TURBO

REFRIGERATING COMPANY

C-LINE ICEMAKER
FREON® MODELS
OPERATION & MAINTENANCE MANUAL

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Company: **Index West International**
Attention: **Tom Bernacchi**
Address: **426 S. Cleveland**
Oceanside, CA 92054

Phone Number: **614-433-3591**

Date: **August 13, 1992**

Serial Number:
and/or
❑ Reference ■ Duplicate ❑ Control Panel

Manual Number: **63**
Manual Edition: **7/92** Revision:
Electrical Schematic:
Piping Schematic:

Model:
- ❑ CF
- ❑ SC
- ❑ SCA
- ❑ SCE
- ❑ SCAR
- ❑ SCER
- ❑ R
- ❑ Model Number:

Voltage:
- ❑ 230/3/60
- ❑ 460/3/60
- ❑ Spcl:

All controls 115/1/60.

- ❑ Supplied 230/1/60 to 115/1/60 control circuit transformer.

Options:
- ❑ Slow Speed Breaker Bar
- ❑ Slush Kit
- ❑ Winterizing
- ❑ Weatherizing
- ❑ Preheaters
- ❑ Dump Valves
- ❑ Thermostatic Water Blending Valves
- ❑ Cooling Tower (SC Model)
- ❑ Cooling Tower Pump (SC Model)
- ❑ Air-Cooled Condenser With Flood-Back Controls & Starters (SCAR Model)
- ❑ Evaporative Condenser With Damper Controls (SCER Model)
- ❑ Programmable Controller
- ❑ Outboarding of Compressors
- ❑ Mirror Image Units
- ❑ Other:

R-22 SERVICE DISCLAIMER

This manual (prepared prior to the regulations resulting from the Clean Air Act of 1990) contains recommendations and procedures for service work on refrigeration equipment utilizing refrigerant R-22. The Clean Air Act of 1990 will result in changes to the procedures in this manual for handling refrigerant R-22.

The owner and/or service provider using this manual is responsible for compliance with all local, state, or federal codes and regulations regardless of the procedures or recommendations cited in this manual, which are not intended to supersede or contradict applicable regulations in effect at the time of service.

CONTENTS

FIGURES & TABLES

Read Safety Section before installing or using equipment.

INTRODUCTION

Turbo Refrigerating Company offers this manual as a guide to owners and operators of TURBO® icemaking systems in maintaining the equipment for reliable and efficient operation. TURBO supplies icemakers and storage systems for use in producing high quality plate ice. TURBO does not engineer or design buildings, warehouses, mechanical rooms, or any structures that use icemaking equipment but can assist in all phases of selecting the proper equipment to meet the needs of the customer.

Information on safety, installation, operation, maintenance, and trouble shooting is contained in this manual. If you have questions concerning any of these phases, contact Turbo Refrigerating Company or one of its distributors to ensure you fully understand the instructions and guidelines.

You must read all of the information carefully and make sure that all personnel involved in the installation and operation have also read and understood the information and safety instructions. This will help avoid injury to personnel and/or damage to the equipment. Both are valuable assets to your operation. **Take the time to protect them.**

Read the manual contents before you start your installation or operation. Review the installation instructions prior to the actual rigging operation to ensure that the necessary materials and tools will be available at the jobsite when the equipment arrives.

History

Since 1960, Turbo Refrigerating Company has made the highest quality industrial icemakers available on the market. Since developing the plate icemaker, TURBO has been the leader in icemaking technology. TURBO's ability to respond to its customer's needs is one of the primary reasons that TURBO has become the major supplier in the industrial icemaker market. This ability, along with TURBO's commitment to provide high quality, reliable equipment is incorporated in all of its icemaking products.

The TURBO nameplate on the electrical control panel has the serial number along with other information. This information should be recorded and used whenever referring to the equipment.

If you have an application or a need that is not discussed here, contact the sales department of Turbo Refrigerating Company or a TURBO distributor to discuss your needs:

Turbo Refrigerating Company
P.O. Box 396
Denton, Texas
76202-0396
Phone: 817-387-4301
Fax: 817-382-0364

Model Descriptions

All icemakers are provided with:

- Stainless steel exterior panels
- Control panel with programmable controller (standard on models built from 1992 to date; earlier models are equipped with electro-mechanical controls and cam timers)
- Stainless steel evaporator plates
- PVC water circulating tubes
- 230/3/60 or 460/3/60 motors with 115/1/60 controls; magnetic starter with overload protection for each motor
- Open compressors direct-coupled to an open-drip proof motor, a semi-hermetic compressor, a screw compressor, or multiple open reciprocating compressors

- Suction accumulator/heat exchangers for maximum compressor protection
- Complete safety console with gauges and safety switches for high and low pressure, oil pressure, and oil temperature protection
- Breaker bar and ice sizing mechanism

All surfaces in contact with the water or ice are either stainless steel, PVC, or hot-dipped galvanized for maximum corrosion resistance.

Note:
Freon® will be referred to as R-22 in this manual.

CF Series Models

All current refrigerant R-22 models are designated by 'CF'. The 'C' represents the plate configuration and the 'F' represents R-22 (Freon®).

Prior to 1978, 'BF' series units were built. The primary difference between the 'B' and the 'C' series plate configuration is the spacing between the icemaking surfaces of each plate set. Refer to Figure 1-1. 'B' series spacing is wider than the current 'C' series. Additional space available between the plate sets permits thicker ice production without freeze-up.

The TURBO model number consists of three parts. For example:

<u>CF</u> <u>40</u> <u>SC</u>

CF = C-series evaporator plates, refrigerant R-22

40 = Number of evaporator plates used (also determines icemaking capacity in tons of ice)

SC = Method of high side condensing

Refer to TURBO product literature for a complete listing of models and tonnages available.

SC (self-contained high & low side)

- Completely self-contained, including refrigerant charge
- Uses a water-cooled condenser with water regulating valves
- Optional cooling tower pump and starters for cooling tower pump and fan(s) are available

SCA (self-contained air-cooled)

- Completely self-contained, including refrigerant charge
- Uses an air-cooled condenser and includes a refrigerant receiver

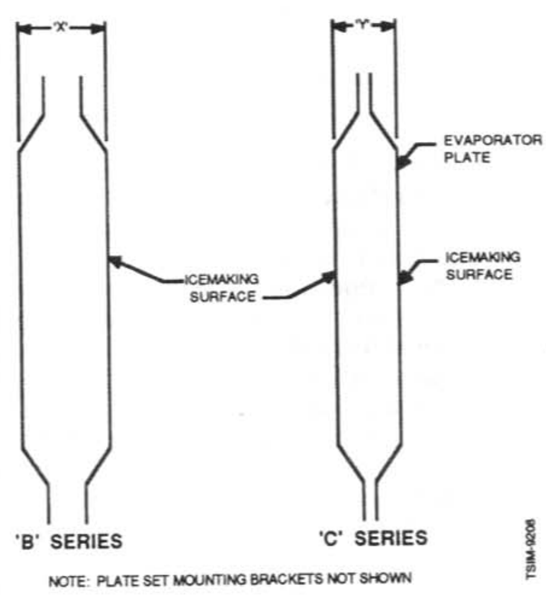


Figure 1-1 'B' and 'C' Series Icemakers Plate Set Spacing

- Head pressure controls provided with the air-cooled condenser
- Complete unit and condenser are mounted on a common base frame

SCE (self-contained evaporative-cooled condenser)

- Completely self-contained, including refrigerant charge
- Uses an evaporative-cooled condenser and includes a refrigerant receiver
- Head pressure controls provided with the evaporative-cooled condenser (damper controls are standard)
- Complete unit and condenser are mounted on a common base frame

SCAR (self-contained air-cooled remote)

- Unit set up for remote air-cooled condenser
- Air-cooled condenser head pressure controls and starters for the condenser fan(s) can be furnished as options
- No refrigerant charge
- Receiver and isolating valves are shipped loose
- Interconnecting wiring and pumping by others

SCER (self-contained evaporative remote)

- Unit set up for remote evaporative-cooled condenser
- Evaporative-cooled condenser head pressure controls and starters for the condenser pump and fan(s) can be furnished as options
- No refrigerant charge
- Receiver and isolating valves are shipped loose
- Interconnecting wiring and piping by others

R (low side evaporator only)

- No high side or condenser
- No refrigerant charge
- High side piping and wiring by others

TURBO® Equipment

TURBO® Plate Icemaker
Since 1960, TURBO has provided icemaking equipment for the packaged ice industry. TURBO® icemakers for this application produce a dry, subcooled, and uniform sized ice suitable for bagging and distribution to convenience and grocery stores. Stainless steel, PVC, or hot dip galvanizing is used everywhere the ice comes into contact with the icemaker to ensure a sanitary product. These icemakers are USDA approved and suitable for use in food processing applications.

TURBO®
Ice Generator (TIG)
Standard TURBO® icemakers (above) use a water defrost and produce a dry hard ice on one side of the evaporator plate. TIG ice generators use hot gas defrost and produce ice on both sides of the evaporator plate. TIG ice is wet when compared to the C-series icemaker ice. With proper handling, TIG ice can be used for packaged ice applications. TURBO® ice rake systems allow the ice to "cure" in the storage bin before going to the bagging line.

TIG models do not have an ice sizing mechanism (standard on C-series). A TURBO® ice sizer must be used to obtain the uniform ice nugget sizing required.

All parts of the TIG ice generator that are in contact with ice or water are either stainless steel, PVC, or hot-dipped galvanized. These models have preliminary USDA approval.

Since these models use both sides of the evaporator plates, the overall size of the unit is smaller than the C-series models of the same tonnage. This means lower installation and operating cost per ton of ice. There are no minimum make-up water temperature requirements because hot gas defrost is used.

TURBO® Block Press
TURBO offers another feature to make it possible to maximize your ice production. Instead of throwing away the snow produced by the breaker bar, screw conveyors or other handling devices, install a TURBO® block press. The block press converts the snow into a ten or fifty-five pound block of ice.

Introduced in 1977, the block press is a completely automatic hydraulic powered unit capable of producing from 120 to an excess of 400 ten pound blocks per hour. The block press includes a block bagger attachment which again means:

- less handling
- a better product
- higher profits for the ice person

Rugged industrial construction and stainless steel or PVC in all areas of ice contact make the TURBO® block press the most reliable on the market.

TURBO® Ice Rake
TURBO offers the only proven automatic ice storage and delivery system (from 20 to 300 ton capacities).

There are two basic sizes in the hydraulic version as well as two larger versions known as "automatic ice rakes". The smaller hydraulic models range in capacity from 20 to 75 tons of ice while the larger automatic ice rakes range from 100 to 300 tons of ice storage.

All TURBO® ice storage systems are USDA approved. Each system is designed to make the loading and unloading of the ice storage system as safe and simple as possible. TURBO® ice rakes are self-leveling and self-unloading.

TURBO® Ice Sizer
The ice sizer is an all stainless steel cutter assembly designed for installation in the delivery system to a bagging line. It converts large irregular fragments of ice (typical from a TIG ice generator) into a uniform nugget suitable for packaging. A minimum of snow is produced. The addition of the ice sizer to the TIG provides an effective combination to produce a uniform low-cost ice.

Associated TURBO® Equipment

Instantaneous Fluid Chiller
Stainless steel evaporator plates are mounted in a stainless steel frame and paneling over a sump. Make-up water up to 90°F (consult the factory for higher temperature requirements) enters the chiller and leaves at 33°F without requirements for recirculating the water. Chillers are used primarily in industrial applications such as beef and poultry chilling, vegetables, chemical processes, and other applications requiring 33°F water on a continuous basis.

TURBO® chillers can also be used with TIG ice generators to reduce the make-up water temperature. As the make-up water temperature is reduced, ice production is increased.

TURBO® Ammonia (NH3) Plate Icemaker
TURBO builds a complete line of ammonia (NH3) icemakers using the same basic features as the refrigerant R-22 models. These models are designated as CAR or CAR-LR.

CAR models are low side evaporators only for installation in plants with existing NH3 high side(s) and liquid recirculation unit(s). CAR-LR models are the same as the CAR models except that a built-in NH3 recirculation system is provided. This unit is connected to an NH3 high side.

Both CAR and CAR-LR models are available in ice capacities for 5 to 60 tons per day. Refer to TURBO product literature for a complete listing of models and ice production rates.

Ammonia (NH3)
High Side (Optional)
Complete skid mounted NH3 high sides including the:

- NH3 compressor/motor set
- condenser (water-cooled only; air-cooled or evaporative can be provided but may require separate field installation)
- controls
- isolation valves

are available. On CAR models, an NH3 liquid recirculation unit is also required. On CAR-LR models, the addition of the high side completes the refrigeration system. High sides can be provided for single icemakers (dedicated use) or for multiple icemakers.

Ammonia (NH3)
Liquid Recirculation Unit
Complete skid mounted recirculation packages consisting of the:

- surge drum
- recirculation pump(s)
- oil recovery system, controls, regulators
- isolation valves

are available. This package is used only with CAR models to provide the recirculated liquid to the evaporator.

Recirculation units can be provided for single or multiple icemakers. All vessels used in the recirculation are ASME coded.

TURBO® Pneumatic Delivery System
TURBO provides a complete line of pneumatic blowers, rotary airlocks, two and three-way diverter valves, and cyclones for use in transporting ice long distances. Pneumatic delivery systems are used primarily in industrial applications such as:

- fish hole icing
- truck icing
- top icing in the field
- concrete icing
- chemical processes
- other applications where "central" ice product operations are located remotely from the processing area in which the ice is to be used

Complete delivery systems including piping can be provided for easy field installation.

Typical Industrial Applications

- produce (broccoli, carrots, etc.)
  - top icing in the field or in the processing area
  - units can be trailer mounted
- concrete icing
- ingredient icing (as in bakeries)
- fish icing
- poultry icing
- chemical and dye processes
- emergency cooling loads
- ice slurries
- catering trucks
- salad bars or display ice
- food processing
- packaged ice for convenience stores

Customer Service

The TURBO service department provides assistance for all customer needs. TURBO conducts training schools at the factory and various locations throughout the world. For information, contact the service department at Turbo Refrigerating Company.

The model and serial number of your TURBO® equipment is located on the nameplate attached to the electrical control panel. Please refer to the model and serial number when making inquiries about the equipment. This will enable our personnel to handle your questions quickly and accurately.

High Values

TURBO highly values its friends and customers in the industry. Please remember to:

T hink safely - act safely.

U nderstand operating procedures and dangers of the equipment.

R emember to think before you act.

B efore you act, understand- the consequences of your actions.

O bserve equipment warnings and labels.

TERMS & CONDITIONS

Turbo Refrigerating Co. (the "Company") agrees to sell the Equipment described herein upon the following terms and conditions of sale which, accordingly, supersede any of Buyer's additional or inconsistent terms and conditions of purchase.

1. TERMS AND PRICES

(a) All orders are to be accompanied by a twenty percent (20%) down payment or an acceptable irrevocable letter of credit confirmed on a U.S. Bank acceptable to Turbo. No orders are to be entered without payment or L/C in hand.

(b) All orders are subject to the approval of the Company's home office. Unless otherwise stated, standard terms of payment are thirty (30) days net from the earlier of date of shipment or readiness of the Equipment for shipment. If partial shipments are made, payment shall become due and payable to the partial shipment.

(c) In addition to the purchase price, Buyer shall pay any excise, sales, privilege, use or any other taxes, Local, State or Federal, which the Company may be required to pay arising from the sale or delivery of the Equipment or the use thereof. Prepaid freight, if applicable, will be added to the purchase price and invoiced separately. Where price includes transportation or other shipping charges, any increases in transportation rates or other shipping charges from date of quotation or purchase order shall be for the account of and paid by Buyer.

(d) Contract prices are subject to adjustment to the Company's prices in effect at time of shipment unless otherwise specified in a separate Price Adjustment Policy attached to the proposal or other contract document of the Company.

(e) If Buyer requests changes in the Equipment or delays progress of the manufacture or shipment of the Equipment, the contract price shall be adjusted to reflect increases in selling price caused thereby.

2. SHIPMENT

Shipment is F.O.B. Company's plant or place of manufacture, unless otherwise specified. Risk of loss shall pass to Buyer upon delivery to transporting carrier.

3. DELIVERY

(a) The Company will endeavor to make shipment of orders as scheduled. However, all shipment dates are approximate only, and the Company reserves the right to readjust shipment schedules.

(b) Under no circumstances will the Company be responsible or incur any liability for costs or damages of any nature (whether general, consequential, as a penalty or liquidated damages or otherwise) arising out of or owing to (i) any delays in delivery or (ii) failure to make delivery at agreed or specified times due to circumstances beyond its reasonable control.

(c) If shipment is delayed or suspended by Buyer, Buyer shall pay (i) Company's invoice for the Equipment as per payment terms, (ii) Company's handling and storage charges then in effect, and (iii) demurrage charges if loaded on rail cars.

4. LIMITED WARRANTY; WARRANTY ADJUSTMENT; EXCLUSIONS; LIMITATION OF LIABILITY

(a) LIMITED WARRANTY
The Company warrants that at the time of shipment the Equipment manufactured by it shall be merchantable, free from defects in material and workmanship and shall possess the characteristics represented in writing by the Company. The Company's warranty is conditioned upon the Equipment being properly installed and maintained and operated within the Equipment's capacity under normal load conditions with competent supervised operators and, if the Equipment uses water, with proper water conditioning. Equipment, accessories

and other parts and components not manufactured by the Company are warranted only to the extent of and by the original manufacturer's warranty to the Company, in no event shall such other manufacturer's warranty create any more extensive warranty obligations of the Company to the Buyer than the Company's warranty covering Equipment manufactured by the Company.

(b) EXCLUSIONS FROM WARRANTY

(i) THE FOREGOING IS IN LIEU OF ALL OTHER WARRANTIES, ORAL OR EXPRESS OR IMPLIED, INCLUDING ANY WARRANTIES THAT EXTEND BEYOND THE DESCRIPTION OF THE EQUIPMENT. THERE ARE NO EXPRESS WARRANTIES OTHER THAN THOSE CONTAINED IN THIS PARAGRAPH 4 AND TO THE EXTENT PERMITTED BY LAW THERE ARE NO IMPLIED WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE. THE PROVISIONS OF THIS PARAGRAPH 4 AS TO DURATION, WARRANTY ADJUSTMENT AND LIMITATION OF LIABILITY SHALL BE THE SAME FOR BOTH IMPLIED WARRANTIES (IF ANY) AND EXPRESS WARRANTIES.

(ii) The Company's warranty is solely as stated in (a) above and does not apply or extend, for example, to expendable items, ordinary wear and tear, altered units; units repaired by persons not expressly approved by the Company, materials not of the Company's manufacture, or damage caused by accident, the elements, abuse, misuse, temporary heat, over-loading, or by erosive or corrosive substances or by the alien presence of oil, grease, scale, deposits or other contaminants in the Equipment.

(c) WARRANTY ADJUSTMENT

Buyer must make claim of any breach of any warranty by written notice to the Company's home office within thirty (30) days of the discovery of any defect. The Company agrees at its option to repair or replace, BUT NOT INSTALL, F.O.B. Company's plant, any part or parts of the Equipment which within twelve (12) months from the date of initial operation but no more than eighteen (18) months from date of shipment shall prove to the Company's satisfaction (including return to the Company's plant, transportation prepaid, for inspection, if required by the Company) to be defective within the above Warranty. Any warranty adjustments made by the Company shall not extend the initial warranty period set forth above. The warranty period for replacements made by the Company shall terminate upon the termination of the initial warranty period set forth above. Expenses incurred by Buyer in replacing or repairing or returning the Equipment or any part or parts will not be reimbursed by the Company.

(d) SPARE AND REPLACEMENT PARTS WARRANTY ADJUSTMENT

The Company sells spare and replacement parts. This subparagraph (d) is the Warranty Adjustment for such parts. Buyer must make claim of any breach of any spare or replacement parts warranty by written notice to the Company's home office within thirty (30) days of the discovery of any alleged defect for all such parts manufactured by the Company. The Company agrees at its option to repair or replace, BUT NOT INSTALL, F.O.B. Company's plant, any part or parts of material it manufactures which, within one (1) year from the date of shipment shall prove to the Company's satisfactory (including return to the Company's plant, transportation prepaid, for inspection, if required by the Company) to be defective within this Parts Warranty. The Warranty and warranty period for spare and replacement parts not manufactured by the Company (purchased by the Company, from third party suppliers) shall be limited to the Warranty and Warranty Adjustment extended to the Company by the original manufacturer of such parts, in no event shall such other manufacturer's warranty create any more extensive warranty obligation of the Company to the Buyer for such parts than the Company's Warranty Adjustment covering parts manufactured by the Company as set forth in this subparagraph (d). Expenses incurred by the Buyer in replacing, repairing, or returning the spare or replacements parts will not be reimbursed by the Company.

(e) LIMITATION OF LIABILITY
The above Warranty Adjustment sets forth Buyer's exclusive remedy and the extent of the Company's liability for breach of implied (if any) and express warranties, representations, instructions or defects from any cause in connection with the sale or use of the Equipment. THE COMPANY SHALL NOT BE LIABLE FOR ANY SPECIAL, INDIRECT OR CONSEQUENTIAL DAMAGES OR FOR LOSS, DAMAGE OR EXPENSE, DIRECTLY OR INDIRECTLY ARISING FROM THE USE OF THE EQUIPMENT OR FROM ANY OTHER CAUSE WHETHER BASED ON WARRANTY (EXPRESS OR IMPLIED) OR TORT OR CONTRACT, and regardless of any advices or recommendations that may have been rendered concerning the purchase, installation or use of the Equipment.

5. PATENTS

(a) PATENT INDEMNITY AND CONDITIONS
The Company agrees at its own expense to defend and hold Buyer harmless in the event of any suits instituted against Buyer for an alleged infringement of any claim of any United States Patent covering solely to the structure of the Equipment as originally manufactured by the Company per the Company's specifications, and without modification by the Buyer, provided buyer shall (i) have given the Company immediate notice in writing of any such claim or institution or threat of such suit, and (ii) have permitted the Company to defend or settle the same, and have given all needed information assistance and authority to enable the Company to do so. Buyer shall defend and indemnify the Company against all expenses, costs and loss by reason of any real or alleged infringement by the Company's incorporating a design or modification requested by Buyer.

(b) LIMITATION OF LIABILITY
The Company's total liability hereunder is expressly limited to an amount no greater than the sales price of the Equipment and may be satisfied by the Company's refunding to Buyer, at the Company's option, the sales price of the Equipment in the event the Company elects to defend any such suit and the structure of the said Equipment is held to infringe any such United States Patent and if the Buyer's use thereof is enjoined, the Company shall, at its expense and at its option (i) obtain for the Buyer the right to continue using the Equipment, or (ii) supply non-infringing Equipment for installation by Buyer, or (iii) modify the Equipment so that it becomes non-infringing, or (iv) refund the then market value of the Equipment.

