	R	1 1/4"	46	81	235	90	13	211	234	375	9.3	8.31	7.5	6.8	6.1
	U	1 1/2"	42	88	233	106	14	226	250	433	12.9	12.0	11.2	10.4	9.4

Table 11-5A
P24F Normal Operating Vitals For R-404a

			Suction Pressure (psig) R22		Discharge Pressure (psig) R22		Harvest Times (secs)			Ice per cycle Average (lbs)	Freeze Time (minutes)				
			End of Freeze	End of Thaw	End of Freeze	End of Thaw	First Ice	All Ice Out	Total Harvest		Water Temperature (deg. F)				
											90	80	70	60	50
60 HZ	C	1"	32	70	190	80	28	100	130	450	15.2	13.9	12.6	11.3	10.0
	Y	1 1/4"	30	65	195	73	47	135	165	650	20.5	18.3	17.4	16.5	15.0
	L	1 1/2"	27	70	194	85	80	150	180	750	22.0	19.3	18.5	17.7	17.0
	C	1"	37	70	190	80	11	191	212	260	8.7	7.9	7.0	6.1	5.6
	R	1 1/4"	34	65	195	73	13	211	234	375	9.3	8.31	7.5	6.8	6.1
	U	1 1/2"	31	70	194	85	14	226	250	433	12.9	12.0	11.2	10.4	9.4
50 HZ	C	1"	32	70	190	80	28	100	130	450	15.2	13.9	12.6	11.3	10.0
	Y	1 1/4"	30	65	195	73	47	135	165	650	20.5	18.3	17.4	16.5	15.0
	L	1 1/2"	27	70	194	85	80	150	180	750	22.0	19.3	18.5	17.7	17.0
	C	1"	37	70	190	80	11	191	212	260	8.7	7.9	7.0	6.1	5.6
	R	1 1/4"	34	65	195	73	13	211	234	375	9.3	8.31	7.5	6.8	6.1
	U	1 1/2"	31	70	194	85	14	226	250	433	12.9	12.0	11.2	10.4	9.4

Table 11-5B
P24F Normal Operating Vitals For R-22

TABLES & CHARTS

RECOMMENDED SPARE PARTS LIST**Vogt Model P24F Tube-Ice[®] Machine**

QTY	P24F PART NO.	DESCRIPTION
1	12A7503E22	Thaw timer 208/230
1	12A2590G10	Suction pressure gage 30"-150# / R22
1	12A2590G11	Discharge pressure gage 30"-400# / R22
1	12A4200H0601	Roberts float valve 3/4"
1	12A4200HP01	10" float valve stem
1	12A4200HP02	Float for Roberts 6"
1	12A2600G08	Freezer cover gasket (P24-27" o.d., P34-37" o.d.)
1	12A2600G09	Water tank gasket (P24-30" o.d.,P34-40" o.d.)
1	12A2625G05	Gage glass 1/2" x 29" lg.
2	12A4199V26	Gage glass O-ring
1	12A2117C03	Freezer pressure switch Asco #PA16A
1	12A2117T03	Transducer for above control Asco RE10A44
1	12A7515E22	Control Circuit Breaker (190/208/230V-50/60Hz)
1	12A7515E21	Control Circuit Breaker (380/460V-50/60Hz)
1	12A7515E08	Circuit Breaker 15 amp.
144	12B2185V31	Water distributors 1 1/2" (P34-306 Req'd)
198	12B2185V21	Water distributors 1 1/4" (P34-420 Req'd)
264	12B2185V12	Water distributors 1" (P34-564 Req'd)
as req'd	126531RED	Red vent tubes (one per water distributor)
1	12A4200A0607	Flush valve Sporlan 3/4" FPT solenoid
1	12B2615D03	P24 drive gear--aluminum, bronze
2	12A7503E22	Timer (delay on make)
2	12A7503E39	Timer Base
1	12A7530E56	Cutter Motor Starter (190/208/230V-50/60Hz)
1	12A7530E55	Cutter Motor Starter (380/460V-50/60Hz)
1	12A7530E56	Pump Motor Starter (190/208/230V-50/60Hz)
1	12A7530E54	Pump Motor Starter (380V-50Hz)
1	12A7530E55	Pump Motor Starter (460V-60Hz)
2	12A7517E27	Relay
1	12B7503E20	Elapsed Timer (50Hz)
1	12B7503E21	Elapsed Timer (60Hz)
1	12B2060B01	Hub for drive gear

TO ORDER SPARE PARTS, PLEASE CONTACT YOUR DISTRIBUTOR.

**TEMPERATURE - PRESSURE CHART
FOR COMMON REFRIGERANTS (°F-psig)**

Deg F	R-12	R-22	R-502	R-134a	R-404A	R-717	MP-39	Deg F	R-12	R-22	R-502	R-134a	R-404A	R-717	MP-39
-50	-7.6	-3.0	0.2	-9.0	0.0	-7.0	-9.1	50	46.7	84.0	97.4	45.5	102.9	74.2	45.3
-48	-7.2	-2.4	0.7	-8.7	0.8	-6.5	-8.7	52	48.8	87.3	101.0	47.7	109.0	77.7	60.0
-46	-6.8	-1.7	1.5	-8.3	1.6	-6.0	-8.3	54	51.0	90.8	104.8	50.1	113.0	81.3	62.0
-44	-6.3	-1.0	2.3	-8.0	2.5	-5.4	-7.9	56	53.2	94.3	108.6	52.3	117.0	84.9	65.0
-42	-5.8	-0.2	3.2	-7.6	3.4	-4.9	-7.4	58	55.4	97.9	112.4	55.0	121.0	88.7	68.0
-40	-5.4	0.5	4.1	-7.1	5.5	-4.3	-7.1	60	57.7	101.6	116.4	57.5	125.0	92.6	70.0
-38	-4.9	1.3	5.0	-6.7	6.5	-3.6	-6.6	62	60.1	105.4	120.4	60.1	130.0	96.6	73.0
-36	-4.4	2.2	6.0	-6.3	7.5	-3.0	-6.1	64	62.5	109.3	124.6	62.7	134.0	100.7	76.0
-34	-3.8	3.0	7.0	-5.8	8.6	-2.3	-5.6	66	65.0	113.2	128.8	65.5	139.0	104.9	79.0
-32	-3.3	4.0	8.1	-5.3	9.7	-1.6	-5.2	68	67.6	117.3	133.2	68.3	144.0	109.3	82.0
-30	-2.7	4.9	9.2	-4.8	10.8	-0.8	-4.4	70	70.2	121.4	137.6	71.2	148.0	113.7	85.0
-28	-2.1	5.9	10.3	-4.2	12.0	0.0	-4.1	72	72.9	125.7	142.2	74.2	153.0	118.3	89.0
-26	-1.5	6.9	11.5	-3.8	13.2	0.8	-3.4	74	75.6	130.0	146.8	77.2	158.0	123.1	92.0
-24	-0.8	7.9	12.7	-3.0	14.5	1.7	-2.9	76	78.4	134.5	151.5	80.3	164.0	127.9	95.0
-22	-0.1	9.0	14.0	-2.4	15.8	2.6	-2.2	78	81.3	139.0	156.3	83.5	169.0	132.8	99.0
-20	0.6	10.1	15.3	-1.8	17.1	3.5	-1.7	80	84.2	143.6	161.2	86.8	174.0	137.9	102.0
-18	1.3	11.3	16.7	-1.1	18.5	4.5	-1.0	82	87.2	148.4	166.2	90.2	180.0	143.2	106.0
-16	2.1	12.5	18.1	-0.4	20.0	5.6	-0.2	84	90.2	153.2	171.4	93.6	185.0	148.5	109.0
-14	2.8	13.8	19.5	0.3	21.5	6.7	0.4	86	93.3	158.2	176.6	97.1	191.0	154.1	113.0
-12	3.7	15.1	21.0	1.1	23.0	7.8	1.4	88	96.5	163.2	181.9	100.7	197.0	159.7	117.0
-10	4.5	16.5	22.6	1.9	24.6	8.9	2.2	90	99.8	168.4	187.4	104.4	203.0	165.5	121.0
-8	5.4	17.9	24.2	2.8	26.3	10.2	3.1	92	103.1	173.7	192.9	108.2	209.9	171.4	125.0
-6	6.3	19.3	25.8	3.6	28.0	11.4	3.9	94	106.5	179.1	198.6	112.1	215.0	177.5	129.0
-4	7.2	20.8	27.5	4.5	29.8	12.8	4.8	96	110.0	184.6	204.3	116.1	222.0	183.7	133.0
-2	8.2	22.4	29.3	5.5	31.6	14.2	5.7	98	113.5	190.2	210.2	120.1	229.0	190.1	138.0
0	9.2	24.0	31.1	6.5	33.5	15.6	6.7	100	117.2	195.9	216.2	124.3	235.0	196.1	142.0
2	10.2	25.6	32.9	7.5	35.6	17.1	7.7	102	120.9	201.8	222.3	128.5	242.0	203.3	146.0
4	11.2	27.3	34.9	8.5	37.4	18.6	8.8	104	124.7	207.7	228.5	132.9	249.0	210.2	151.0
6	12.3	29.1	36.9	9.6	39.4	20.3	9.9	106	128.5	213.8	234.9	137.3	256.0	217.2	156.0
8	13.5	30.9	38.9	10.8	41.6	21.9	11.0	108	132.4	220.0	241.3	142.8	264.0	224.4	160.0
10	14.6	32.8	41.0	12.0	43.9	23.7	12.2	110	136.4	226.4	247.9	146.5	271.0	231.7	165.0
12	15.8	34.7	43.2	13.1	46.0	25.4	13.4	112	140.5	232.8	254.6	151.3	279.0	239.2	170.0
14	17.1	36.7	45.4	14.4	48.3	27.4	14.6	114	144.7	239.4	261.5	156.1	286.0	246.9	175.0
16	18.4	38.7	47.7	15.7	50.7	29.3	15.9	116	148.9	246.1	268.4	161.1	294.0	254.8	180.0
18	19.7	40.9	50.0	17.0	53.1	31.3	17.2	118	153.2	252.9	275.5	166.1	302.0	262.8	185.0
20	21.0	43.0	52.5	18.4	55.6	33.3	18.6	120	157.7	259.9	282.7	171.3	311.0	271.0	191.0
22	22.4	45.3	54.9	19.9	58.2	35.5	20.0	122	162.2	267.0	290.1	176.6	319.0	279.4	196.0
24	23.9	47.6	57.5	21.4	59.9	37.7	21.5	124	166.7	274.3	297.6	182.0	328.0	288.0	202.0
26	25.4	49.9	60.1	22.9	63.6	40.0	23.0	126	171.4	281.6	305.2	187.5	336.0	296.7	207.0
28	26.9	52.4	62.8	24.5	66.5	42.4	24.6	128	176.2	289.1	312.9	193.1	345.0	305.7	213.0
30	28.5	54.9	65.6	26.1	69.4	44.8	26.2	130	181.0	296.8	320.8	198.9	354.0	314.8	219.0
32	30.1	57.5	68.4	27.8	72.3	47.4	27.9	132	185.9	304.6	328.9	204.7	364.0	324.2	225.0
34	31.7	60.1	71.3	29.5	75.4	50.0	29.6	134	191.0	312.5	337.1	210.7	373.0	333.7	231.0
36	33.4	62.8	74.3	31.3	78.5	52.7	31.3	136	196.2	320.6	345.4	216.8	383.0	343.4	237.0
38	35.2	65.6	77.4	33.2	81.8	55.5	33.2	138	201.3	328.9	353.9	223.0	392.0	353.4	243.0
40	36.9	68.5	80.5	35.1	85.1	58.4	35.0	140	206.6	337.3	362.6	229.4	402.0	363.5	250.0
42	38.8	71.5	83.8	37.0	88.5	61.3	37.0	142	212.0	345.8	371.4	235.8	412.0	373.8	256.0
44	40.7	74.5	87.0	39.1	91.9	64.4	39.0	144	217.5	354.5	380.4	242.4	423.0	384.4	263.0
46	42.7	77.6	90.4	42.0	95.5	67.6	41.0	146	223.1	363.4	389.5	249.2	434.0	395.2	269.0
48	44.7	80.7	93.9	43.3	99.2	70.8	43.1	148	228.8	372.3	398.9	256.0	444.0	406.1	277.0
50	46.7	84.0	97.4	45.5	102.9	74.2	45.3	150	234.6	381.5	408.4	263.0	449.0	432.0	283.0