6. PRIOR USE

If damage to the Equipment or other property or injury to persons is caused by use or operation of the Equipment prior to being placed in initial operation ("Start up") by the Company where start up is included in the purchase price, then Buyer shall indemnify and hold the Company harmless from all liability, costs and expenses for all such damage or injury.

7. EQUIPMENT CHANGES

The Company may, but shall not be obligated to, incorporate in the Equipment any changes in specifications, design, material, construction, arrangement, or components.

8. SECURITY INTEREST; INSURANCE

(a) To secure payment of the purchase price, Buyer agrees that the Company shall retain a security interest in the Equipment until Buyer shall have paid in cash the full purchase price when due, interest at the highest lawful contract rate until so paid and the costs of collection, including reasonable attorney's fees. The Equipment shall at times be considered and remain personal property and Buyer shall perform all acts necessary to assure and perfect retention of the Company's security interest against the rights or interests of third persons. In the event Buyer defaults in payment of any part of the purchase price when due, or fails to comply with any and all provisions of this contract, the Company shall have the remedies available under the Uniform Commercial Code.

(b) So long as the purchase price is unpaid, Buyer at its cost shall obtain insurance against loss or damage from all external causes, naming the Company as an insured, in an amount and form sufficient to protect the Company's interest in the Equipment.

9. CANCELLATION

Buyer cannot cancel orders placed with the Company, except with the Company's express written consent and upon terms and payment to the Company indemnifying the Company against loss, including but not limited to expenses incurred and commitments made by the Company.

10. LOSS, DAMAGE OR DELAY

The Company shall not be liable for loss, damage or delay resulting from causes beyond its reasonable control or caused by strikes or labor difficulties, lockouts, acts or omissions of any governmental authority or the Buyer, insurection or riot, war, fires, floods, Acts of God, breakdown of essential machinery, accidents, priorities or embargoes, car and material shortages, delays in transportations or inability to obtain labor, materials or parts from usual sources. In the event of any delay from such sources, performance will be postponed by such length of time as may be reasonably necessary to compensate for the delay. In the event performance by the Company of this agreement cannot be accomplished by the Company due to any action of governmental agencies, or any laws, rules or regulations of the United States Government, the Company (at its option) may cancel this agreement without liability. In no event shall the Company be liable for any loss or damage of any kind, including consequential or special damages of any nature.

11. WORK BY OTHERS: ACCESSORY AND SAFETY DEVICES

The Company, being only a supplier of the Equipment, shall have no responsibility for labor or work of any nature relating to the installation or operation or use of the Equipment, all of which shall be performed by Buyer or others. It is the responsibility of Buyer to furnish such accessory and safety devices as may be desired by it and/or required by law or OSHA standards respecting Buyer's use of the Equipment. Buyer shall be responsible for ascertaining that the Equipment is installed and operated in accordance with all code requirements and other applicable laws, rules, regulations and ordinances.

12. COMPLETE AGREEMENT

THE COMPLETE AGREEMENT BETWEEN THE COMPANY AND BUYER IS CONTAINED HEREIN AND NO ADDITIONAL OR DIFFERENT TERM OR CONDITION STATED BY BUYER SHALL BE BINDING UNLESS AGREED TO BY THE COMPANY IN WRITING. No course of prior dealings and no usage of the trade shall be relevant to supplement or explain any terms used in this Agreement. This Agreement may be modified only by a writing signed by both the Company and Buyer and shall be governed by the Uniform Commercial Code as enacted the State of Texas. The failure of the Company to insist upon strict performance of any of the terms and conditions stated herein shall not be considered a continuing waiver of any such term or condition or any of the Company's rights.

WARNING! Read this section first. Failure to carefully follow these instructions could result in permanent injury or loss of life.

SAFETY

Here are some safety points to keep in mind when creating an efficient and safe working environment.

Safety Definitions

Statements or labels in this manual, or on the product, preceded by the following words are of special significance:

Warning
Indicates severe personal injury or death will result if instructions are not followed.

Caution
Indicates a strong possibility of severe personal injury or death if instructions are not followed.

Important
Means hazards or unsafe practices which could cause minor personal injury or product or property damage.

Note
Gives helpful information.

Machinery Is Dangerous

Machinery can hurt you if you are not careful. Use caution during assembly and operation of equipment.

ALWAYS:

- Read the entire manual first.
- Use common sense and be careful.
- Have enough manpower.
- Have the proper tools.
- Follow directions and illustrations.
- Check to see that all equipment meets applicable installation codes for your area.
- Have sufficient safety warnings on all equipment.

Note:
Warning labels attached to the control panel, above the ice discharge, and on access panels should be followed. They are shown in Figure 2-1, Figure 2-2, and Figure 2-3. Figure 2-4 shows typical labels for use on screw conveyor covers and belt guards.

If all labels are not attached and visible or labels start to become illegible, contact Turbo Refrigerating Company immediately.

Turbo Refrigerating Company
P.O. Box 396
Denton, Texas 76202
Phone: 817-387-4301
Fax: 817-382-0364

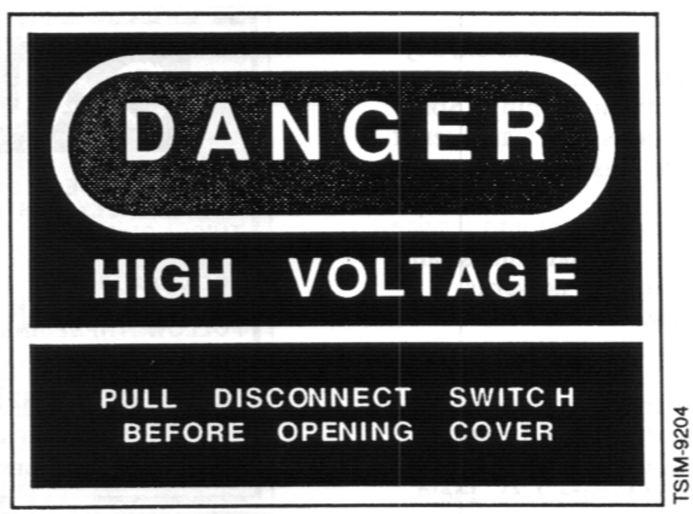


Figure 2-1 Warning Labels On The Control Panel

WARNING! Read this section first. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Involve Your People

Before operating equipment, have the people involved in the operating or maintenance of the equipment meet to discuss the dangers and safety aspects of the icemaker.

- Warn them of the danger of miscommunication.
- Turn electricity off and **lock it out** when working on the icemaker.
- Have a person trained and qualified in the operation of the equipment on duty to ensure that the electricity stays **locked out** to protect the personnel working on the equipment.

WARNINGS

- The icemaker is an automatic machine. When in operation, any and all motors may start without warning. Some motors may start even if the master control switch is in the "OFF" position. Never attempt to service the icemaker unless all electrical power is disconnected and **locked out.**
- The ice discharge opening has a warning label (refer to Figure 2-2 and Figure 2-3). Field installation must ensure that a cover or guard (not supplied by TURBO) is in place on the ice discharge opening before operating to prevent entry into the screw conveyor.

Figure 2-2 Warning Label Above The Ice Discharge

ONE ON ALL ACCESS PANELS (ONE PER SIDE)

Figure 2-3 Warning Label On The Access Panels And Above The Ice Discharge

WARNING! Read this section first. Failure to carefully follow these instructions could result in permanent injury or loss of life.

- Pull disconnect and **lockout** all electrical service before removing any guards, access panels, and/or covers.
- Never operate the unit without all guards, access panels, and covers in place and securely fastened.
- If leaks in the refrigerant piping require soldering or welding, be sure refrigerant is bled off and the system is open before attempting to repair. Protect eyes with the proper eye protection.
- When changing oil in the compressor (by others on R models and NH3 units), make sure the pressure is bled off before opening the system.
- Always wear eye protection when cleaning the system.
- Do not expose insulation (polyurethane) to open flame. If ignited, it will give off highly toxic fumes. Leave the area and notify qualified personnel.
- Use only recommended ice machine cleaners. Follow instructions and warnings supplied by the manufacturer of the cleaning agents.
- Never open the control panel without disconnecting and **locking out** electrical service. All electrical work should be performed by a qualified electrician.
- When servicing the icemaker, TURBO recommends that at least two (2) people be present at all times.
- Although Turbo Refrigerating Company does not supply conveying equipment beyond the ice discharge opening, any conveyors used in association with the operation of TURBO® equipment must be sufficiently guarded to prevent injury.

Notes:

1. Conveyor manufacturer's instructions and warnings are on pages 15–16.
2. Per the OSHA Hazard Communication Standard, material safety data sheets for refrigerant and refrigerant oils are on pages 17–24.

Figure 2-4 Typical Warning Labels On Screw Conveyor Covers And/Or Belt Pulley Guards

WARNING! Read this section first. Failure to carefully follow these instructions could result in permanent injury or loss of life.

3. Figure 2-4 illustrates typical safety labels for use on screw conveyor covers and/or belt guards. Warning labels such as these should be furnished by the supplier of such equipment, and properly installed.

- If an outside contractor is required to install or service your icemaker, require him to furnish you with a certificate of insurance before performing any work on your equipment. TURBO also recommends that the person hiring a contractor to perform work be satisfied with their experience and competence.

Lockout

A switch is provided to control the icemaker operations (on and off). To **lockout** the icemaker controls:

1. Pull disconnect and **lockout** all electrical service.

2. Turn selector switch (provided) to the "OFF" position.

For more details, refer to the Safety Lockout Procedure on page 25.

If you have any questions, call Turbo Refrigerating Company at:

1-817-387-4301.

WARNING! Read this section first. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Conveyor Manufacturer's Instructions and Warnings

Turbo Refrigerating Company does not install conveyors, consequently it is the responsibility of the contractor, installer, owner, and user to install, maintain, and operate the conveyor, components, and assemblies in such a manner as to comply with the Williams-Steiger Occupational Safety and Health Act and with all state and local laws and ordinances and the American National Standard Institute (ANSI) safety code.

In order to avoid an unsafe or hazardous condition, the assemblies or parts must be installed and operated in accordance with the following minimum provisions.

1. Conveyors shall not be operated unless all covers and/or guards for the conveyor and drive unit are in place. If the conveyor is to be opened for inspection, cleaning, maintenance, or observation, the electric power to the motor driving the conveyor must be **locked out** in such a manner that the conveyor cannot be restarted by anyone (however remote from the area) until conveyor cover or guards and drive guards have been properly replaced.
2. If the conveyor must have an open housing as a condition of its use and application, the entire conveyor is then to be guarded by a railing or fence in accordance with ANSI standard B20.1-1976, with special attention given to section 6.12.
3. Feed openings for shovel, front loaders or other manual or mechanical equipment shall be constructed in such a way that the conveyor opening is covered by a grating. If the nature of the material is such that a grating cannot be used, then the exposed section of the conveyor is to be guarded by a railing or fence and there shall be a warning sign posted.
4. Do not attempt any maintenance or repairs of the conveyor until power has been **locked out.**
5. Always operate conveyor in accordance with these instructions and those contained on the caution labels affixed to the equipment.
6. Do not place hands or feet in the conveyor.
7. Never walk on conveyor covers, grating, or guards.
8. Do not use conveyor for any purpose other than that for which it was intended.
9. Do not poke or prod material into the conveyor with a bar or stick inserted through the openings.
10. Keep area around conveyor drive and control station free of debris and obstacles.
11. Always regulate the feeding of material into the unit at a uniform and continuous rate.
12. Do not attempt to clear a jammed conveyor until power has been **locked out.**
13. Do not attempt field modification of conveyor or components.

Turbo Refrigerating Company insists that disconnecting and **locking out** the power to the motor driving the unit provides the only real protection against injury. Other devices should not be used as a substitute for **locking out** the power prior to removing guards or covers. We caution that use of secondary devices may cause employees to develop a false sense of security and fail to **lockout** power before removing covers or guards. This could result in a serious injury should the secondary device fail or malfunction.

WARNING! Read this section first. Failure to carefully follow these instructions could result in permanent injury or loss of life.

There are many kinds of electrical devices for interlocking of conveyors and conveyor systems such that if one conveyor in a system or process is stopped, other equipment feeding it, or following it can also be automatically stopped.

Electrical controls, machinery guards, railings, walkways, arrangement of installation, training of personnel, etc. are necessary ingredients for a safe working place. It is the responsibility of the contractor, installer, owner, and user to supplement the materials and services furnished with these necessary items to make the conveyor installation comply with the law and accepted standards.

Conveyor inlet and discharge openings are designed to connect to other equipment or machinery so that the flow of material into and out of the conveyor is completely enclosed.

WARNING! Read this section first. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Material Safety Data Sheet for Freon®

A. General Information

TRADE NAME (COMMON NAME, SYNONYM):
Refrigerant 22, Freon 22, Genetron 22,
Fluorocarbon 22, CFC-22, R-22

CAS NO.: 75-45-6
DOT NO.: UN 1018

CHEMICAL NAME: Chlorodifluoromethane or monochlorodifluoromethane

FORMULA: $CHClF_2$

MANUFACTURER'S ADDRESS: (MAILING)

Racon Inc.
P.O. Box 198
Wichita, KS 67201

(LOCATION)

Racon Inc.
6040 S. Ridge Road
Wichita, KS 67215

CONTACT:
Vice President of Manufacturing
(316) 524-3245 or
(800) 835-2916

ISSUE DATE: 11/18/85
REVISED DATE:

For Emergency Medical Information: Call Collect (415) 821-5338 (24 hrs.)

B. First Aid Measures

Inhalation --- Vapor contact --- primary route of exposure. If inhaled, remove to fresh air. Keep warm and at rest. If breathing is difficult (labored), give oxygen. If not breathing, give artificial respiration and check for pulse. If no pulse, start CPR (cardiopulmonary resuscitation). **Do Not** give stimulants (adrenaline, epinephrine or hand-held asthma aerosols). Call 911 (if available) and a physician. Keep patient at rest for 24 hours after overexposure. No long-term effects are expected.

Eyes and/or Skin ---
Vapor contact --- flush with fresh water for at least 20 minutes.
Liquid contact --- flush exposed area with lukewarm water or otherwise warm skin slowly. Frostbite is probable. Treat accordingly. Call a physician.

Ingestion --- Liquid --- not probable --- if ingested however, keep patient calm, if conscious, and get to a physician immediately --- frostbite is probable, indicated by necrosis of lips and tongue (contacted tissue), blanching of skin, pain and tenderness. Warm skin slowly.

WARNING! Read this section first. Failure to carefully follow these instructions could result in permanent injury or loss of life.

C. Hazards Information

TOXICITY AND HEALTH

EXPOSURE LIMITS: TLV 1000ppm(vol) (8 hr. TWA) STEL 1250ppm(vol)

ACUTE EXPOSURE EFFECTS:

Inhalation --- CFC-22 is relatively non-toxic following acute exposure. Although no long-term comprehensive studies have specifically investigated acute overexposure of humans to CFC-22, experience indicates the cardiovascular and respiratory systems are the primary systems affected. Abuse (intentional inhalation) has caused death. Human exposure to high concentrations (e.g. 20%) may cause confusion, lung (respiratory) irritation, tremors and perhaps coma, but these effects are generally short lived and reversible without late aftereffects when removed to fresh air. LC_{50} values for rats and mice range from 277,000 to 390,000ppm(vol) over varying time periods of 15 minutes to 2 hours. High atmospheric concentrations of CFC-22 produce stimulation and then depression and finally asphyxiation.

Ingestion --- not probable, at atmospheric pressure, liquid CFC-22 boils at -41.4° F (-40.8° C). Freezing and severe frostbite of contacted tissue will result.

Skin --- contact of vapor CFC-22 with skin or eyes should not cause injury. Contact of liquid CFC-22 will result in freezing and frostbite of contacted tissue.

Note: Human Poisoning Potential --- Sniffing of fluorocarbon propellants for their intoxicating effects has produced over 100 deaths. Fluorocarbons exhibit very toxic properties (asphyxiation, cardiac arrhythmia) when sniffed; however, because of variations in response, it is difficult to predict which symptoms will be exhibited following exposure. It is possible that individuals with heart or respiratory disorders may prove especially susceptible.

SUBCHRONIC/CHRONIC EXPOSURE EFFECTS:

Overexposure by inhalation of various animals to 46,000ppm(vol) --- 50,000ppm(vol) of CFC-22 for 8 days to 10 months caused alterations in body weight and physiological endurance, and affected the lungs, central nervous system (CNS), heart, liver, kidneys and spleen. No information was found concerning effects on humans.

CARDIAC STUDIES:

CFC-22 inhaled at concentrations of 50,000ppm and above has been shown in tests on dogs to sensitize the heart to exogenous (outside the body) adrenaline, resulting in serious and sometimes fatal irregular heart beats (cardiac arrhythmias).

CARCINOGENIC POTENTIAL:

A lifetime inhalation study on rats and mice was performed by ICI, Ltd, (UK). The results from this test showed no effects on either rats or mice up to 10,000ppm(vol). At 50,000ppm (vol), CFC-22 was weakly carcinogenic to the oldest male rats (exhibiting a low incidence of fibrosarcoma in the salivary gland). The significance of this finding is questionable. No abnormal incidence was found in mice of either sex or in female rats at 50,000ppm(vol). No other findings of biological significance were made.

TERATOGENIC POTENTIAL:

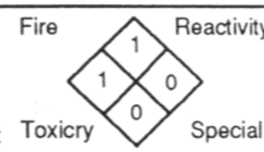
Teratogenic studies on rats and rabbits showed an increased incidence of absence of eyes in rat fetuses at exposure levels of 50,000ppm. (CFC-22 exposure occurred from the 6th to 15th day of pregnancy). There was no effect on rabbits or their offspring at this level. There was no evidence of other overt fetal abnormalities.

WARNING! Read this section first. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Material Safety Data Sheet for Suniso 3GS & 4GS

Product: Refrigeration Oil Suniso 3GS and 4GS

NFPA
4 – extreme
3 – high
2 – moderate
1 – slight
0 – insignificant



Section I.

Manufacturing Division or Subsidiary: Sonneborn Division

Address (Number, Street, City, State, Zip Code): P.O. Box 308 Gretna, Louisiana 70053

Emergency Telephone (Manufacturer): 1-504-366-7281

Chemical Name or Family: Refined Mineral Oil

Formula: A mixture of liquid hydrocarbons refined from petroleum.

Section II. Chemical and Physical Properties

Hazardous Decomposition Products: Upon combustion, CO_2 and CO are generated.

Incompatibility (Keep Away From): Strong oxidizing agents such as chromic acid, hydrogen peroxide and bromine.

List All Toxic and Hazardous Ingredients: None

Form: Viscous liquid

Odor: Petroleum

Appearance: Clear liquid

Color: Amber

Specific Gravity (water = 1): 0.91 @ 15.6° C

Boiling Point: >500° F (>260° C)

Melting Point: NA

Solubility in Water: Insoluble

% Volatile (by weight %): Negligible

Evap. Rate: Negligible

Vapor Pressure (mm Hg at 20° C): <0.0001

Vapor Density (air = 1): >10

pH As Is: NA

Strong Acid ☐
Strong Base ☐
Stable ■
Unstable ☐

Viscosity Sus at 100° F: <100 ☐ 100 or > ■

WARNING! Read this section first. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Section III. Fire and Explosion Data

Special Fire Fighting Procedures: Wear self-contained breathing apparatus. Water spray is an unsuitable extinguishing agent.

Unusual Fire and Explosion Hazards: None

Flash Point (Method Used): ASTM D-92 >300° F (>150° C)

Flammable Limits %: NA

Extinguishing Agents:

■ Dry Chemical	■ CO_2
❑ Waterspray	■ Foam
■ Waterfog	■ Sand/Earth
❑ Other ______________________	

Section IV. Health Hazard Data

Permissable Concentrations (air): 5 mg/m^3 mineral oil mist (OSHA).

Effects of Overexpose: Prolonged contact may cause minor skin irritation.

Toxicological Properties: NDA

Emergency First Aid Procedures:

Eyes:	Flush with large amounts of water for at least 15 minutes. If redness or irritation persists, contact a physician.
Skin contact:	Wash with soap and water. Wash clothing before reuse.
Inhalation:	None normally required.
If Swallowed:	Call a physician.

Section V. Special Protection Information

Ventilation Type Required (Local, Mechanical, Special): NA

Respiratory Protection (Specify Type): NA

Protective Gloves: Oil resistant rubber

Eye Protection: Chemical splash goggles

Other Protective Equipment: Rubber apron

WARNING! Read this section first. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Section VI. Handling of Spills or Leaks

Procedures for Clean-up:

Stop leak, dike up large spills. Use inert absorbent material such as earth, sand, or vermiculite for clean-up.

Waste Disposal:

Dispose of in accordance with Local, State, and Federal government regulations.

Section VII. Special Precautions

Precautions to be Taken in Handling and Storage:

Avoid exposure to heat and flame. Protect against eye and skin contact. Wash thoroughly after handling.

Section VIII. Transportation Data

Unregulated by D.O.T. ■ Regulated by D.O.T. ☐

Transportation Emergency Information: CHEM TREC 1-800-424-9300

U.S. D.O.T. Proper Shipping Name: NA U.S. D.O.T. Hazard Class: NA

I.D. Number: NA

RQ: NA Label(s) Required: NA

Freight Classification: Petroleum Oil NOIBN

Special Transportation Notes: NA

Section IX. Comments

CAS #64742-52-5

Signature: ______________________
Telephone: ______________________
Revision Date: ______________________
Supersedes: ______________________
Title: ______________________
Date: ______________________
Sent To: ______________________
____
____

TURBO believes the statements, technical information and recommendations contained herein are reliable, but they are given without warranty or guarantee of any kind, express or implied, and we assume no responsibility for any loss, damage, or expense, direct or consequential, arising out of their use.

WARNING! Read this section first. Failure to carefully follow these instructions could result in permanent injury or loss of life.

WARNING! Read this section first. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Safety Lockout Procedure
Effective November 1, 1989

I. Purpose

The purpose of this procedure is to prevent injury and/or death to personnel by requiring that certain precautions be taken before servicing or repairing equipment. It has been developed and implemented so as to comply with 29 CFR 1910.147, of the Occupational Safety and Health Act, as amended.

These precautions include:

1. Shutting off and locking out electrical power.

2. Releasing pressure in pneumatic and hydraulic systems.

3. Effectively isolating those portions of equipment and machinery that are energy intensive and are being serviced or maintained.

II. Scope

This procedure includes those employees whose duties require them to do maintenance work on power-driven equipment. It covers the servicing or maintenance of machines or equipment in which the unexpected energization, start-up or release of stored energy could cause injury.

III. Supervisory Responsibility

It is the responsibility of all supervisors having contact with such operations to:

A. Instruct all affected employees as to the content of this program.

B. Ensure compliance with this procedure.

IV. Safety Locks

Safety locks and keys will be issued to designated employees. Locks and keys must be returned to the plant manager when an employee transfers to another assignment or terminates his employment. Safety and supervisory personnel shall have access to master keys for protective locks, and under certain controlled conditions, be available to assist in the removal of safety locks.

Safety locks are painted yellow for electricians and red for maintenance personnel. These locks are to be used only for locking out machinery, tooling, and equipment described in this procedure.

V. Safety Department Responsibility

It is the responsibility of the Safety Coordinator to inspect the plant on a periodic basis to ensure compliance with this procedure. If it is determined that this procedure is not being complied with, immediate corrective action will be initiated. Wherever possible, such action will be taken in conjunction with the first-line supervisor; however, higher level management personnel will be involved if the violation is of a serious or repetitive nature.

VI. Rules and Regulations

The following rules and regulations have been established and are mandated:

A. Any electrician or maintenance person whose duties require that he or others be exposed to the hazards of electrical shock or moving equipment, must perform those duties in a safe and uncompromising manner. The following steps outline such precautions:

   1. The employee must understand the equipment with which he is working and its hazards.

   2. When working with electrical equipment where the accidental starting of such equipment or release of stored energy would create a hazard, the employee <u>must turn off all power to the unit or</u>

WARNING! Read this section first. Failure to carefully follow these instructions could result in permanent injury or loss of life.

use energy isolating devices and apply his personal lock, and have the supervisor of that area apply his personal lock. At all times when maintenance is being performed on our equipment, that equipment will have 2 locks on it, one by the person performing the maintenance plus the one of the supervisor.

3. In instances where multiple circuits are in a circuit breaker box, an attaching mechanism will be placed on the outside of the box to allow that box to be locked out and prevent the door from being opened.

B. Each employee who performs the duties prescribed above will be provided with an individual safety lock and one key. If more that one employee is assigned to a task, each employee is required to place his own lock and tag so the controls cannot be operated, even though another person may have completed his own task, and remove his own lock.

C. If the equipment controls are so located that only one lock can be accommodated, a special attachment that accommodates several locks must be used. This attachment will be issued to all designated employees.

D. Should an employee be required to work on another piece of equipment and need to leave his lock on the present equipment, another lock must be obtained from the plant manager.

E. Should it be necessary to operate a piece of equipment which is locked out, every effort should be made by supervision to locate the employee whose lock is on the equipment. If that employee cannot be located, the supervisor may obtain a master key for the lock. The supervisor must personally assure himself that it is safe to remove the lock. The lock should than be returned to the proper employee.

This procedure must be used with extreme caution and good judgement. There is danger that the employee involved will return thinking that the machine is still locked out, when it has actually been turned back on.

F. If a machine is locked out and it is necessary to leave the area, recheck the lock upon returning to make sure that the machine is still locked out. While supervision will make every attempt to avoid the removal of locks, there may be situations when it must be done. This recheck is for your protection.

G. It is sometimes necessary to operate equipment for purposes of testing or making adjustments prior to the actual completion of the work. It is recognized that electricians must work on live circuits from time to time, particularly when trouble-shooting, but extreme caution must be used under these circumstances. Never work alone when changing live wiring.

VII. Outside Contractors

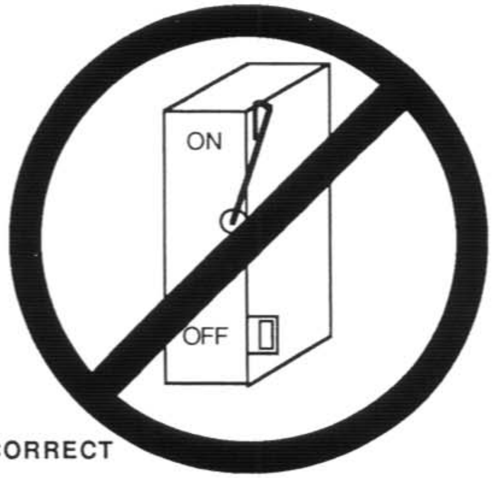
Whenever outside servicing personnel are to be engaged in activities covered by the scope and application of this lockout and tag procedure, such personnel are to be informed of this procedure by the person responsible for their work activity and are to direct them to follow its requirements. Failure to do so shall require that they do not be permitted to continue working in the plant.

VIII. Failure To Follow Procedures

These procedures have been developed to protect employees from serious injury. It is necessary that all employees follow them. Those employees not complying with the provisions in this procedure will be subject to disciplinary action, up to and including discharge.

DISCONNECTING POWER & LOCK OUT

Turbo Refrigerating Company insists that **disconnecting** and **locking out** the power to the motor driving the unit provides the only real protection against injury. Other devices should not be used as a substitute for **locking out** the power prior to removing guards, covers, or other safety devices. Turbo warns that the use of secondary devices may cause employees to develop a false sense of security and fail to **lock out** power before removing guards, covers, or other safety devices. This could result in a serious injury should the secondary device fail or malfunction.



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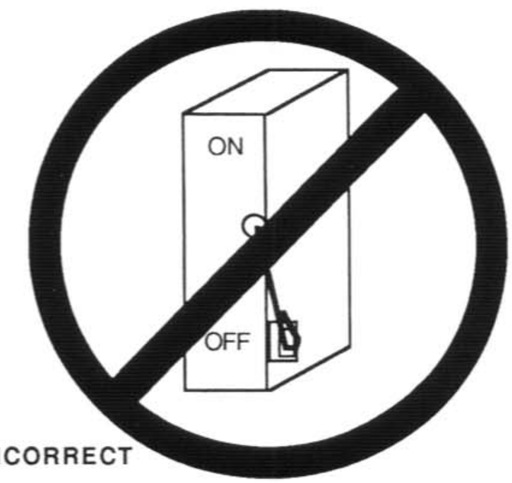

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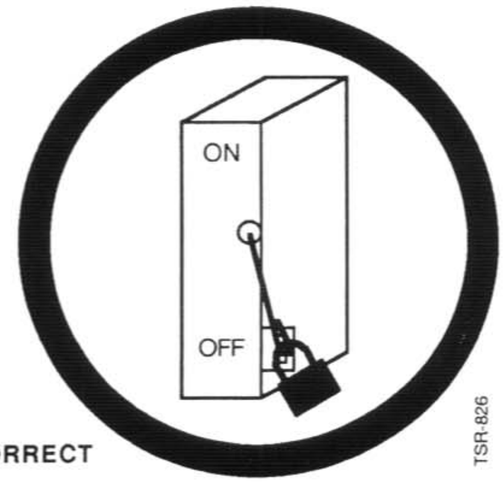


CORRECT

TSR-826

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

INSTALLATION & PRE-START-UP REQUIREMENTS

To install and prepare the TURBO® icemaker for operation, you will need two to four people whose skills include mechanical, welding, and plumbing capabilities as well as a qualified electrician.

This section includes instructions on site preparation, installation, and connection of your icemaker. Your icemaker has been tested and inspected at the factory prior to packing and shipping. The general installation sequence is as follows:

1. Site Preparation
2. Delivery Inspection
3. A. Hoisting Or Moving
   B. Mounting And Leveling
4. Steel Platforms For Elevated Installation
5. Ice Discharge Opening Transition Chutes
6. Refrigerant Piping
7. Electrical Connections
8. Water Connections
9. Aligning Reciprocating Compressors And Motors
10. Testing Refrigeration System For Leaks
11. Evacuating The System
12. Charging The Unit With Refrigerant Oil
13. Refrigerant Charging
14. Air-Cooled Condensers
15. Evaporative-Cooled Condensers
16. Water-Cooled Condensers
17. Standard Preheater Kits
18. Alternate Preheaters
19. Winterizing
20. Pre-Start-Up Checklist
21. Start-Up Checklist

IMPORTANT

Pay special attention to any bold print or boxed in paragraphs. Following this information is essential for a safe, efficient installation and operation.

To Help You Get Started

- Read instructions completely before installation.
- Gather all required tools.
- Establish the front and rear, and the left and right of the icemaker by facing the ice discharge opening (see Figure 3-1, Figure 3-2, and Figure 3-3).
  - The motor/compressor or semi-hermetic compressor, condenser (SC models), water pumps, and breaker bar drive(s) are located under the ice slide in the lower evaporator section.

    Note:
    On the 60 ton model, the motor/compressor sets and condensers on the SC model are located outboard as shown in Figure 3-3.
  - Access to the equipment under the ice slide is from the rear through removable panel on the lower portion of the cabinet.
  - Access to the evaporator section and evaporator piping is from the rear. Doors are provided on the upper portion of the cabinet for this purpose.
  - Standard configurations for SCA and SCE models include an outboard extension of the frame on which the air-cooled or evaporative condenser is mounted. This equipment is located on the right when you face the ice discharge opening(s) (unless otherwise specified).

    Note:
    A left-hand version is available as an option.

    On 10 ton and smaller models, outboard equipment is located at the rear, as indicated in Figure 3-1.
  - The control panel is always located on the rear and on the right end as you face the ice discharge. On 60 ton models, two separate enclosures are mounted on the outboard section for the compressor motor starters.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Note:
On 30 and 40 ton models with reduced voltage starters, a separate three-phase enclosure is located on the rear (left corner). This enclosure is for all motor starters (compressors, breaker bars, water pumps). Refer to Figure 3-2 and Figure 3-3.

- Field wiring connections for electrical enclosures are made at the location indicated for the control panel and/or three-phase panel.

- Water connections (make-up and condenser for water-cooled models) are typically on the left or right end. Refer to the data sheet for the model supplied for the exact location.

- Access openings to breaker bar and ice sizer bearings and adjustments are located on both ends of the unit. On larger models (30 ton and up), additional access openings are provided on the rear.

- Water supply and defrost tubes are accessable from the left and right on 10 ton and smaller models and from the front and rear on 15 ton and larger models. (Access from the top is normally not required. Removable roof panels are provided and a minimum clearance space of 36" above the unit is recommended for service or change out of water tubes.)

- The ice discharge opening must be covered by a discharge transition chute or other suitable guard to prevent access to the breaker bar mechanism located inside. This cover is field installed by others.

WARNING

Failure to install a cover or guard over the ice discharge opening(s) could result in serious injury or death. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Helpful Hints

- Record the serial number located on the control panel for reference when contacting TURBO for parts or service.

- The refrigerant piping and valves for the evaporator are located behind the access doors on the left side for 10 ton and smaller models and on the rear for 15 ton and larger models.

- Adequate space must be left around all sides, ends, and the top of the evaporator for service access.

- Do not run piping and/or conduit across the top of the unit (this would limit the ability to remove the roof panels for access to the water distribution system).

- Check the location of all connections before setting the unit in place.

- **Always remember - SAFETY FIRST !!!**

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

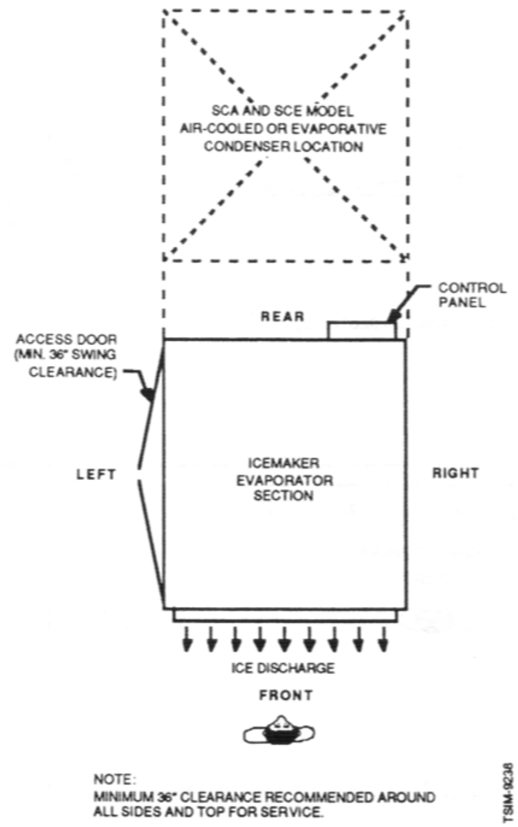


Figure 3-1 Typical Icemaker Layout (C-Series – 3 to 7 Ton Models)

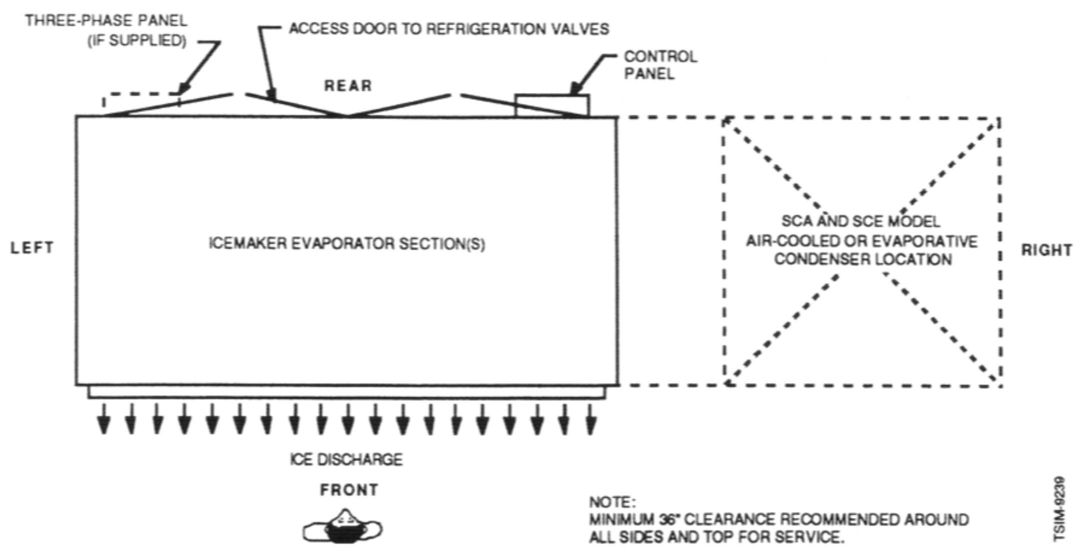


Figure 3-2 Typical Icemaker Layout (C-Series – 10 to 40 Ton Models)

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

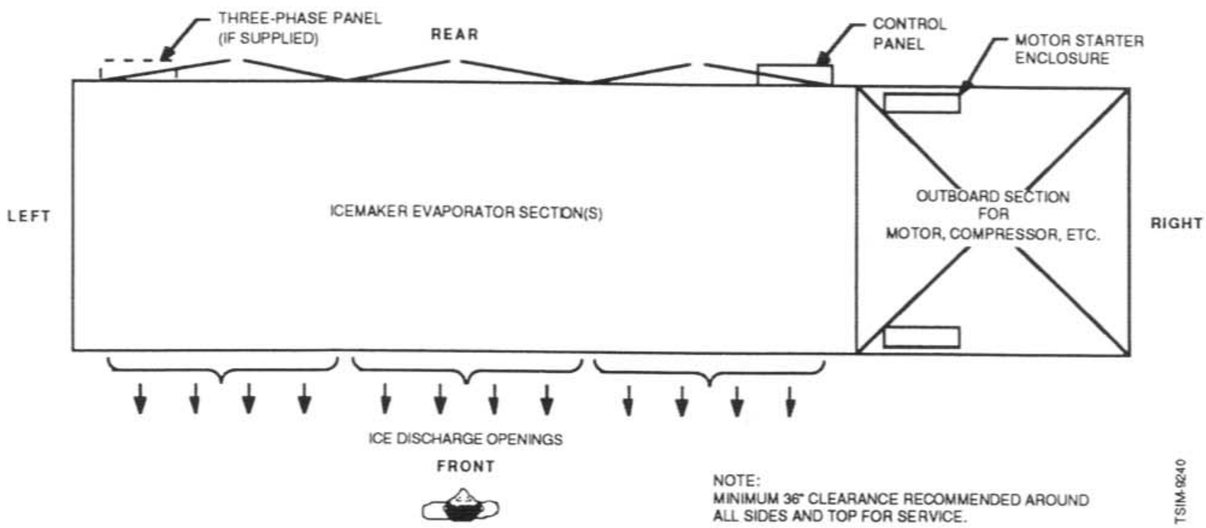


Figure 3-3 Typical Icemaker Layout (C-Series – 60 Ton Model)

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

TOOLS

To install the icemaker, you will need two to four people whose skills include mechanical, welding, and plumbing capabilities as well as a qualified electrician. The following is a list of tools required for safe erection and assembly of the icemaker:

- Wrenches and sockets (a full set up to 1 1/8")
- Phillips (not cross-point) and standard (slotted) screw drivers
- Level (four feet long)
- Tape measure (fifty feet long)
- Pry bar
- Chain hoists (one ton) or two "come alongs" (1000#)
- Allen wrenches (sizes 1/8" to 1/2")
- Chains (two - 3/8 inch, minimum - ten feet long)
- Arc welder
- Amp probe
- Voltage tester
- Continuity tester
- Framing square
- Forklift or crane
- 8" and 12" adjustable wrench
- Channel-lock pliers
- Needle-nose pliers
- Wire cutter and stripper
- Hand operated refrigerant oil pump
- Portable vacuum pump
- Magnetic mount dial indicator (compressor alignment)
- Refrigerant gauge manifold set with hoses
- Oxy-acetylene brazing set-up with various brazing and cutting tips (primarily for SCAR and SCER models where field installation of refrigerant piping is required)

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

1. SITE PREPARATION

IMPORTANT

Next to the selection of the proper equipment for the applications, the most important pre-delivery task is the job site preparation for the installation of the ice-making equipment.

Installations using concrete pads fabricated at the jobsite must ensure that location and construction of the pad is dimensionally and structurally compatible with the icemaker, and overall system requirements.

The following guidelines should assist in properly preparing for installation of the TURBO supplied equipment. Questions concerning site preparation should be discussed with a qualified TURBO distributor or TURBO application engineer.

Location

The icemaking equipment may be installed indoors or outdoors. See general requirements for each installation below. Outdoor installations may require optional winterizing kits. Consideration should be given to providing a cover over the control panel area to provide shading from direct sunlight (overheating) and to permit safe access during all types of weather conditions.

Indoor Installation General Requirements

- Access by a forklift or overhead hoist should be provided to the equipment room for removal of large components such as compressors and motors.
- Install the icemaker in an area where the ambient temperature does not fall below 40°F or rise above 100°F. The evaporator (freezing) compartment of the unit is insulated against excessive heat infiltration. The machinery compartment is designed to provide ventilation for the machinery and motors. Auxiliary heating may be required to maintain the equipment above 40°F during shut-down to prevent damage to components containing water.
- Ventilation of the room is required to remove the heat generated by the motor/compressor assembly (if supplied), and refrigerant in case of a refrigerant leak.
- If located next to offices or residential areas where noise may be objectionable, consideration should be given to noise abatement in the equipment room.
- Adequate water supply and drainage must be available. Refer to step 8 – Water Connections on page 61.
- Control of water inside the room (resulting from water supply line rupture) should be considered.
- Adequate lighting for service work:
  - Around the top of the unit for cleaning the water distribution system.
  - In front of the evaporator access doors for valve adjustment and observation of unit operation.
  - Above and around the engine compartment to check operation and observe compressor crankcase oil levels.
  - Above and around the electrical control panel and three-phase panel.

Note:
The National Electric Code requires a minimum of 36" clearance in front of the electrical enclosures. State or local codes may require additional clearance. The contractor is responsible for ensuring that all equipment is installed in accordance with all local, state, and national codes.

- Adequate access to the equipment room should be provided for service and inspection. Provide means of locking access doors.

- Access to and removal of compressors, condensers, breaker bar, and water pumps should be considered in equipment room layout.

- Strainers are provided on the inlet water connection to prevent clogging of the water pump impeller and water distribution system. Access for regular cleaning should be provided.

- Adequate space should be allowed on all sides and the top for cleaning and service.

Note:
TURBO recommends a minimum 36" clearance around all parts of the equipment for service and maintenance access. The water distribution system located in the top of the evaporator section requires 36" minimum clearance for cleaning.

- Provisions for interfacing icemaking equipment with equipment or components located outside the equipment room (remote condensers, heat exchangers, etc.) should be provided.

- Provisions for routing safety relief valve vent lines to safe discharge location(s) should be provided.

Outdoor Installation General Requirements

In general, the same requirements exist for outdoor installations as indoor installations. In addition, the following factors and requirements should be considered for outdoor installations:

- Covers should be provided over the electrical control panel and three-phase panel to prevent direct exposure to sunlight. Overheating of the electrical panels could result.

- Provisions should be made for either permanent or temporary covering of the engine compartment and/or evaporator section during all types of weather including rain, sleet, snow, and gusting winds so that service and routine maintenance can be performed without regard to outside conditions.

- A source of heat will be required for all vessels, pumps, or components containing water to prevent freeze-up during shut-down in low ambient (below 40°F) conditions.

- Provisions must be made for access to the equipment with fork lifts, cranes, or other service equipment during all types of weather conditions (i.e. paving up to equipment when surrounding area is muddy, etc.).

- Access to ladders, stairways, and steel platforms should be limited during icing or other inclimate conditions, which could result in personal injury due to hazardous and slippery conditions.

- Adequate fencing should be provided around installation to prevent access by unauthorized personnel.

- Adequate warning labels and signs should be provided around the equipment installation (refer to section 2 – Safety on page 11) to limit access by authorized personnel only.

Concrete Pad

If the icemaker is to be mounted on a concrete pad, the surface of the pad must be level to within 1/4" or shimming must be provided under the unit to ensure that it is level and properly supported. When shimming is required, use caution to prevent long unsupported spans under the structural base frame of the unit. See Grouting Guidelines on page 49.

IMPORTANT

Failure to follow these guidelines could result in excessive equipment vibration or uneven water distribution over the evaporator plates.

When preparing the pad, it may be desirable to embed steel plates or anchors in the concrete to secure the unit in place after it is set. Refer to Figures 3-4.

Unit details for each model are available from TURBO to allow placement of metal inserts to match the structural steel base frame. No part of the unit frame should be cantilevered or unsupported. Refer to Figure 3-5.

Raised Curbing

A raised curbing around the outside of the unit is recommended to contain any condensate, leakage, or cleaning fluid that could escape from the unit. A maximum curbing height of 3/4-1 inch is all that would be needed. Refer to Figure 3-4 and step 3B – Mounting and Leveling on page 47. The lowest point of curbing must be at least 1/4" above the highest point of the slab.

Elevated Installation

Some installations require mounting the icemaker above grade. The unit can be mounted on a properly designed steel structure. Typical steel platform dimensions and arrangements are shown in step 4 – Steel Platforms For Elevated Installation.