TABLE 11-6
All pressures are in lbs/in² gage (psig).

TABLES & CHARTS

REFERENCE INFORMATION**CONVERSION FACTORS: English to Metric**

To Convert	From	To	Multiply by
Area	ft ²	m ²	9.2903e-2
	in ²	m ²	6.416 e-4
Energy	BTU	Joule (J)	1054.48
	hp	BTU/Hr	2546.2
	kW	hp	1.34
Length	ft.	m.	0.3048
	in.	m.	0.0254
Pressure	lbf/ft ²	Paschals	47.88
	lbf/in ² (psi)	Paschals	6894.76
	in. Hg	psi	0.491
	in H ₂ O	psi	0.03612
Temperature	°F	°C	$T_C = 5/9 * (T_F - 32)$
	°C	°F	$T_F = (9/5 * T_C) + 32$
Volume	ft ³	m ³	2.8317e-2
	gal(U.S.)	m ³	3.7854e-3
	ft ³	gal(U.S.)	7.48

TABLE 11-7**CONSTANTS**

Specific heat of Water	1 BTU/(lbm °F)
Specific heat of Air	4.19 kJ/(kg °C) 0.24 BTU/(lbm °F)
Tube-Ice Density	32-35 lbs/ft ³
Ice Latent Heat	144 BTU/hr
Water Sensible Heat	1 BTU/(lb °F)
Ice Melting Effect (IME) 1 Ton Refrigeration	12,000 BTU/hr
Atmospheric pressure	14.7 psia
Weight of Water	62.4 lbs/ft ³ 8.33 lbs/gal
1 gpm water	12013 lb/day
Weight of air	0.0749 lbs/ft ³ 0.0100 lbs/gal
1 Horsepower	2545.6 BTU/hr
1 Kilowatt	1.34 horsepower
Gravitational accel.	9.81 m ² /sec

TABLE 11-8