IMPORTANT

On installations of this type, never leave the equipment frame overhanging or unsupported. A structural steel platform capable of supporting the dynamic as well as static load must be provided. Total operating weight should include the dry weight of the icemaker, the water charge of all tanks, the refrigerant charge, the weight of the ice on the plates (use 1 1/2 times the total ice weight per cycle), railing or platforms for access, and any equipment used during service or maintenance of the equipment.

Due to variations in local and state codes, a local firm specializing in structural steel should be consulted to determine the requirements for the

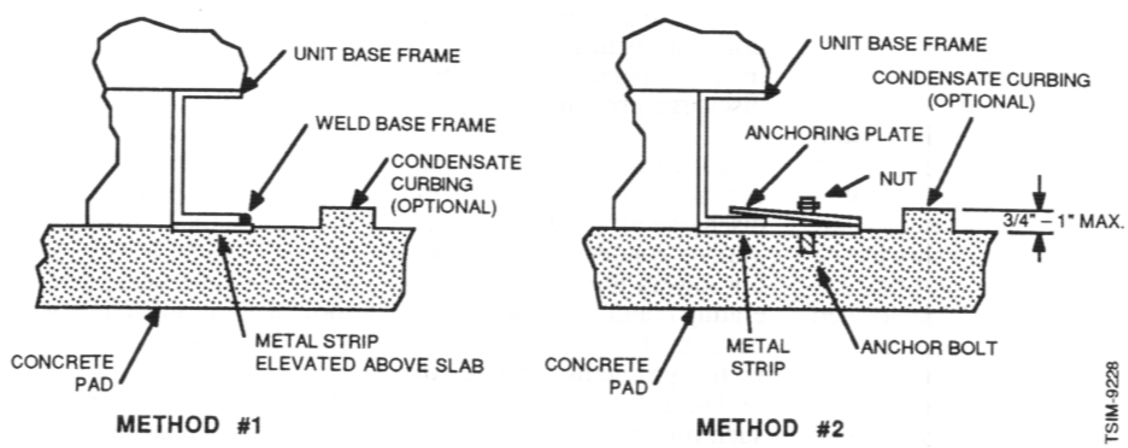


Figure 3-4 Typical Concrete Pad Detail - Icemaker To Concrete Pad

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

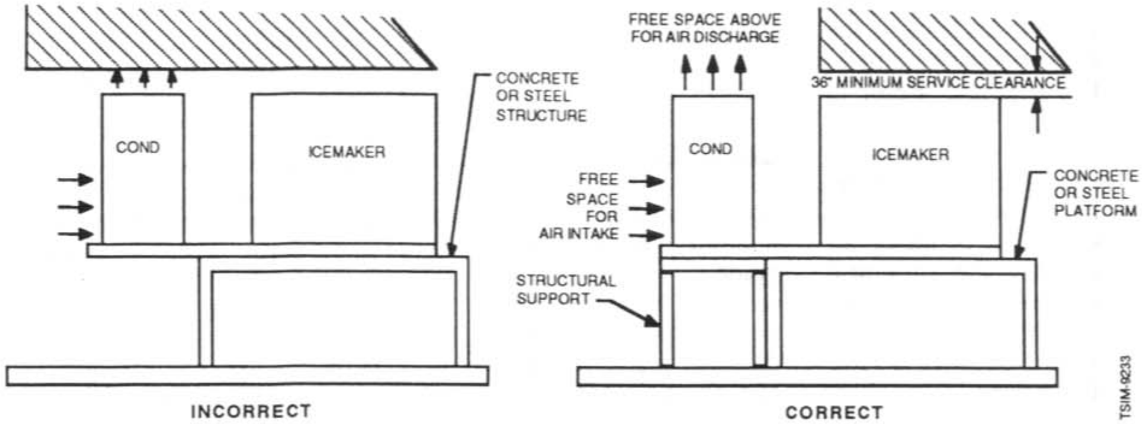


Figure 3-5 Elevated Installation With Overhang Frame

steel to be erected. TURBO can be contacted for information required by the local firm to provide the steel platform. The steel supporting the unit must be level or shimmed to obtain a satisfactory level. The guidelines for unsupported sections apply for installations using steel and concrete structure. Refer to Figure 3-5.

Access, Service, And Air Space

In laying out the unit installation, adequate space should be allowed around the unit for access and service. Particular attention should be given to the engine compartment and equipment located under the ice slide on the cabinet interior. Removal or service of larger, heavier components (condensers, compressors, etc.) may require access by a forklift or other lifting devices which require additional space.

For air-cooled condensers, evaporative condensers, and cooling towers, adequate space must be allowed for air intake and air discharges to prevent insufficient air supply or recirculation of discharge air.

Precautions must be taken when installing equipment in a corner or in an area surrounded by three or more walls. Improper air circulation can result in elevated air inlet temperatures and high discharge pressure.

Vapor fumes created by condensation of moisture in the discharge air streams of evaporative condensers and cooling towers during certain operating conditions should also be considered to avoid aesthetic problems around the building due to visibility of such fumes.

Space must be allowed for electrical disconnects and load centers near the equipment and for conduit runs from the load center to the equipment.

Water Supply

TURBO® icemakers require 70°F make-up water at rates specified in the tables located in the appendix. Some systems require several hundred gallons of water. Inadequate water supply lines may result in excessive time required to fill the tank or prevent adequate flow during defrost. Refer to step 8 – Water Connections on page 61.

Before the equipment installation begins, an adequate supply of water must be available to clean and charge the water tank(s) as well as to supply remote equipment such as cooling towers, evaporative condensers, and oil coolers with sufficient water flow and pressure.

Most cooling towers and evaporative condensers require 40 psig water pressure at the make-up water connection for continuous operation.

Water piping from cooling towers to the water-cooled condenser in SC models must be properly sized to deliver the specified flow and pressure. The cooling tower pump must be sized for the proper flow at the total head of the system including pressure drop in the supply line, piping, and condenser, plus the static head resulting from installation of the icemakers above the cooling tower. Refer to step 16 – Water-Cooled Condensers on page 91 for details.

Evaporative condensers also require a continuous source of make-up water during operation.

Drain Connection

Cleaning of the water tank(s) prior to starting the unit is essential. Water may be used to wash down the walls of the tank, water tubes, and interior panels as well as external devices such as screw conveyors. Every effort should be made to keep the tank and all related piping as clean as possible to prevent fouling of the icemaker evaporator plates, heat exchangers, and water distribution system.

To obtain the proper cleaning of the tank, it will be necessary to drain the water from the tank during clean-up and possibly during start-up of the equipment due to debris in the water piping system to the icemaker water connection. Provisions must be made for draining and refilling the tank in a reasonable time.

A strainer is provided for the make-up water line to prevent the debris from entering the unit.

Water Filtration

Cleanliness of the icemaker and heat exchangers is essential for maximum efficiency and utilization of the equipment without unnecessary maintenance as well as obtaining a clear quality ice product. Permanent water filtration is provided in the make-up water line to the evaporator. The filtration is capable of removing all water borne solid particulate matter larger than 25 microns in size.

Regular periodic cleaning and/or replacement is required. Inspection and cleaning is essential during start-up and the first 100 hours of operation.

If water borne solids of the filtration system continues beyond the first 100 hours of service, the system should be checked to determine the source of the contaminants. It may be necessary to contact a water treatment specialist. Operating personnel should also observe the water in the tank for floating debris.

Water Treatment

Consult a local water treatment company to determine if additional water treatment or filtration is required to produce the desired ice quality, reduce maintenance of the water distribution system, and prevent contaminants that may prevent proper operation of the equipment. Extremely hard water will tend to make cloudy, softer ice and leave deposits within the machine necessitating frequent cleaning. Water supplies in various parts of the country are unique in terms of acidity, solid content, and chemistry that may affect the water system.

Consultation with a qualified water treatment company can identify the needs for your system. After start-up, water samples should be taken regularly to evaluate biological, chemical, or other contaminants that may result from operation of the system.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Highly chlorinated water should be avoided during operation or cleaning due to the highly corrosive effect on all materials including stainless steel.

Refer to section 6 – Maintenance on page 169 for guidelines on cleaning evaporator plates and the water distribution system.

Water used in the icemaking process is consumed as the ice is produced and may not require additional treatment. However, the water used in water-cooled condensers, cooling towers, and evaporative condensers is continously recirculated. Although blow-down is generally sufficient in these components to control the build-up of contaminants and solids (due to the evaporation of water), additional continuous treatments may be required to prevent calcium and other mineral build-up on heat exchanger surfaces. Such build-up or fouling will result in high discharge pressure and poor operating efficiency.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

2. DELIVERY INSPECTION

All self-contained units are thoroughly inspected and tested at the factory to assure shipment of a mechanically sound piece of equipment.

Inspect the unit thoroughly upon arrival at the installation site to check for any shipment damage.

Report any damage to the transportation company immediately so that an authorized agent can examine the icemaking equipment, determine the extent of the damage, and take the necessary steps to rectify the claim without costly delays. Notify TURBO of any claims made.

TURBO® icemakers are shipped on "air-ride" trailers to ensure that the equipment arrives in the best possible condition. Accessory equipment is shipped by common carrier.

Delivery Inspection Checklist

Panels

- Inspect all panels for damage.
- Check hardware on panels and door hinges.
- Check all door handles.
- Check roof panels and roof panel sealing strips.
- Make sure all panels and doors are on the equipment or shipped loose with the equipment.

Loose Equipment And Crates

- Open all crates and boxes shipped with the unit.
- Verify all loose parts and crates versus components listed on packing slip.
- Check all components, boxes, or crates for damage.

Evaporator Plates

- Check the mounting of the evaporator plates on the mounting channels for loose or damaged plates.
- Check the water distribution tubes at the top of the evaporator plates for damage and proper attachment to the plates.

Valves and Piping

- Check for broken or damaged tubes and piping in the evaporator and engine compartment.

Connections To Equipment

- Check all electrical connection stubs for damages.
- Check all water connection stubs for damages.
- Check all refrigerant connection stubs for damages.
- Note location of all connections and verify against data sheets.

Warning Labels

- Check that warning labels are in place (refer to section 2 – Safety on page 11) and that an installation manual is available at the jobsite.
- If labels are not in place or a manual is not available at the job site, contact Turbo Refrigerating Company immediately:

Turbo Refrigerating Company
P.O. Box 396
Denton, TX 76202-0396
Phone: 817-387-4301
Fax: 817-382-0364

Lifting Lugs/Pipes

- Check that lifting lugs and pipes are in place and in proper condition for lifting equipment.

WARNING

Do not attempt to hoist equipment if lifting devices are damaged or missing. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

TURBO® Nameplate

- Locate the TURBO® nameplate on the electrical control panel of the unit(s) and record all of the information for future reference.
- The TURBO® serial number (located on the nameplate) should be referenced in all inquiries to TURBO.
- Remote equipment (condensers, etc.) and optional equipment will have the same serial number as the icemaker.

Note:
If the remote equipment is purchased separately, they will have a separate nameplate and serial number.

Equipment

- Check equipment ordered versus the purchase order and TURBO sales acknowledgement form. Report any discrepancies to Turbo Refrigerating Company immediately.

IMPORTANT

TURBO will provide guidelines and advice relative to sizing, configuration, etc. of remote equipment supplied by others with prior written notice of equipment detail. TURBO assumes no liability for proper sizing or installation of equipment, supplied and installed by others. TURBO will not assume responsibility for proper interfacing, capacity, or installation of remote equipment by others.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

3A. HOISTING OR MOVING

Equipment Rigging Instructions

The TURBO® icemaker must be lifted by the lifting lugs, eyes, or pipes provided by TURBO. Please note that these lifting lugs, eyes, or pipes are not intended to be used for extended lifting periods. Depending on the orientation of the lifting means provided, the use of a spreader bar and blocks may be required to protect the exterior panels. In some cases, removal of certain exterior panels during the rigging operation may be required.

Figure 3-6 shows the configuration of lifting eyes on the icemaking equipment ends. This configuration is normally used on smaller units. The use of blocks and spreader bars are required to avoid damage to the cabinetry.

Figure 3-7 shows the lifting pipes arrangement used on larger units. The lifting lugs may be used by running a sling through the 3" pipes which run through the unit.

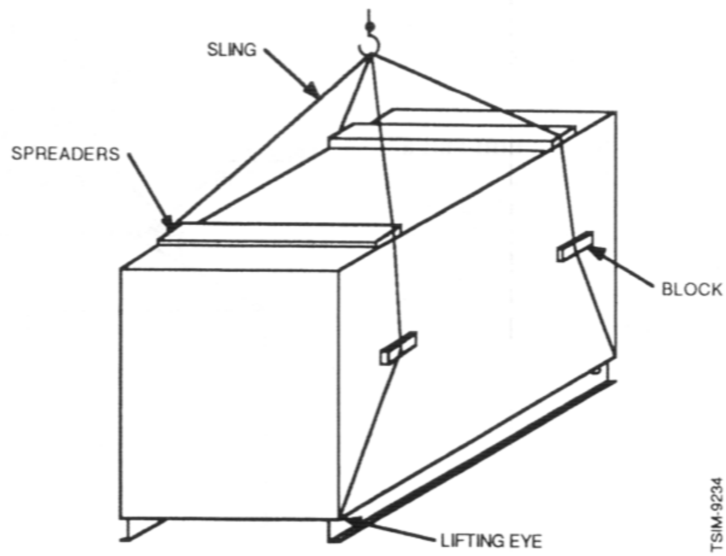


Figure 3-6 Small Icemaker Lifting Configuration

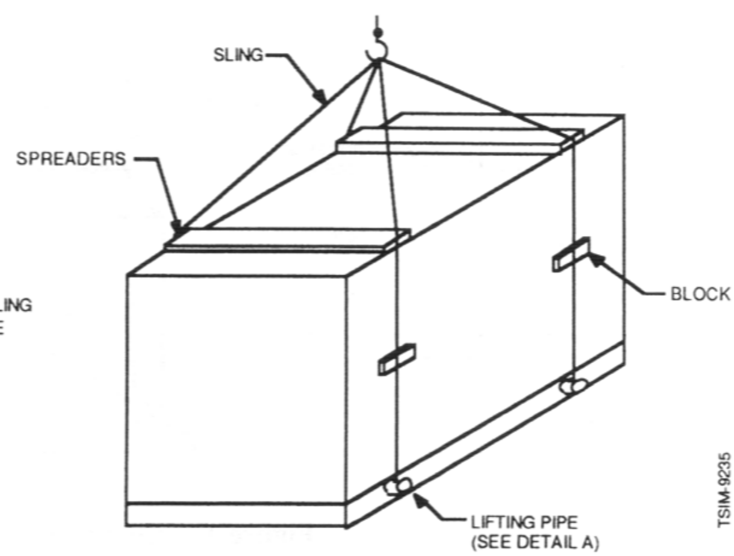
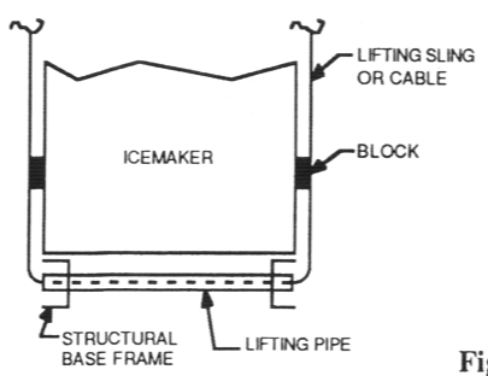


Figure 3-7 Large Icemaker Lifting Configuration



DETAIL A

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Figure 3-8 shows a larger unit requiring middle support during lifting. Additional lifting device(s) will be provided as required for proper rigging (shown with lifting lugs).

Figure 3-9 shows a unit and a condenser mounted on a common skid. The lifting method is similar to that of Figure 3-7, except lifting lugs are used. Both spreader bars and blocks are required in this method.

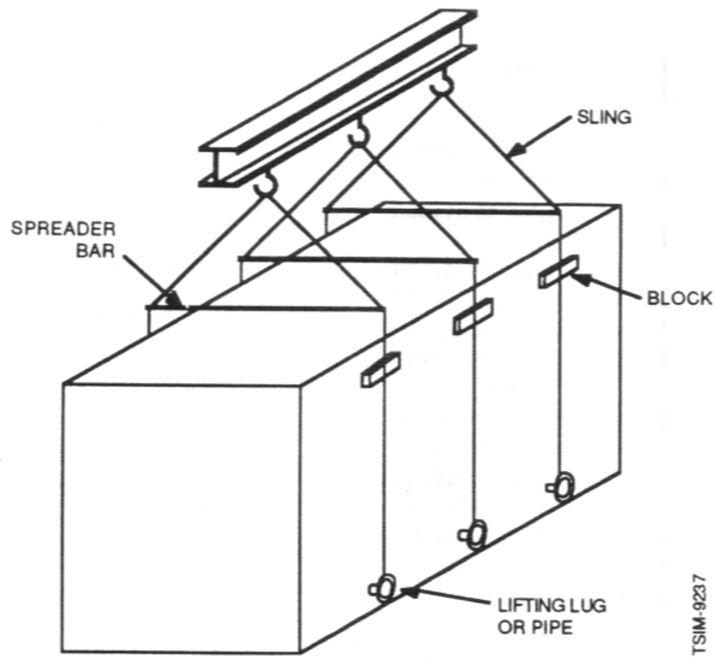


Figure 3-8 Large Icemaker With Middle Support

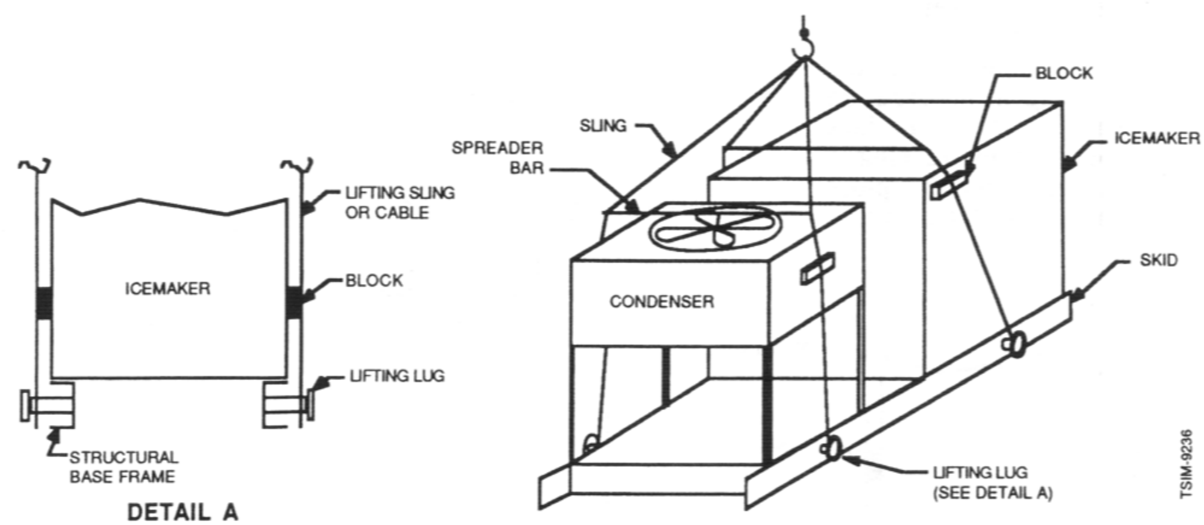


Figure 3-9 Common Skid

Figure 3-10 shows a typical unit with an air-cooled condensing unit. This configuration is typical of SCA and SCE models and is the same as Figure 3-8, except that lifting eyes are provided. Multiple spreader bars and blocks are required.

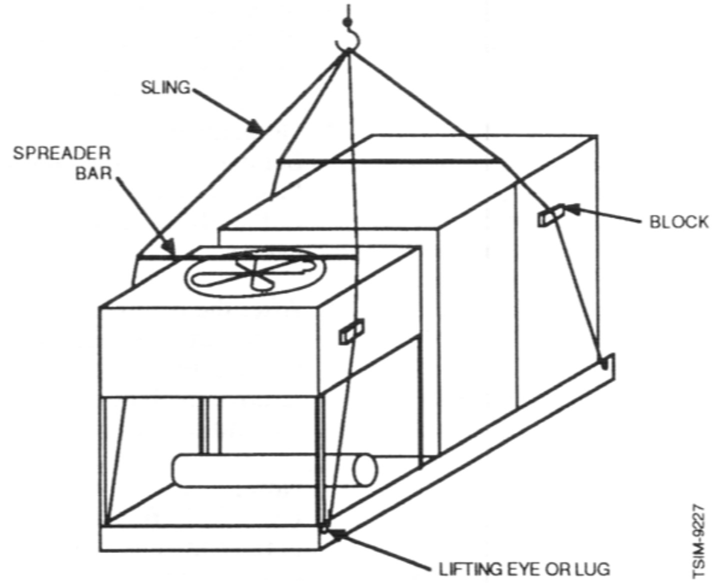


Figure 3-10 Icemaker With An Air-Cooled Condensing Unit

Hoisting Or Moving

If a unit is installed in a location that requires the unit to be lifted by means of a crane, Turbo requires that the lifting and/or slinging be done from the bottom of the unit and that the unit be kept level during hoisting. Do not hoist from one end. The lifting angle should not exceed 20°.

Use a spreader at the top of the unit to prevent the unit panels from crushing. A competent rigging and hoisting contractor can handle the job without danger or damage to the unit.

If a unit has to be moved along a floor, road, driveway, etc., use either pipes as rollers or dollies of sufficient capacity under the unit.

IMPORTANT

Never lift or sling the unit with devices fastened to the top frame structure. Only lift the unit from the lifting lugs, eyes, or pipes provided.

The self-contained water-cooled icemaker contains a condensing unit located under the ice slide inside the evaporator cabinet (on all models except the 60 ton, which has the condensing unit outboarded). The evaporator and condensing sections are located on a common base frame provided with either lifting eyes, lugs, or pipes. Before hoisting, the rigger must ensure that the load is properly balanced to prevent tilting or tipping of the unit. Test the load before lifting off the truck or ground.

WARNING

Hoisting or moving heavy equipment should only be done by competent rigging and hoisting contractors. Never allow personnel under the unit while it is in the air. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Models Without Lifting Eyes, Lugs, Or Pipes

Many icemakers built prior to 1992 do not have lifting eyes or lugs. This configuration is typical on models with a production capacity of 5 tons or less and on all "Spacesaver" models. On these models, the following lifting method should be used:

Hoisting Using A Crane

Refer to Figure 3-11.

1. Using a forklift, hoist, or crane, lift each end of the unit up and set on blocks.
2. Remove and discard the wood shipping skids on which the unit is shipped.
3. Once both ends are securely set on blocks, secure a flat strap or cable under each end of the unit (refer to Figure 3-11).

WARNING

Use a board, rod, or some other suitable means to push the lifting strap or cable under the unit. Do <u>not</u> put hands, arms, feet, or any part of your body under the unit. Failure to carefully follow these instructions could result in permanent injury or loss of life.

4. Secure each end of the lifting straps or cables to a lifting eye or bar.
5. Hoist the unit in place. Set one end of the unit on blocks to enable removal of the lifting straps or cables.
6. After the lifting straps or cables are removed, lift the end that is blocked up, remove the block, and set the unit in place.

   Note:
   Use a forklift or housejack to raise the end of the unit (refer to Figure 3-11).

7. Use a forklift, pry bars, chain come-alongs, or other suitable device to slide the unit into its final position.

Alternate Method Using A Forklift

1. With a forklift of suitable lifting capacity, pick up the unit.
2. Remove the wood shipping skids attached to the icemaker base frame and discard.

WARNING

Do not place hands, arms, feet, or any part of your body under the unit unless it is securely blocked or supported with means suitable to prevent it from dropping. Failure to carefully follow these instructions could result in permanent injury or loss of life.

3. Set the unit in the desired location with one end blocked to allow removal of the forklift.
4. Using the end of the lifting forks, lift the end of the unit that is blocked and remove the blocks.

WARNING

Use a board, rod, or some other suitable means to remove the lifting strap or cable from under the unit. Do <u>not</u> put hands, arms, feet, or any part of your body under the unit. Failure to carefully follow these instructions could result in permanent injury or loss of life.

5. Secure (temporarily) the end opposite the forklift using a chain, fastener, temporary weld, etc. to prevent movement of the unit during step 6.
6. Lower the forks to ground level and back the forks from under the unit frame.
7. Use the forklift or pry bars to slide the unit into its final position.
8. Secure the unit in place.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

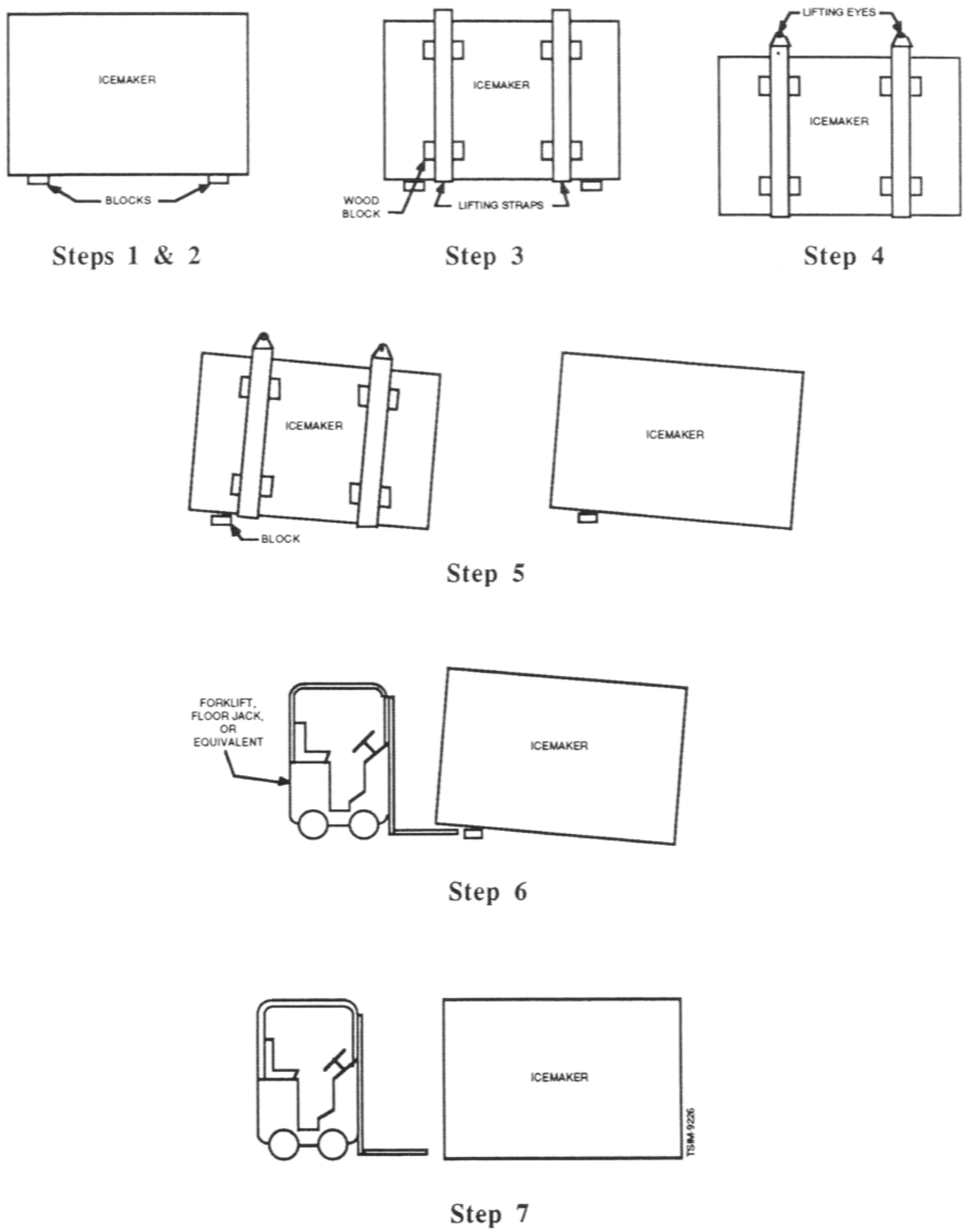


Figure 3-11 Hoisting Icemaker Models Without Lifting Eyes Or Lugs

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

3B. MOUNTING AND LEVELING

Set and secure the unit on a solid, level concrete pad or steel structure. Refer to step 1 – Site Preparation on page 33 for additional details.

IMPORTANT

It is imperative that the icemaker be level along the top (interface of unit and the pad or steel structure) in both length and width. Failure to level the mounting interface of the unit in both directions will result in excessive shimming of the icemaker when it is mounted on the pad or steel structure. Failure to properly level the icemaker will disturb the water flow pattern over the evaporator plates and may cause incomplete coverage of the freezing surfaces.

Use a level with a minimum length of forty-eight (48) inches to ensure a good installation.

Since shimming is required to level the unit, use caution to prevent long unsupported spans (greater than 30") along the structural base. Mechanical vibration or gas pulsation from the condensing unit could produce unacceptable vibrations resulting in failure of components, broken refrigerant lines, and excessive noise.

Loose dirt, scale, and other debris should be removed from the bottom of the unit interface prior to mounting to the pad or steel structure.

IMPORTANT

Leveling the icemaker may require shimming. Long spans and voids under the structural base of the unit must be avoided to ensure solid support of all structural members. Failure to follow these instructions could result in excessive vibration, refrigerant line breakage, compressor failure, and loss of refrigerant.

Units installed above grade should be provided with railing around the steel platform, ladders, or stairway access to the equipment that conform to all local, state, and federal requirements.

WARNING

Access to the unit should be secured and limited to authorized personnel only. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Units installed at grade should also be provided with fencing if installed outdoors, or in a room with limited access to prevent access to the icemaker by unauthorized personnel.

On concrete pads, the icemaker is secured to the floor with the steel inserts described in step 1 – Site Preparation or other suitable anchoring. The unit base frame should be welded to the steel platform intermittently around the entire base frame or to the steel inserts embedded in the concrete pad.

Securing The Unit

There are several ways to secure the unit to the pad on which it will rest. The anchoring method used should provide a secure installation and conform to all local, state, or federal codes. Figure 3-12 shows a steel insert placed in the pad on which the unit base frame is set. In this configuration, the unit bottom frame member is directly welded to the steel insert.

Figure 3-13 shows bolts which hold down a steel plate which secures the icemaker to the pad. This configuration eliminates the need for holes in the bottom structural member of the unit for securing the icemaker

As a result of shimming to level the unit, it may be necessary to weld a steel tab to the base frame as shown in Figure 3-14 to anchor the unit to the concrete pad.

Note:
The concrete pad must be suitable for supporting the weight of the unit with a full water charge, all catwalks, guard rails, ladders, miscellaneous equipment, and personnel. The unit must be level and properly supported under the entire base frame.

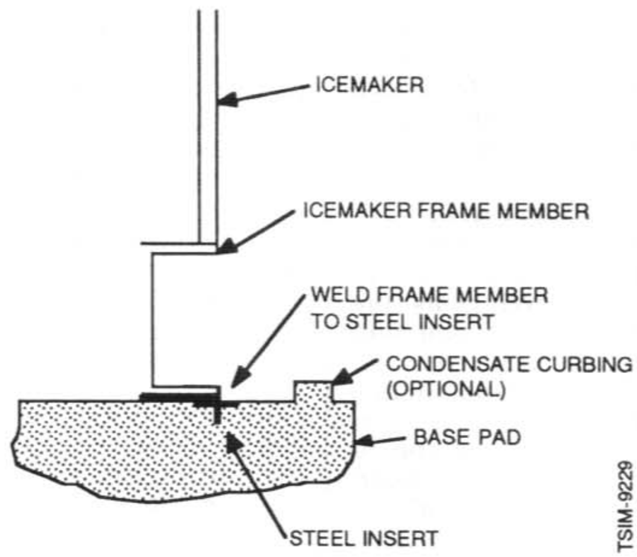


Figure 3-12 Icemaker To Concrete Pad (Steel Insert)

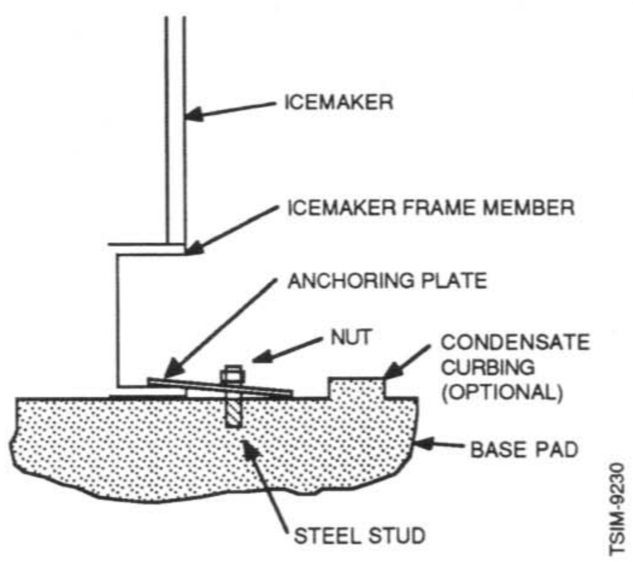


Figure 3-13 Icemaker To Concrete Pad (Steel Plate)

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

If the above anchoring procedure cannot be followed, contact TURBO for alternate methods.

TURBO should be notified in writing of variations from the above guidelines. Comments on these variations will be provided by TURBO. However, TURBO assumes no liability for designs and installations provided by others.

IMPORTANT

Failure to provide written notifications of unauthorized icemaker installation designs or installation techniques will release TURBO from any obligation or warranty resulting from such installations.

Grouting Guidelines

If the concrete pad is uneven and leveling is required, it may be necessary to grout under the frame to ensure proper support. Follow these guidelines if grouting is required (refer to Figure 3-14).

Provide clearance for 3/8" to 1/2" grout. Wet the top of the concrete pad, pour grout and tamp to fill spaces between frame and concrete pad. Allow grout to dry slightly and then trowel smooth.

A suggested mixture for the grout is one (1) part Portland cement to two (2) or three (3) parts of sharp sand.

When the grout has hardened for twenty-four (24) to thirty-six (36) hours, tighten any foundation or anchor bolts used to attach the frame to the concrete. Full curing of the grout may require additional time. Consult the installing contractor.

All grouting material and installation of grouting is supplied and installed by others. Use non-shrink grout.

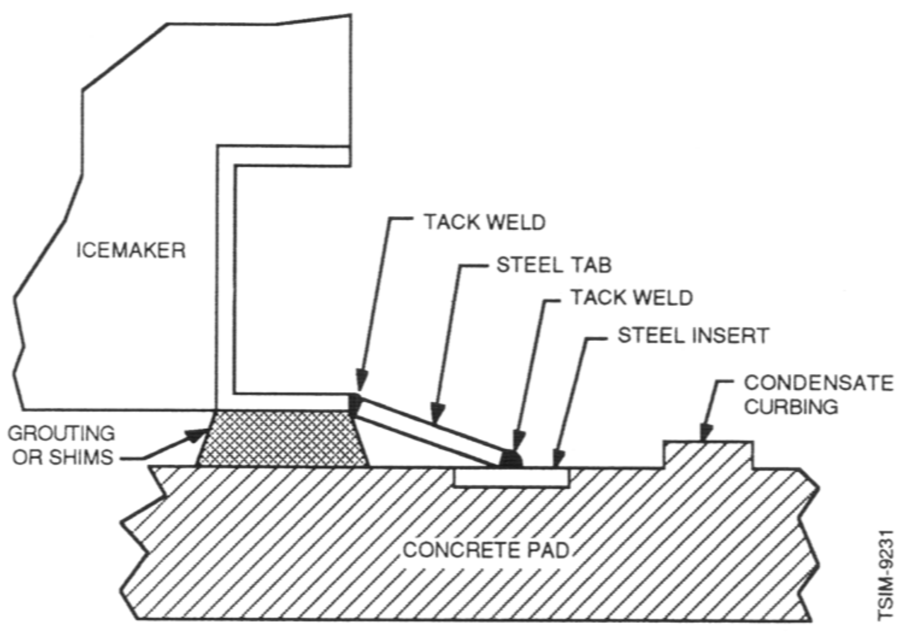


Figure 3-14 Anchoring Unit After Leveling And Grouting

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

4. STEEL PLATFORMS FOR ELEVATED INSTALLATION

TURBO® icemakers may be mounted on a steel platform in indoor or outdoor installations. Such installations often simplify conveying the ice from the icemaker to a TURBO® ice rake storage system. Ice is discharged into the top of the ice rake system requiring the ice to be transported via inclined or vertical screw conveyors unless the icemaker is mounted above the storage system.

Laying Out The Steel Platform Guidelines

These guidelines are for all standard TURBO® icemakers. Actual design and selection of the material used for construction must be provided by a local contractor to ensure that:

- All local, state, and federal codes are followed.
- The structure will support the live load of the icemaker as it produces and discharges the ice.

IMPORTANT

TURBO will provide guidelines and advice relative to the design and construction of steel platforms supplied by others. TURBO assumes no liability for the design, load calculations, or fabrication of such platforms, nor the interfacing, installation, or orientation of structures provided by others. Final selection and approval of design, load calculations, and fabrication should be obtained from a registered professional engineer, design firm, or agency licensed or registered to provide such service.

Factors that should be considered include:

- Total operating weight including full water tank(s), refrigerant charge, water in condensers, cooling tower, or evaporative condensers.
- Total operating weight if the evaporator plate fails to harvest and the evaporator section is solid ice (maximum weight = operating weight + weight of ice if bridged solid between evaporator plates, typically 1 1/2 times the rated production).
- Weight of accessory equipment attached to the icemaker – screw conveyors, ice discharge transition chute(s), railing, etc.
- Weight of ice in the discharge slide, chute, or screw conveyors during harvest.
- The dynamic load generated by rotating equipment – compressors, water pumps, breaker bars, screw conveyors, etc.
- The dynamic and static effect of equipment to be used on the platform for service or removal of components.
- The effect of personnel movement and access to the platform.
- Environmental factors – seismic, wind, soil conditions (footings), ice storms, snow, etc.

IMPORTANT

The above factors are for consideration in performing the design, load calculations, and fabrication of a steel platform for the icemaker and accessory equipment. Other factors or conditions may exist that affect the design load calculations or fabrication process to meet all applicable codes and guidelines.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Dimensional Data

The tables below list the dimensional data required to ensure that the icemaker can be properly installed upon arrival. Table 3-1 covers SC, SCA, SCAR, SCER, and R models.

SCE models can also be mounted on steel platforms. However, due to the wide variation in condenser selections, the factory should be consulted for data.

Note:
Dimensional data and weights are subject to change without notice. Consult the data sheet supplied with the equipment or the factory for final data.

Refer to step 5 – Ice Discharge Opening Transition Chutes for additional details. This chute is supplied by others and is field installed.

Some models shown in Table 3-1 are no longer available. Consult TURBO for information.

Table 3-1 SC/SCA/SCAR/SCER/R Models Dimensional Data

Nominal Ice Capacity U.S. Tons (24 hrs.)	Model Number	Overall Dimensions L x W x H (inches)	Net Weight (lbs.)	Ship Weight (lbs.)
1	CF2SC	76 x 24 x 72	1173	1285
1	CF2SCA	76 x 82 x 78	1793	2016
1	CF2SCAR	76 x 24 x 72	1331	1443
2	CF4SC	76 x 24 x 72	1402	1514
2	CF4SCA	76 x 86 x 78	2474	2698
2	CF4SCAR	76 x 24 x 72	1331	1443
3	CF6SC	78 x 44 x 88	3420	3610
3	CF6SCA	120 x 88 x 94	4070	4450
3	CF6SCAR	78 x 44 x 88	3170	3360
5	CF8SC	78 x 44 x 88	3730	3920
5	CF8SCA	134 x 88 x 94	4967	5347
5	CF8SCAR	78 x 44 x 88	3420	3610
5	CF8SCE	144 x 88 x 94	4967	5347
5	CF8SCER	78 x 44 x 88	3420	3610
7	CF14SC	78 x 72 x 94	5596	5854
7	CF14SCA	191 x 88 x 102	7204	7462
7	CF14SCAR	78 x 72 x 94	5466	5766
7	CF14SCE	88 x 150 x 102	7204	7462
7	CF14SCER	78 x 72 x 94	5466	5724
10	CF88SC	78 x 72 x 94	6626	6884
10	CF88SCA	213 x 88 x 102	8554	8964
10	CF88SCAR	78 x 72 x 94	6425	6680
10	CF88SCE	176 x 88 x 102	8554	8964
10	CF88SCER	78 x 72 x 94	6425	6680
10	CF16SC	78 x 72 x 94	6626	6884
10	CF16SCE	176 x 88 x 102	8554	8964
10	CF16SCER	78 x 72 x 94	6425	6680
14	CF28SC	99 x 94 x 110	9039	9390
14	CF28SCA	312 x 96 x 118	11500	11800
14	CF28SCAR	96 x 94 x 110	8519	8870
14	CF28SCE	240 x 94 x 118	11500	11800
14	CF28SCER	99 x 94 x 110	8519	8870
15	CF28SC	99 x 94 x 110	9039	9390
15	CF28SCA	312 x 96 x 118	11500	11800
15	CF28SCAR	99 x 94 x 110	8519	8870
15	CF28SCE	240 x 94 x 118	11500	11800
15	CF28SCER	99 x 94 x 110	8519	8870
20	CF40SC	128 x 94 x 110	11702	12160
20	CF40SCAR	128 x 94 x 110	9206	9664
20	CF40SCER	128 x 94 x 110	9206	9664
30	CF56SC	198 x 94 x 110	21012	21540
30	CF56SCAR	198 x 94 x 110	19972	20500
30	CF56SCER	198 x 94 x 110	19972	23600
40	CF80SC	256 x 94 x 110	22580	23220
40	CF80SCAR	256 x 94 x 110	21760	22400
40	CF80SCER	256 x 94 x 110	21760	22400
60	CF120SC	480 x 94 x 121	40075	40755
60	CF120SCER	480 x 94 x 121	38475	39175

TSIM-9265

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

5. ICE DISCHARGE OPENING TRANSITION CHUTES

All TURBO® icemakers have an ice discharge opening located on the lower front portion of the unit. The rotating breaker bar is located directly behind the opening which must be covered to prevent access to the ice discharge opening. Since the ice must be transported to a storage or distribution system, it is necessary to "collect" or "funnel" the ice into a conveyor system. Covering the ice discharge opening and collecting the ice can be accomplished by field installation (material and installation by others) of a discharge transition chute.

WARNING

The icemaker ice discharge opening must be covered to restrict access to the rotating breaker bar located behind it. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Figure 3-15 shows typical discharge transition chute configurations and the location relative to the icemaker. Galvanized sheet metal or stainless steel are typically used to construct the transition chute which is field installed.

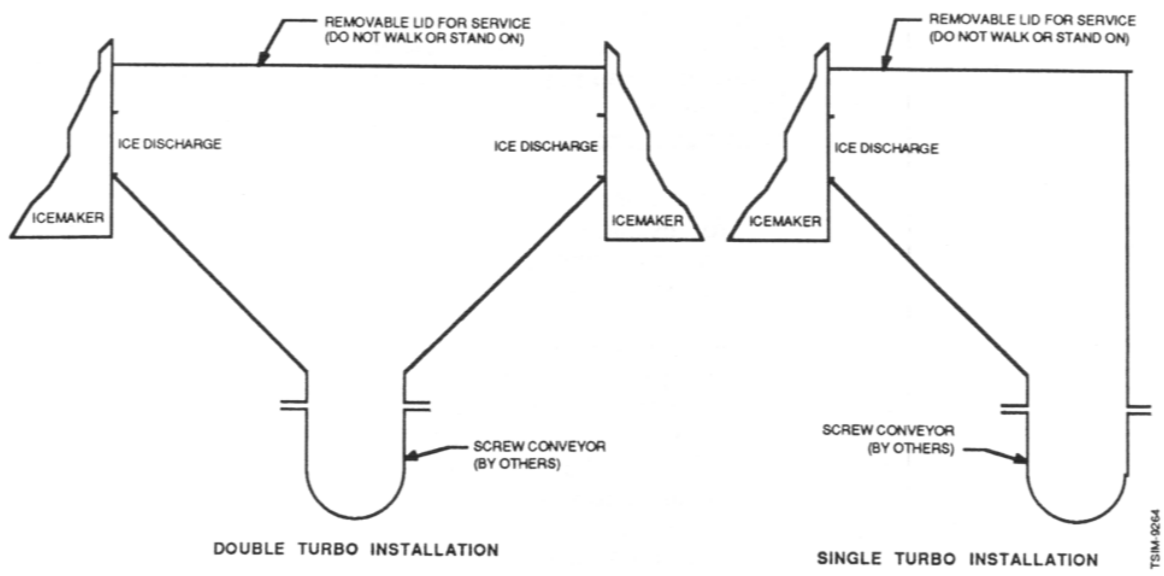


Figure 3-15 Typical Discharge Transition Chute Configurations

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

IMPORTANT

TURBO provides the guidelines for the discharge opening transition chute based on experience and knowledge. TURBO assumes no liability for the proper design, fabrication, or installation of the chute, its attachment to the icemaker, or other accessory equipment such as screw conveyors. It is the responsibility of the owner, contractor, consulting engineer, or other agency licensed or registered to make the final design and installation per all local, state, federal, or other agency codes or guidelines.

Design And Installation Factors

- Select a sheet metal gauge suitable to handle discharge of the ice from the icemaker to the transition and the weight of the transfer screw conveyor. On larger models (300-400 pounds of ice), ice will be discharged each harvest cycle.
- Consider the loading caused by the ice on the walls of the transition chute by the transport device (typically a screw conveyor) moving the ice.
- The top of the chute should be removable for service access.

WARNING

Warning labels should be attached to any removable covers or guards prohibiting operation of the equipment without the covers or guards in place. Failure to carefully follow these instructions could result in permanent injury or loss of life.

- Provisions should be made for a grating or platform above the transition chute to avoid standing on the covering when performing service on the icemaker.

WARNING

Never walk or stand on the transition chute cover, screw conveyors cover, or any other protective cover. Failure to carefully follow these instructions could result in permanent injury or loss of life.

- Provisions should be made for insulating the entire transition chute to prevent excessive heat infiltration.
- Provide a minimum of 1/4 inch per 10 feet pitch at the bottom to incline the screw conveyor. Provide a drain on the bottom of the inclined screw conveyor to permit constant drainage of condensate or accidental overflow of water from the icemaker.
- Do not discharge ice directly from the transition chute into the ice storage bin. A transition screw is recommended to permit drainage of condensate or accidental water overflow from the icemaker prior to entering the ice storage (TURBO® rake) bin. This arrangement also permits cleaning of the icemaker, icemaker ice slide, transition chute, and transfer screw conveyor without water or cleaning agents getting into the ice storage bin.
- For ice storage bins in below freezing rooms, ice build-up or "clumps" of ice can form in the bin and cause damage to the system if condensate and water are not removed prior to discharge into the bin.
- Refer to section 2 – Safety on page 11 for "lockout" procedures to be followed while working on the transition chute or accessory equipment attached to it.

6. REFRIGERANT PIPING

Piping in a refrigerant system has two functions:

1. To carry the refrigerant through the system as a liquid or a gas with a minimum pressure drop.
2. To return any oil entrained in the refrigerant to the compressor. Suction mains should be pitched toward the compressor to prevent liquid (oil or refrigerant) traps and compressor slugs.

Field piping installation and configuration is critical for proper system operation. Proper refrigeration piping should be installed following commonly accepted piping practices and guidelines.

IMPORTANT

TURBO will provide guidelines and advice relative to sizing, configuration, and location of piping supplied by others with prior written notice of the piping detail. TURBO assumes no liability for proper sizing or installation of piping supplied and installed by others. TURBO will not assume responsibility for proper interfacing, capacity, or installation of piping by others.

Refrigerant Installations

For threaded connections on piping for refrigerants, use Teflon thread sealing tape. Wrap the tape around the threaded male portion of the joint about two full turns, thread into the female portion, and tighten. If thread sealing tape is not available, conventional thread filling compound may be used. Use thread filling compound sparingly and on the pipe only. Do not put any thread filling compound on the first two threads, this prevents any of the compound from entering the system.

For R-22 refrigerant installations, use copper pipe with solder type fittings where possible. The use of screw type fittings should be held to an absolute minumum to prevent R-22 from leaking through.

Copper Tubing

Piping for R-22 refrigerant systems must be type K or L copper (depending on the application). Steel pipe is used in large installations when joints are welded and on all ammonia (NH3) systems.

Note:
Stainless steel piping is available on ammonia (NH3) icemakers.

Type "K" is suitable for working pressures up to 400 psi. Type "L" is suitable for working pressures up to 300 psi. Check local requirements before installation because some local codes forbid the use of type "L". Never use type "M"; it does not have adequate wall thickness to withstand the operating pressures and is used for water service only.

Only wrought copper fittings should be used for R-22 refrigerant piping. Cast fittings used for water service are porous and not suitable for the refrigerant service. Exception: In larger pipe sizes, wrought fittings are not available. Specially tested cast fittings are available to use with complete safety in refrigerant piping systems.

Soldering

When soldering copper tubing joints, silver solder such as "SilFos", "Phoson #15", "Silbond 15", or any solder that has 15% silver content can be used. Soft solder should never be used because its melting point is too low. Soft solder lacks mechanical strength and tends to break down chemically in the presence of moisture.

On joints between dissimilar metals (such as copper to steel or stainless to mild steel), a 40% silver and staysil flux may be required.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

All joints, regardless of material being used, must be cleaned with emery paper or other suitable material to obtain a clean, bright surface before brazing.

Steel Pipe Cleaning

Carbon steel or stainless steel pipe can be used for refrigerant lines but must be either sand blasted or pickled to ensure complete removal of wax, oil, or other processing films.

Pipe Line Hangers

Hangers and supports for coils and pipe lines should receive careful attention. Hangers must have ample strength and be securely anchored to withstand any vibration from the compressor and adequately support the pipe lines.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

7. ELECTRICAL CONNECTIONS

Before electrical checks (see Electrical Checklist on page 58) are made, all piping and installation of the equipment should be completed to prevent operation without all components being properly installed.

WARNING

All electrical work should be done only by a qualified electrician. Do NOT turn power on at this time. Failure to carefully follow these instructions could result in permanent injury or loss of life.

IMPORTANT

Electrical wiring diagrams are located in each control panel and are furnished with each operating manual. These diagrams should be consulted before making the electrical service connections.

Separate electrical connections are required for the single phase control circuit and three phase motors supplied with the unit. A UL listed electrical panel is provided.

Single Phase

Standard single phase power to the icemaker is 120 volts at 60 hertz. Other voltages and frequencies are available as options. Systems provided for connection to a 240 volt, 60 hertz supply are provided with an optional control circuit transformer. All components in the control panels or components in the icemaker connected to the controls will remain 120 volts.

Connection of the single phase control power is made at a conduit connection located next to the control panel. Wiring and wire conduit to this connection is provided by others. Ten amp circuit breakers or fuses are provided on the control wiring. Additional circuit breakers, disconnects, short-circuit protection, or other circuit protection devices must be field installed ahead of the control panel. Standard models require 10 amps electrical service. Consult the wiring diagram and sales order for options requiring additional single phase electrical service.

Single phase controls include a cam timer or programmable controller, control relays, interlocks, terminal blocks, and provisions for connection of remote controls (optional).

Wiring from the terminal strips to the solenoid valve coils or other devices located in the evaporator compartment or under the ice slide is factory installed.

Consult the supplied wiring schematic for specific field wiring requirements (i.e., bin level switch, delivery screw, interlocks, etc.).

Three Phase

Motor starters or contactors are provided for each motor. Factory wiring is from the motor to the bottom of the starter or contactor (contactors with separate overload protection are provided with semi-hermetic compressors). Field wiring is required from a field installed motor control center (supplied by others) to each starter or contactor in the electrical panel.

IMPORTANT

Separate fusing or circuit breakers must be provided for each device (motor) per the National Electrical Code. All wiring and connections must be made in compliance with the National Electrical Code and all other applicable local, state, or federal codes or guidelines.

As noted above, all three phase wiring from the top of each starter or contactor is field installed and supplied by others.

As an option, branch circuit protection can be provided for each starter supplied. If

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

the optional control power transformer is selected, it will be located in this panel. Also, a main circuit breaker can optionally be provided to serve as a main disconnect for the equipment.

IMPORTANT

The electrical contractor should ensure that all interconnecting wiring complies with local, state, and federal codes.

Electrical Controls Check

After the control wiring is complete and with all three-phase power off (main breaker/disconnect off), the electrical control system operation should be simulated to ensure that the proper sequencing is occurring and all protective switches and controls are functioning properly. External controls or switches should be manually tripped to ensure the proper control response.

Example:
If the optional BLS switch located in a storage bin (to indicate the storage is full) is used, the switch should be manually tripped to ensure that the icemaker controls respond properly. The unit should go through the final harvest and shut down.

Refer to section 4 – Operating Instructions on page 109 for the proper operating sequence.

IMPORTANT

Refer to step 6 in the Electrical Checklist on this page for instructions on disconnecting the oil pressure safety switch during check-out of the controls with the three-phase power disconnected.

WARNING

Never run the control circuit electrical check with the three-phase power to the motors connected during the control circuit check-out. Improperly connected wiring or controls could result in unsafe operation of the motors. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Electrical Checklist

1. Check the voltage supply versus the voltage indicated on the icemaker nameplate.
2. Check the preset valves, the safety switches (high pressure switch and low pressure switch, cut in and cut out, oil temperature thermostat, etc.), and manual resets on safety devices.
3. Check all connections for short to ground.
4. Check for electrical continuity on L1 and L2.
5. Check all wiring to interlocks and controls that were field installed versus the wiring diagram supplied with the unit. Check all connections to the input/outputs (I/Os) of the programmable controller or electro-mechanical controls for loose connections.
6. Remove and secure the L2 connection (black with white tracer wire) from OPTDH to prevent oil pressure failure trip due to lack of oil pressure during simulation check-out. To properly verify operation of the oil pressure failure safety switch, the hot wire to the oil failure switch heater (OPTDH) should be connected. Check time delay required for switch to trip.
7. Check safeties and automatic shut down as well as refrigeration/defrost cycles.
8. Check motor overload heater sizing or settings for each motor (setting should not exceed motor nameplate FLA amps).
9. Connect three-phase power to each motor individually and verify proper rotation by manually "bumping" the starter on and then off.
10. Check the crankcase oil temperature switch setting. This should be set at 140°F.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Note:
An oil temperature thermostat is not required on units with a semi-hermetic compressor, which utilizes built-in cylinder head discharge temperature safety switches.

11. Turn on the power to the compressor crankcase heater for a minimum of 24 hours prior to operation of the compressor to ensure proper oil temperature and removal of any condensed liquid refrigerant in the compressor crankcase.

IMPORTANT

Failure to turn on the compressor crankcase for 24 hours prior to operation could result in liquid slugging and failure of the compressor.

On remote equipment installed in the field, circuit breakers must be provided. TURBO supplied optional three-phase panels contains all breakers for the unitary mounted equipment. Motors located remotely may require a disconnect at the motor to meet local, state, or federal codes.

Electrical Service Connections

Icemakers are furnished completely wired internally, but may require some interconnecting wiring (e.g. interlocks to screw compressors, ice storage bins, etc.; refer to the wiring diagram supplied with the unit and in this manual) as well as the electrical service connections. The electrical service connections required are:

- The three-phase L1, L2, and L3 connections to each of the motor starters/contactors, unless the unit is supplied with the optional main circuit breaker and branch circuit protection. The ampere load requirement for both the individual three-phase loads and the entire unit is listed on the nameplate on the control panel door. If starters are supplied for motors which are provided by others, the interconnecting wiring must also be done by others.

WARNING

Never drill or install components in the control panel, three-phase panel, or circuit breaker panel without turning off and locking out all power. Failure to carefully follow these instructions could result in permanent injury or loss of life.

- The single-phase (L1 and L2) connections to terminal blocks in the control panel, unless the optional control panel transformer is selected. In most cases, a 10 amp 115/1/60 power supply is adequate. Some units may require additional amp service; therefore, the wiring diagram must be referred to for the individual installation.

CAUTION

If additional starters or controls are field mounted in the control panel, three-phase panel, or circuit breaker panel, all wiring and installation must conform to all applicable standards. If it is necessary to drill holes for mounting such devices, other components in the enclosure must be covered to prevent "fillings" and metal chips (debris from drilling operation) from falling into and lodging in the contact of starters, relays, or coil wiring. Failure to follow these instructions could result in the shorting of electrical controls or components.

- The equipment grounding as required by the local, state, and federal codes must be done by others.

- All 120V control circuits are grounded to the B/P on the L2 leg. Make sure the 120V supply can be grounded without damage to equipment. 240V circuits (L1 or L2) are not grounded.

- Pay attention to markings on panels:

  The nameplate lists individual three-phase loads and total FLA for control and three-phase. Field wiring must use copper, 60°C wire insulation (minimum) if rated less than 100 amps or copper 75°C wire insulation (minimum) if rated 100 amp or more.

Tighten torque for field wiring to terminal blocks, starters, contactors, circuit breakers, and power distribution blocks.

Icemakers are furnished completely prewired internally but require electrical service connections to:

- Top wiring (the L1, L2, and L3 connectors) on each of the motor starters (three phase) except on units with optional circuit breaker installed
- The L1 and L2 connections of the control circuit (single phase)
- The top wiring to the circuit breakers (optional) on all units so equipped and is field installed by others.

All of these connections are located inside the icemaker control panel. Install disconnect switches (by others) in the incoming power lines ahead of the control panel on the unit.

Checking Rotation

WARNING

Make sure the compressor is clear of all obstacles and warn all personnel to stay clear of the compressor at all times. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Note:
When checking rotation, only the power to the motor being checked should be on.

Control Panel Winterizing (Optional)

Ambient temperatures can affect many of the electronic controls in the control panel. In general, the devices TURBO uses operate properly in temperatures between 32°F and 140°F.

In operating ambients under 40°F, TURBO recommends that a source of heat be available in the control panel to maintain a temperature above 40°F. This will ensure continuous, reliable operation of all components (even in severe applications*). An optional winterizing kit consisting of a heat source and control thermostat can be provided as a factory installation or as a retrofit to existing control panels.

* The control panel winterizing kit is designed for equipment operations in ranges from 0 to 40°F. Consult TURBO for equipment operations in conditions below 0°F.

Installation

All winterizing components are factory installed and prewired when ordered with the unit. Kits are also available for field installation.

Operating Sequence

As the control panel temperature drops below the set point of 40°F, the contacts of CPHT thermostat close to energize the panel heater coil. As the temperature rises above the differential setting of the thermostat, the contact opens to turn off the heater. The thermostat continues to maintain the interior temperature above 40°F. Refer to Figure 3-16.

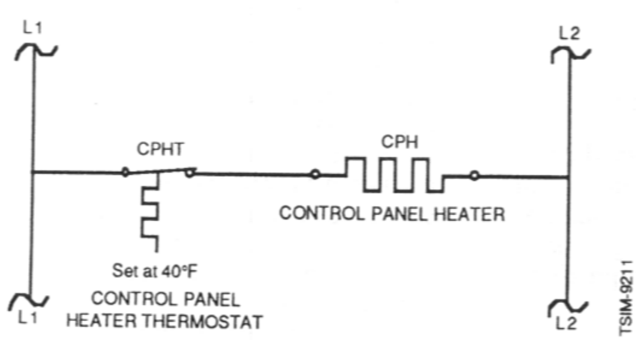


Figure 3-16 Control Panel Winterizing Wiring

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

8. WATER CONNECTIONS

Make-Up Water

Once the unit is installed, a water line must be field installed from a pottable water source to the make-up (defrost) water connection on the icemaker. A line capable of supplying the water volume specified and allowing a 15 psig pressure at the unit inlet water connection must be used. Refer to Table 3-2. Pressure drops due to line losses, valves, strainers, and vertical lift must all be considered to ensure 14 psig is available at the inlet connection. The water supplied must be a minimum temperature of 70°F to ensure proper defrost.

The location of the make-up water connection is shown on the data sheet for each model. PVC or galvanized steel pipe may be used. Suitability of materials used should be checked to ensure local codes are met.

Supply (city) water temperatures range from 33°F to 60°F. Insulation of the water recirculating piping is recommended (field installed by others). Heat tracing (by others) may also be required for systems operating or exposed to ambient temperatures below 40°F to prevent freezing of the piping.

If the water is below 70°F, a source of heat must be provided to obtain the 70°F water temperature required for rated capacity and proper operation.

Water at 70°F is introduced into the unit through the make-up water (defrost) connection during the defrost sequence. Make-up water is used to:

- Harvest (defrost) the ice from the plates.
- Refill the water tank.
- Provide water blow-down.

Refer to the section 4 – Operating Instructions on page 109 for a complete description of water circuit during refrigeration and defrost. All external piping, valves, and connections are field installed and provided by others.

All make-up water lines are supplied with a strainer, shipped loose for field installation. Strainers can be installed anywhere in the make-up water line. Installation in a location convenient for cleaning access (including provisions for draining of the water released from the line during cleaning) is recommended.

Overflow Drain Connection

The water tank is refilled during the defrost cycle. A stand-pipe is located inside each water tank to prevent the tank from overflowing during the defrost cycle.

Since the icemaking cycle causes solids to concentrate in the water tank during the icemaking process, a small amount of water is intentionally overflowed to remove excess solids and to ensure the clarity of the ice. This process is referred to as "blowdown". All of the water tanks are connected to a common drain line. The common line is then routed to a single field connection on the exterior of the unit.

Note:
The stand-pipe in the water tank can be removed for draining and cleaning the tank. Older models have a threaded PVC stand-pipe. Newer models have a stand-pipe with an O-ring that is inserted into a socket in the bottom of the tank. Both types of stand-pipes have two notches on the top to assist in removal. Always check for leakage when reinstalling.

A wire gutter strainer is supplied with the stand-pipe. This strainer is inserted in the top of the stand-pipe to prevent large solids, trash, or ice fragments from entering the stand-pipe and causing a restriction.

All external piping should be routed to a sewer or suitable disposal point. Piping should be sized to permit sewer flow. This prevents water from backing up in the drain line causing the water tank to overflow. The piping connection provided on the unit is sized to permit sewer flow for piping runs up to 100 feet. Larger pipe sizes may be required for longer piping runs.

IMPORTANT

Local, state, and federal codes should be consulted to ensure that proper material is used for external piping runs. In most cases, PVC pipe is suitable.

All external piping, valves, and connections are field installed and supplied by others.

IMPORTANT

The overflow drain should never be plugged. Without a properly connected drain, the water tank will overflow. Water running down the ice slide and out the ice discharge could result in flooding of the equipment room.

IMPORTANT

If 70°F water cannot be supplied to the unit, optional water preheater kits, boilers, or water blending valves must be provided. Contact TURBO for additional information on the available options. Built-in preheater kits can be factory installed.

Pan Drain Connection

Each icemaker has a pan drain installed in the floor of the equipment compartment to remove water, condensation, oil, and other fluid that collects in the pan under the evaporator/ice slide upper section. Drain lines should be connected from these connections to a suitable floor drain or disposal point.

All piping, valves, and fittings are supplied by others and are field installed.

Heat tracing of drain line(s) may be required in some installations. Consult TURBO for additional guidelines.

Other Requirements

On indoor installations, containment of overflow water should be given extra consideration to avoid flooding of basements, mechanical rooms, or occupied space.

Heat tracing of the make-up water, pan, or overflow drain lines may be required for installations operating in low ambients (below 40°F).

Water Pressure (Icemaker)

As stated previously, the icemaker requires a specified gpm (gallons per minute) of 70°F water at the make-up connection. The pressure drop in the piping run, valves, connections, and vertical lifts must be considered to ensure that a minimum water pressure of 15 psig is available at the make-up connections. If the available pressure is below 15 psig, the unit will not defrost properly. In some cases, a booster pump may be required to obtain the proper minimum pressure.

The water solenoids used to control the make-up water flow are typically selected for maximum operating pressures of 80 psig. If the pressure in the make-up water line exceeds 80 psig, a pressure reducing valve must be installed.

Condenser (SC Models Only)

Icemakers with water-cooled condensers will require piping from the water-cooled condenser mounted in the engine compartment to a remote cooling tower. Water regulating valve(s) are supplied by TURBO for field installation. All other piping, valves, and connections are supplied by others and are field installed.

Refer to step 16 – Water-Cooled Condensers on page 91 for details of water regulating valves, cooling tower, and cooling tower pump installation.

Cooling Tower Connections

Icemakers using a water-cooled condenser will require a cooling tower to remove the heat in the water used to condense the superheated discharge gas. All cooling towers require a continuous make-up feed connection to replace water lost through evaporation in the airstream of the fan and for blow down to prevent the build-up of solids in the sump. The supplier of the cooling tower should be consulted for the flow requirements and connection size and location.

A cooling tower can be supplied as optional equipment for field installation.

Water Temperatures (Condenser)

When cooling towers are used and no other positive means of regulating head pressure are provided (such as fan and pump pressure switches), a water regulating valve will be required. Adequate head pressure is important to provide proper refrigerant flow through expansion valves or other refrigerant control devices in order to maintain the suction pressure.

When contemplating the use of city or well water for condensing, a careful check should be made of the seasonal variation in the water temperatures. Water flow lines should be sized large enough for the required flow at the maximum water temperature to be encountered. For applications requiring condenser water above 85°F, consult TURBO. When units are installed in an area where the ambient falls below freezing, refer to section 8 – Optional Features and Accessories for Winterizing on page 187.

Water Pressure Requirements (Condenser)

Water pressure at the water-cooled condenser (if so equipped) is provided by a separate water pump and is typically 5 psig or less at maximum rated flow.

As stated previously, the condenser water pressure required is a minimum of 5 psig at the inlet connection to the condenser (total minimum pressure drop is generally 15–20 psig, see below). Pressure drops through the piping, valves, and vertical lift must all be allowed for.

The water pressure at the water-cooled condenser inlet connections is determined by the pressure drop through the condenser and must include the pressure drop through the water regulating valve(s) as well as piping, valves, and vertical lift losses. Pressure drops through the condenser and water regulating valve(s) generally are between 10–15 psig. Specifications on each model should be used to determine the actual pressure drop to determine pump discharge head requirements.

Connections from the condenser are piped to the exterior of the engine compartment cabinet for connecting to external valves and piping by others in the field. The condenser inlet and outlet are each identified. The water regulating valve(s) is installed in the outlet connection line.

A local expert on water treatment should be consulted to determine if additional water treatment (chemical, filtration, etc.) is required to obtain the desired water quality for the cooling tower.

IMPORTANT

Normal freeze up precautions should be taken when water lines must be exposed to freezing temperatures.

Water Flow Requirements

Make-Up Water

Refer to Table 3-2 for water flow requirements.

Water-Cooled Condenser

Condenser water requirements are based on 85°F water to the condenser, 95°F water off the condenser, and 105°F condensing. The condensers design water flow rate is based on 3 gpm/ton of refrigeration.*

The actual rate of flow is contingent on the water temperature and evaporator load but will not exceed the design flow.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

* Tons of refrigeration:
Total heat of heat rejection at 0°F SET/105°F SDT for icemaking or 20°F/105°F for chilling divided by 15,000 BTU/ton.

(SET = saturated evaporator temperature)
(SDT = saturated discharge temperature)

Heat of rejection should be calculated for the highest evaporator temperature at which the system will operate.

Water Treatment

Icemaker

Most city water supplies provide suitable water to produce clean, quality ice. If the water supply is provided from a well or a source with high mineral content, water treatment may be beneficial. Consult a local water treatment firm for recommendations for the water. Water from reverse osmosis systems may be used.

Water-Cooled Condenser And Cooling Tower

Water in the water-cooled condenser and cooling tower is recirculated and may require treatment to prevent mineral build-up, scaling, and other biological growth. If the water is not properly treated, fouling of the condenser will occur.

IMPORTANT

Fouling of the condenser resulting from improper water treatment will result in high head pressure. If not corrected, the unit may terminate operation on the discharge pressure safety switch. Higher discharge pressure (above design) will result in reduced icemaking capacity.

Consult a local water treatment firm for evaluation of water treatment requirements.

Table 3-2 Make-Up (Defrost) Water Flow Requirements

Model (Tons Ice/Day)		Min. GPM @ Inlet	Recommended IPS Minimum Line Size
CF6	(3)	9	1 1/4
CF8	(5)	15	1 1/4
CF14	(7)	21	1 1/2
CF16, CF88	(10)	30	1 1/2
CF28, 2 compr.	(14)	21	2
CF28, 1 compr.	(15)	21	2
CF40	(20)	30	2
CF56	(30)	21	2
CF80	(40)	30	2
CF120	(60)	30	2

TSIM-9263

1. Based on 15 psig water pressure at icemaker make-up water connection.
2. Based on 40 psig city water pressure and 200 equivalent feet of piping (includes equivalent feet for elbows, fittings, valves, etc.)
3. Does not include losses due to vertical lift for elevated installations.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

9. ALIGNING RECIPROCATING COMPRESSORS AND MOTORS

Icemakers are furnished with direct coupled motors and compressors or semi-hermetic compressors. Semi-hermetic compressors do not require alignment. For open compressors, the coupling center section is shipped loose for field installation. The compressor and motor are carefully aligned at the factory before shipping. However, the coupling center section is removed for shipment and must be re-installed and checked in the field.

Table 3-3 Compressor Alignment Tolerances

PARALLEL ALIGNMENT	
TOP–BOTTOM	± 5 MILS
SIDE–SIDE	± 5 MILS
ANGULAR ALIGNMENT	
TOP–BOTTOM	± 7 MILS
SIDE–SIDE	± 7 MILS

TSIM-9209

THE COMPRESSOR ALIGNMENT SPECIFIED ABOVE SHOULD BE USED INSTEAD OF THE SPECIFICATIONS RECOMMENDED IN THE MANUFACTURER'S GUIDE.

REFER TO COMPRESSOR MANUFACTURERS INSTALLATION, START-UP, AND SERVICE INSTRUCTIONS FOR ADDITIONAL DETAILS.

Coupling Center

Check for alignment before inserting the coupling center section.

Compressor Motor

Inspect the compressor motor alignment with a dial indicator to check if it may have been disturbed during shipment or installation. See Table 3-3.

Motor And Compressor Flanges

Check the alignment of the motor and compressor flanges with a dial indicator on the motor flange. The procedure for checking alignment and alignment tolerances follow. Both angular and parallel must be checked. For the details on the compressor manufacturer alignment procedure, refer to the installation, start-up and service instructions supplied with this manual.

Motor/Compressor Assembly

The motor/compressor assembly should be doweled to the base after the final alignment and hot check is completed to help maintain alignment and aid in repositioning the motor after servicing.

Compressor Alignment

If, for any reason, the compressor alignment is not within tolerance after reinstallation of the coupling, it must be realigned (refer to Table 3-3).

Doweling Procedure

Since doweling is performed after the motor/compressor alignment has been hot checked (i.e. compressor has been run and brought up to operating temperature after initial alignment), the doweling should be done at start-up.

Note:
All self-contained SC, SCA, and SCE models are factory run and doweled. SCAR and SCER utilize remote condensers and are not factory run.

In such cases, doweling is done after the initial start-up of the equipment. The following procedure is used:

1. With the compressor at operating temperature, verify the compressor alignment.
2. With the compressor still at operating temperature, drill and ream two (2) holes diagonally opposite on both the compressor and motor. Do not ream the holes too deep. Part of the dowel pin should protrude above the compressor or motor foot (see step 4 below). See Figure 3-17.

   Tools Required:
   - drill
   - 9/32" diameter drill
   - #6 taper reamer
3. Insert the #6 x 2 1/2" hardened taper dowel pins in the holes.

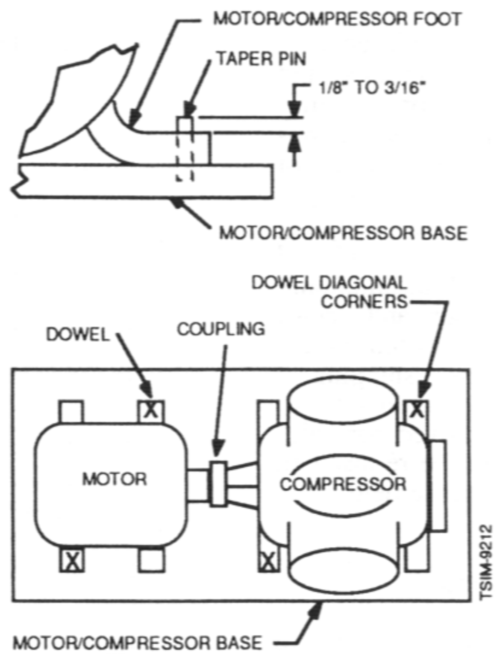


Figure 3-17 Doweling

4. Using a rubber hammer or mallet, tap the dowel lightly into position. Leave 1/8" – 3/16" of the dowel pin above the motor foot (required to tap and loosen the dowel for removal when required).
5. Coat the dowels with white lead or lubricant to prevent rusting.

Reference

Refer to the compressor manufacturer alignment procedure in the installation, start-up and service instructions supplied with this manual.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

10. TESTING REFRIGERATION SYSTEM FOR LEAKS

Testing for leaks assures a tight system that operates without loss of refrigerant.

In order to test for leaks, the system pressure must be built up. Test pressures for various refrigerants are listed in USAS (formerly ASA) B.9.1 Code Brochure entitled "Safety Code for Mechanical Refrigeration" and USAS B31.5 "Refrigeration Piping Code". These pressures will usually suffice but check local codes as they may differ.

IMPORTANT

Do not use the compressor to build up the pressure - it is not designed to pump air. Serious overheating and damage may result.

Prior To Testing

Before testing, follow these instructions:

1. If test pressures exceed the settings of system relief valves or safety devices, remove the system relief valves or safety devices and plug the connection during the test.
2. Open all valves except those leading to the atmosphere.
3. Open all solenoids by lifting their stems manually.
4. Open all by-pass arrangements.

Oil free dry nitrogen may be used to raise the pressure to the proper level for testing.

WARNING

Never use combustible gas or oxygen or a combustible mixture of gases for system testing. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Testing

When the proper pressure is attained:

1. Test for leaks with a mixture of four parts water and one part liquid soap applied to all flanges, threaded, soldered, or welded joints with a one inch round brush. A small amount of glycerine added to the test solution will strengthen the bubbles and improve the solution.
2. Observe the entire joint. If a leak is present, the escaping gas will cause the test solution to bubble.
3. After all leaks are found and marked, relieve the system pressure and repair leaks.

IMPORTANT

Never attempt to repair soldered or welded joints while the system is under pressure. Soldered joints should be opened and resoldered. Do not simply add more solder to a leaking joint.

4. After all the joints have been repaired and the system is considered "tight", test the unit with refrigerant.
5. Attach a drum of the proper refrigerant to the system and allow the gas to enter until a pressure of 5 psig is reached.
6. Remove the refrigerant drum and bring the pressure to the recommended test level with oil free dry nitrogen.
7. Check the entire system again for leaks, using a halide torch or electronic leak detector. Check all flanged, welded, screwed, soldered and gasket joints, and all parting lines on castings. If any leaks are found, they must be repaired and rechecked before the system can be considered tight.

Note:
See warning on next page.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

WARNING

No repairs should be made to welded or soldered joints while the system is under pressure. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

11. EVACUATING THE SYSTEM

Reasons To Evacuate

Refrigeration systems operate best when only refrigerant is present in the system. Steps must be taken to remove all air, water vapor, and all other non-condensables from the unit before charging it with refrigerant. If air, water vapor, or non-condensables are left in the system, various operating difficulties can be encountered:

1. The moisture will react with the oil in the system forming sludge which can clog passage-ways and lead to lubrication problems.

2. Air and non-condensables will lodge in the condenser, decrease the space for condensing liquid and cause the head pressures to rise.

3. A combination of moisture and refrigerant, along with free oxygen, can cause the formation of acids and other corrosive compounds which could corrode the internal parts of the system.

Helpful Hints

If properly evacuated as outlined below, the system will be oxygen free, dry, and there will be no non-condensables to cause problems later.

- If at all possible, the piping should not be insulated before the evacuation process is started.

- The evacuation should not be done unless the room temperature is 60° or higher (to allow for proper moisture boil off).

- If free moisture is in the system before evacuation (such as water collected in traps or low places in the piping), this can easily be detected by feeling of these traps and low places. If moisture is present it will condense in the low places and freeze. It can be removed by gently heating the trap farthest away from the vacuum pump. This causes the water to boil, the ice to melt, and the vapor to collect in the next trap towards the vacuum pump. Repeat this process until all pockets of water have been boiled off and the vacuum pump has had a chance to remove all of the water vapor from the system.

Proper Measuring Instrument

It is not possible to read high vacuums or low absolute pressures with a pressure gauge or mercury monometer. Use the proper gauge manufactured by McLeod, Stokes, and Airserco. These gauges usually read in the range from 20 to 20,000 microns.

High Vacuum Pump

- Use a high vacuum pump capable of attaining a blanked off pressure of 10 microns or less.

- Attach this pump to the system and allow it to operate until the pressure in the system has been reduced somewhere below 500 microns.

- Connect the high vacuum pump into the refrigeration system following the manufacturers instructions.

Note:
For best results, connect the pump to the high side and the low side of the system so that the entire system is thoroughly evacuated.

- Connect the vacuum indicator or gauge into the system in accordance with the manufacturer's instructions.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

First Evacuation

A single evacuation of the system is not satisfactory to remove all of the air, water, and non-condensables present. To do a complete job, the triple evacuation method is recommended:

1. When the pump is first turned on, reduce the system pressure as low as the pump is able to bring it.
2. Allow the pump to operate for five (5) or six (6) hours.
3. Stop the pump and isolate the system.
4. Allow it to stand at this vacuum for another five (5) to six (6) hours.
5. Break the vacuum with oil free dry nitrogen.
6. Raise the system pressure up to zero (0) with oil free dry nitrogen.

Second Evacuation

1. Start the second evacuation, again allowing the pump to operate and reduce the pressure to less than 500 microns.
2. Allow the pump to operate for two (2) or three (3) hours.
3. Stop the pump and allow the system to stand with this vacuum for a minimum of three (3) hours.
4. Break the vacuum with oil free dry nitrogen.
5. Raise the pressure in the system to zero (0).

Third Evacuation

For the third evacuation, the foregoing procedure is again followed:

1. Operate the pump until the system pressure is reduced below the 500 micron figure.
2. Allow the pump to operate an additional six (6) hours.
3. Stop the system and allow to stand for approximately twelve (12) hours at the low pressure.
4. Break the vacuum with the oil free dry nitrogen.
5. Allow the pressure in the system to come up to slightly above zero (0) pounds (drier cartridges and moisture indicators may be installed in the system at this time).
6. Evacuate the system below the 500 micron figure and charge with the refrigerant being used for the system.

IMPORTANT

Although this procedure is time consuming, it is the only positive way to ensure a properly evacuated system. Short cuts may result in even more time consuming and expensive clean up of improperly evacuated systems.

12. CHARGING THE UNIT WITH REFRIGERANT OIL

When properly charged, the oil level in the compressor should be visible at the center of the compressor sight glass (located on hand-hole cover on the side of compressor). Other equipment such as the oil filter or oil coolers (when used) also require oil charge. Therefore, the oil level in the compressor should be re-checked after the compressor has been operated. If additional oil is required, add only the oil specified by the manufacturer. Use only dehydrated, wax-free, refrigerant grade oil of suitable viscosity (refer to Table 3-4).

Periodic Checks And Records

The above oil check should be done at start-up, or after any service work is performed. Periodic checks should also be done on a regular basis. Complete records should be kept of any additions or removal of oil to the system.

Refrigerant Oil

Unless otherwise specified, the following refrigeration oil should be used:

- Sun Oil Suniso 3GS or 4GS (refer to Table 3-4)
- DuPont synthetic oil, 150 SSU only
- Texaco Capella B1.

Table 3-4 Compressor Oil Charge

CURRENT SELECTIONS

CARRIER COMPRESSOR	5H40/46	5H60/66	5H80/86	5H120/126
OIL CHARGE (PINTS) *	18	21	41	81

ROYCE COMPRESSOR	CG040	CG060	CG080	CG120
OIL CHARGE (PINTS) **	24	30	32	60

COPELAND COMPRESSOR (SEMI-HERMETIC)	3DS3-1500	4DJ3-3000	6DG-3500	4DJ3-3000
OIL CHARGE (PINTS) *	13	17.5	16.25	17.5

* 3GS OR EQUIVALENT OIL ** 4GS OR EQUIVALENT OIL

OLDER MODELS

COPELAND COMPRESSOR (SEMI-HERMETIC)	NRA2-0500	9RAI-0760	9RSI-1500	6RHI-3500
OIL CHARGE (PINTS) *	5.0	9.0	9.0	10.0

CARRIER COMPRESSOR (SEMI-HERMETIC)	O6EM266
OIL CHARGE (PINTS) *	14.0

TSIM-9210

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

IMPORTANT

- **Do not mix different types or grades of oil.**
- **Do not over fill with oil, this is especially true on the hermetic type compressors.**
- **Make sure the oil is fresh and not contaminated.**

Oil Quality

If the quality of the oil is unknown or is not clear, TURBO recommends that an oil test kit be obtained from a local refrigeration supply house. This will ensure that the oil is acid free and safe to use.

Periodic analysis of oil samples by local testing laboratories can also detect unusual build-up of metals or other contaminants (which result from wear or other debris in the oil) before they become a problem.

13. REFRIGERANT CHARGING

Possible Leaks

Self-contained water cooled, evaporative cooled, and air cooled units are furnished complete with necessary operating refrigerant charge and normally require no field charging. A leak in the refrigerant circuit might occur during shipping or handling. If a leak is detected, immediate corrective action should be taken and additional refrigerant gas should be added to the system. Refer to step 10 – Testing Refrigeration System For Leaks on page 67.

Models with remote (field installed) condensers are shipped with a holding charge only and will require field charging of the systems. These units are designated as R, SCAR, and SCER. Refer to "Initial Refrigerant Charge" instructions on page 74.

Adding Refrigerant

IMPORTANT

Before adding refrigerant or placing the unit in operation, evacuate the entire system to insure a completely dry system. See step 11 – Evacuating The System on page 69.

Whenever refrigerant is added to any system that has already been evacuated and charged, extreme care should be taken in admitting the refrigerant to the system.

1. The unit should be placed in operation and the liquid line sight glass observed during the first five minutes of the freezing cycle.

2. With the head pressure between 180 psig and 210 psig (for R-22 system), the refrigerant should be slowly charged into the suction of the compressor as a gas only (never as a liquid). Be sure that all charging lines are clean and properly purged of air. Air is purged from the charging line by allowing some refrigerant to escape while attaching the hose to the charging port.

3. When the liquid line sight glass is free from bubbles during the first five minutes of the freezing cycle, (the period of heaviest refrigerant flow) the unit is fully charged. The unit nameplate lists the unit model, refrigerant type, and refrigerant charge. Always monitor and record how much refrigerant is added. Never exceed the nameplate charge listed.

IMPORTANT

Do not overcharge the refrigerant circuit. This induces high discharge pressures. Be sure the correct type of refrigerant is being added to the system.

Remote Air-Cooled Or Evaporative-Cooled Units

Self-contained units furnished for use with remote air-cooled condensers (SCAR) or remote evaporative-cooled condensers (SCER) are shipped without the operating charge and will require refrigerant gas. Follow the procedure set forth under "Adding Refrigerant" on this page. Each unit is shipped with a holding charge to keep the system dry during shipment or storage.

Remote Type Units

All remote type (R) models are furnished without refrigerant charge. The entire refrigerant system must be evacuated as per step 11 – Evacuating The System on page 69 and then charged by following the procedure set forth under "Adding Refrigerant" on this page. Each unit is shipped with a holding charge to keep the system dry during shipment or storage.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Initial Refrigerant Charge

For systems shipped with a holding charge only, it will be necessary to add refrigerant to the system before starting.

To transfer refrigerant from a bottle, cylinder, or drum into a refrigeration system requires the pressure in the refrigerant vessel to be higher than the refrigerant system. In typical charging operations, a commercially available and approved electric heater band is strapped to the refrigerant vessel. The low wattage heat input from the heater band safely raises the pressure in the vessel and drives the refrigerant into the refrigeration system, which is at a lower pressure.

Example:
Charging refrigerant (R-22) gas into the suction side of a system operating at a suction pressure of 43 psig would require enough heat to raise the pressure in the charging vessel above 43 psig; charging an idle system at 150 psig will require a pressure higher than 150 psig.

WARNING

Never use a torch or open flame to input heat into a refrigerant charging vessel. Excessive heat can produce unsafe pressures that can result in rupture or explosion of the vessel. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Small 30 pound bottles offer the safest and easiest handling due to light weight and should be used when practical as outlined below. Thirty pound bottles are also easy to weigh to determine how much refrigerant has been added and if the bottle has been emptied.

The large 125 pound bottles are harder to handle but are more practical for systems with larger charges.

IMPORTANT

Proper lifting techniques must be used in lifting the cylinder to avoid injury to the back. Use a hand cart with chains to strap the bottle to the cart during transport. Never try to carry the cylinder up a ladder or stairway by hand. Never lift the cylinder alone.

The 125 pound bottles are easily weighed using standard commercially available scales to determine how much refrigerant has been added and if the cylinder has been emptied.

Large 1,750 pound drums are more practical and economical on larger systems but require special handling with a fork lift, cranes, or other special handling equipment. They are also more difficult to weigh to verify the amount of refrigerant used. Adding a source of low wattage heat is also more difficult.

It is sometimes more practical to lower the pressure of the refrigeration system being charged by either running cool water over the receiver, or surrounding the receiver with ice. Refrigerant liquid transfer pumps are more practical for transferring large refrigerant charge. Because of the size of the charging drum, it may be difficult or impossible to locate the drum next to the system being charged. In this case, it will be necessary to run a charging line from the drum to the system. Copper tubing or charging hoses for this purpose should be used.

Systems with operating charges less than 250 pounds can be safely and easily charged using 30 pound refrigerant bottles. Systems with 250 to 1,500 pounds are more suitable for 125 pound refrigerant containers for safe and easy handling. Systems over 1,500 pounds are generally more suitable for 1,750 pound cylinders with the final charge from 125 pound bottles. The use of 1,750 pound cylinders requires special precautions in handling the drum and may require special charging lines.

Charging procedure:

1. Connect a charging line through a refrigerant gauge set from the charging vessel to the refrigeration system receiver, or combination condenser/receiver.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

- Tighten one end and screw the other end on securely but loose.
- Open (crack) the valve on the charging vessel slightly, allowing a small flow of refrigerant through the hose.
- At the loose end, wiggle the charging line to allow refrigerant and air to escape.
- While the refrigerant is flowing through the loose end, tighten the fitting.
- At this point, both ends of the charging line should be securely fastened and free of air.

CAUTION

Always wear eye protection and protective rubber gloves when attaching the charging line.

WARNING

Never attach the charging line to the discharge (high pressure) side of the compressor. Excessive pressure building in the vessel could result causing the vessel to rupture or explode. Failure to carefully follow these instructions could result in permanent injury or loss of life.

IMPORTANT

Never charge liquid refrigerant directly into the compressor unit or suction line. Damage to the compressor could result. Always charge with refrigerant gas into the low side of the system.

2. Open the valve on the refrigerant vessel to fill the charging line.
3. Connect the heater band to the charging vessel and connect to a proper voltage outlet.
4. Open the inlet (charging) valve on the refrigerant system.
   - Refrigerant should flow from the refrigerant charging vessel to the system.
5. If possible, set the refrigerant vessel on a scale.
   - Record the initial weight and the weight of the bottle or cylinder to determine when the bottle is empty.
   - Record each bottle, drum, or cylinder added and maintain a total of the refrigerant added after each bottle, cylinder or drum is added.
6. Repeat the above process until the refrigerant charge specified on the nameplate is in the system.

WARNING

Do not exceed the recommended refrigerant charge. Overcharging can result in excessive pressure causing rupture or failure of the system. Failure to carefully follow these instructions could result in permanent injury or loss of life.

7. Close the valve on the charging vessel and disconnect the heater band.
8. Close the valve on the refrigerant gauge manifold set.
9. Loosen the hose fitting on the receiver end to allow the Schrader fitting to seat and hold the charge. Screw a cap on the charging fitting to prevent leakage through the schrader fitting.

WARNING

Refrigerant will flow from the Schrader fitting until the stem seats. Always wear eye protection and protective rubber gloves when connecting or disconnecting a hose to the Schrader fitting. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

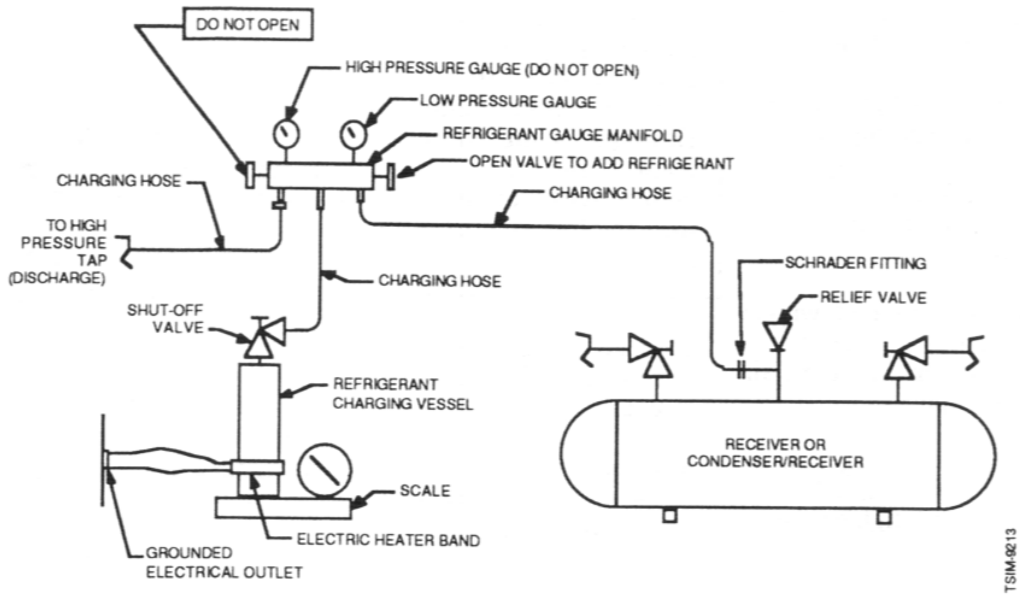


Figure 3-18 Typical Connections For Initial Refrigerant Charge

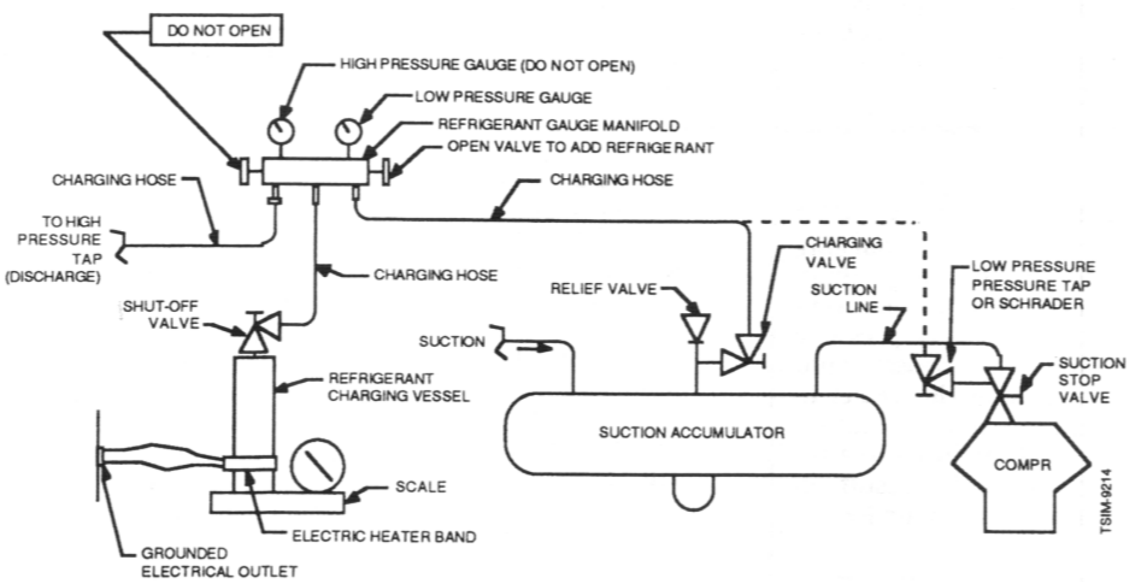


Figure 3-19 Adding Refrigerant To Existing Charged System

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

10. Loosen the fitting on the center manifold connection to release the refrigerant trapped between the gauge set and shut off valve.

11. Remove and secure all empty refrigerant vessels including replacing the protective cap.

Note:
A charging hose is shown connected to the discharge (high pressure) side of the system in Figures 3-18 and 3-19. This is recommended so that the discharge pressure may be observed during the charging procedure to avoid accidental overcharging or overpressure due to the isolation valve being in the wrong position or location.

WARNING

Do not open the manifold gauge set valve connected to the high side during the charging operation. High pressure could enter the charging vessel resulting in rupture or failure causing serious injury. Failure to carefully follow these instructions could result in permanent injury or loss of life.

On large systems where a liquid transfer pump or charging system is used, the manufacturer's instructions should be followed in connecting the pump and hoses. However, all other guidelines as outlined above should be followed.

Relief Devices

Relief valves are installed on pressure vessels (condensers, receivers, etc.) to prevent excessive pressure build-up in the system. These safety relief valves should be vented to a safe discharge point. Field piping (by others) will be required to vent the valve outside for indoor installations or to a location away from personnel exposure for indoor or outdoor installations. Refer to Figures 3-20, 3-21, and 3-22.

WARNING

All relief valves must be piped to a safe discharge location. Failure to carefully follow these instructions could result in permanent injury or loss of life.

All relief valves are tagged with the above or a similar warning.

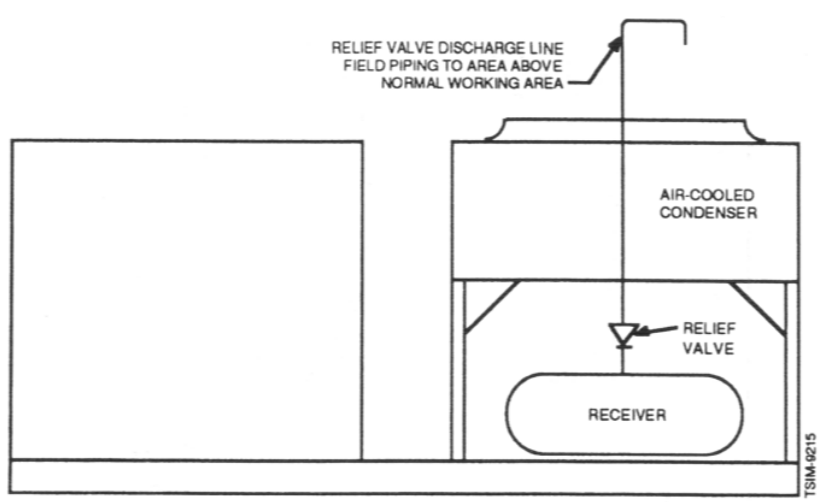


Figure 3-20 Typical Air-Cooled Condenser Relief Valve Field Piping

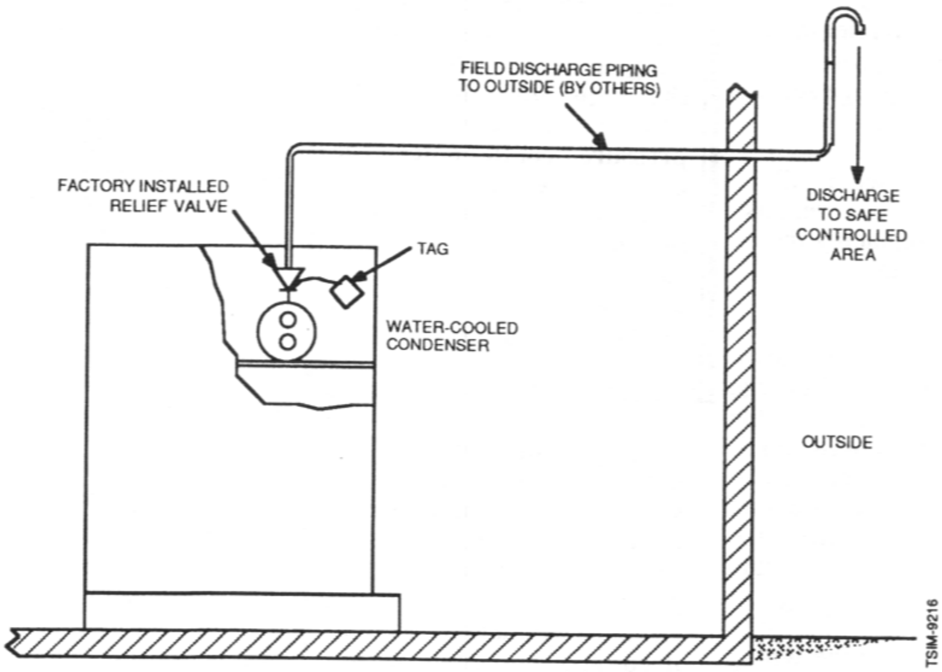


Figure 3-21 Typical Indoor Installation Relief Valve Piping

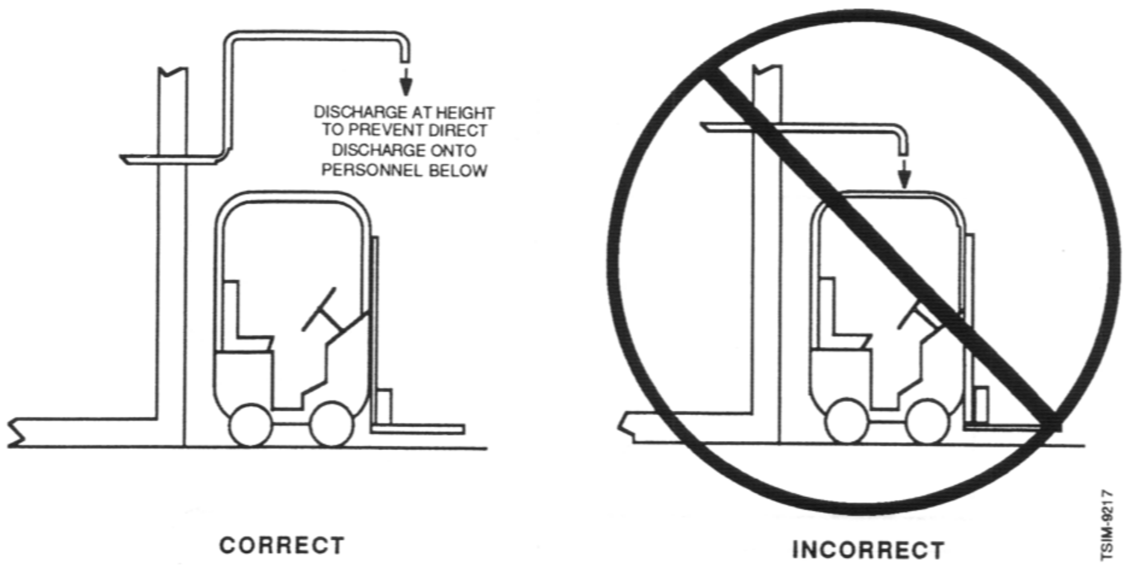


Figure 3-22 Correct And Incorrect Relief Valve Discharge Piping

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Do not attempt to add refrigerant to the system before piping all relief valve connections.

ANSI/ASHRAE 15-1978 code permits a maximum back pressure through the relief valve discharge piping of 25% of the inlet pressure while the device is discharging at rated capacity. Based on the set pressure and capacity of the relief device, the maximum length of discharge piping can be calculated using the formula:

$$L = \frac{9P^2d^5}{16C^2}$$

$$C = f\,DL_1$$

where:

L = length of relief valve discharge piping, in feet

P = 0.25 [(relief valve pressure setting) x 1.1 + 14.7]

d = internal diameter of discharge piping (or tubing), in inches

C = minimum required discharge capacity, in pounds of air per minute

f = 1.6 for R-22

f = 0.5 for ammonia

D = outside diameter of vessel in feet

L_1 = length of vessel in feet

Turn to the next page for example problem.

Example:

A system using a 12 3/4" diameter x 48" receiver.

Design relief pressure is 300 psig.

Refrigerant is R-22.

Therefore, $C = f\ DL = (1.6)\left(\frac{12\ 3/4}{12}\right)\left(\frac{48}{12}\right) = 6.8$ pounds of air per minute.

A 1/2" x 3/4" (inlet x outlet) pressure relief valve rated at 41.6 pounds of air per minute is used.

Maximum discharge piping length:

$$L = \frac{9P^2d^5}{16C^2} = \frac{(9)\ (7{,}430)\ (0.38)}{(16)\ (46.24)} = 34.3 \text{ feet}$$

where:

$P =$ 0.25 [(300) (1.1) + 14.7] = 86.2

$P^2 =$ 7,430

$d =$ 0.824" (3/4" sch40 pipe)

$d^5 =$ 0.38

$C =$ 6.8 pounds of air per minute

$C^2 =$ 46.24

Therefore, a 3/4" SCH40 pipe is completely adequate for normal installations with relief valve discharge piping less than 34 feet long. If longer piping is required, a larger size piping would be required.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

14. AIR-COOLED CONDENSERS

Design Conditions

All SCA condenser selections are based on the following conditions (for R-22):

- 100°F ambient (dry bulb)
- 20°F approach (condensing temperature - air entering temperature)
- 120°F condensing temperature, SDT (260 psig)
- 20°F saturated evaporator temperature, SET during defrost
- THR total heat of rejection (evaporator load in BTUH at highest operating °F SET and 120°F SDT) + (heat of compressor in BTUH)
- During operation on non-design days, the system can and should be operated at a lower saturated condensing temperature. For proper thermal valve operation, a minimum pressure of 150 psig should be maintained.

Example:

Unit with 5H60 compressor.

- Compressor capacity at 20°F SET and 120°F SDT = 35.6 tons = 427,200 BTUH
- Compressor BHP at 20°F SET and 120°F SDT = 55.2
- THR = (427,200) + (55.2) (2,545) = 567,684 BTUH
- Condenser selection would be based on 567,684 BTUH with 20°F TD.

Mounting

Air-cooled condensers supplied with SCA models are based on 100°F air on, 110°F air off, and 120°F condensing (260 psig). The air-cooled condenser is mounted on a common base frame with the evaporator at an elevation that allows free draining of the liquid from the condenser into the receiver and unrestricted airflow through the coil. When an air-cooled condenser is field installed, mount the condenser so that the condensed liquid refrigerant will flow into the receiver without restriction or traps. Pitch the liquid line down from the condenser to the receiver. Mount the air-cooled condenser high enough so trash will not be sucked into the coils by the airflow over the coils. These condensers can be furnished for horizontal or vertical air flow (as required). Horizontal mounting is standard.

Equipment Furnished

Self-contained air-cooled (SCA) models are furnished with a properly sized condenser to reject the total heat of rejection (THR) of the evaporator and the heat of compression. A receiver, isolation valves, safety relief valve, check valve, and winter control valves (for operation in low ambient) are also supplied. The piping and wiring are factory installed.

For remote air-cooled (SCAR) models, the receiver, isolation valves, and relief valves are shipped loose for field installation. Winter control valves and condensers are available as an option. Motor starter(s) for the condenser fan(s) can also be furnished.

Operation

The need for a modulating device for use in conjunction with constant air flow air cooled condensers is generally recognized. Falling ambient temperatures produce correspondingly lower operating pressures and eventually cause system problems at the expansion valve due to low pressure. The TURBO® winter control, which consists of four valves ("L", "G", "LC", "LD"), is a completely automatic system that eliminates these conditions.

Operation of the condenser winter control is as follows (refer to Figure 3-23):

- When low ambient air conditions are encountered which allow condensing pressure to drop, the principle of operation is to hold back enough of the condensed liquid in the air cooled condenser coil so that some of the surface is rendered inactive as condensing surface. This reduction of active condensing surface results in a rise of condensing pressure permitting normal system operation. This method of control is typically called "flood-back" control.

- The receiver must be capable of holding enough refrigerant so that liquid can be stacked in the condenser and still have enough charge in the receiver for proper operation.
- The receiver must have sufficient capacity to hold all of the liquid refrigerant in the system which must be returned to the receiver when high ambient conditions are encountered.

Note:
If the receiver is too small, liquid refrigerant will be held back in the condenser during the high ambient conditions and excessively high discharge pressures will be encountered.

IMPORTANT

Sufficient refrigerant must be in the system to permit the winter control to operate satisfactorily and maintain a liquid seal on the receiver.

Valve Functions

Valve "L" (Upstream Regulator)

Valve "L" (located in the drain line from the condenser outlet to the receiver) is the modulating type. The spring tension is set so that a minimum pressure in the condenser is required before valve "L" will begin to open. Any increase in pressure opens valve "L" more, permitting more condensate to pass into the condenser. If the spring tension is increased (by clockwise adjustment), a higher pressure will be required to open the valve. If the spring tension is decreased (by counter-clockwise adjustment), a lower condenser pressure required. Valve "L" is set at

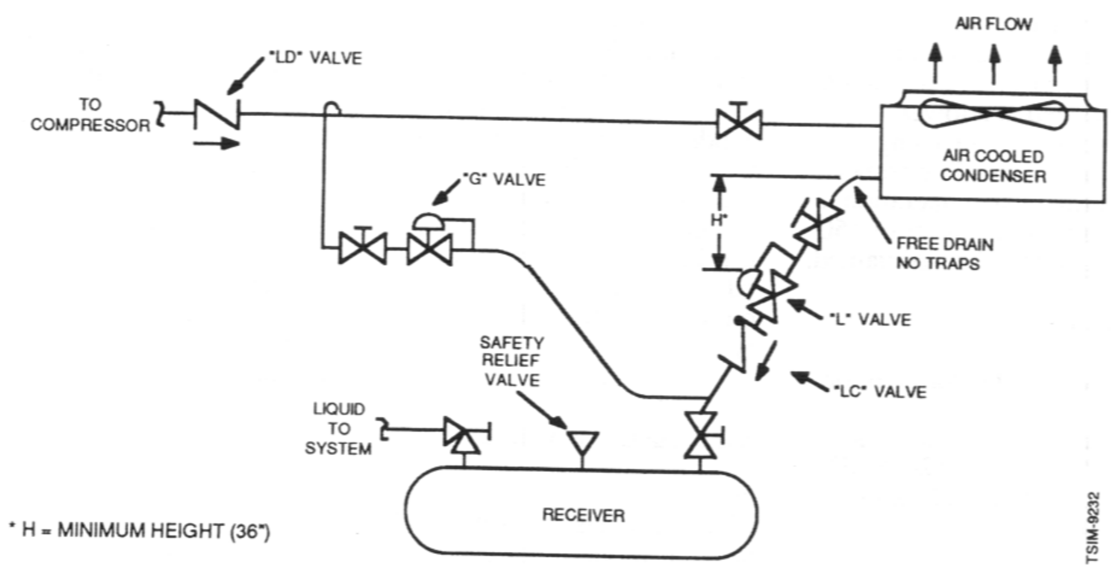


Figure 3-23 Typical Air-Cooled Control & Winter Control Valve Piping (Flood-Back Method)

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

the factory (on SCA models) to open at 180 psig for R-22 which should permit satisfactory operation. If a field adjustment is required and the condenser pressure does not vary with the adjustment, this indicates a shortage of refrigerant in the system.

During start-up, when the condensate in the condenser has been exposed to a low ambient air temperature, it is cooled down below the temperature corresponding to the existing condensing pressure. The pressure in the receiver needs to be raised to a point that corresponds to the pressure required for proper operation of the thermal expansion valve. This is accomplished by permitting hot discharge gas to bypass the condenser and enter the receiver through valve "G" to maintain pressure until the condenser warms up.

Valve "G" (Downstream Regulator)

Valve "G" is a modulating valve that acts in reverse so that the spring tension opens the valve to admit hot gas. Valve "G" remains open until the pressure (temperature) in the receiver rises to the set point and drives the valve closed. Valve "G" is preset at the factory (on SCA models) to close at 160 psig for R-22. If a field adjustment is required, a clockwise adjustment increases the spring tension. A higher rise in pressure is obtained before the valve closes, shutting off the hot gas flow into the receiver. A counter-clockwise adjustment would permit the valve to close at a lower pressure.

Valves "L" And "G"

When adjusting valves "L" and "G", a certain differential in pressures (approximately 20 psig) must be maintained to ensure enough of a difference between discharge pressure and receiver pressure so that hot gas will enter the receiver when required.

When the system is not in operation, no refrigerant gas will enter the condenser. Eventually the pressure in the condenser will drop to a point that corresponds to the ambient air temperature. During this period, there may be a large difference between the pressure in the warm receiver and the cold condenser. The service for which valves "L" and "G" are designed does not require them to be gas tight. During this shut down period, it is possible for refrigerant gas to escape from the higher pressure in the warm receiver through the condenser drain line back into condenser (because of low ambient at a low pressure). A check valve "LC" is placed in the drain to prevent migration of the liquid back to the condenser.

Valve "LC"

To prevent the migration of gas, a check valve ("LC") is located in the drain line which feeds the receiver. This valve is gas tight and must be maintained as such.

The check also closes during low ambient start-up when the "G" valve is open. This allows partial flooding of the condenser in order to maintain a minimum discharge pressure.

Valve "LD"

Valve "LD" is also a check valve which must be installed in the discharge line as close to the compressor as possible. Valve "LD" ensures that no gas in the condenser will migrate to the compressor head during the off cycle. Refer to Figure 3-22 for valve arrangement.

The drain line from the condenser outlet to the receiver inlet is sized "sewer" flow (free flow - 2 ft/min). To ensure that the liquid drains properly from the condenser when the "L" and "LC" valves are open, a minimum drop between the condenser outlet and inlet to the "L" valve is required. This distance is denoted as "H" in Figure 3-23. For typical installations, this distance is 24" to 36". Refer to the piping diagram supplied with the unit for the actual distance (due to variations in condenser pressure drops).

Note:
During low ambient operation, the condenser coil will be partially flooded (floodback) by the "L" valve to maintain a minimum dis-

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

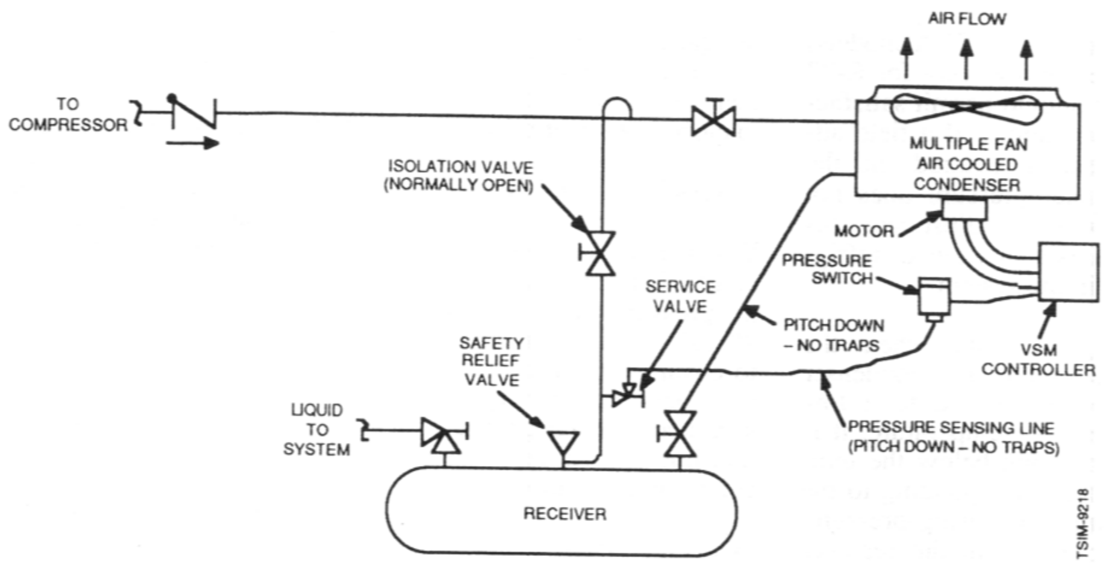


Figure 3-24 Typical Piping For Fan Cycling Or Variable Speed Fan Motor (VSM) Controls

charge pressure and the drain will feel cool due to subcooling of the liquid leaving the condenser.

Alternate Head Pressure Controls

Fan Cycling

On some models, a pressure switch(es) is used to cycle the fan(s) on and off in response to an increase or decrease in discharge pressure. This method reduces the refrigerant charge required with flood-back controls by eliminating the need to flood the condenser coil. It is generally limited to applications using condensers with several fan motors, allowing several capacity reduction steps. Under certain conditions, rapid cycling of the fan(s) may result when used on models with only one or two fans.

Variable Speed Motor (VSM) Controller

A variable frequency solid-state controller is used to vary the output rpm of the condenser fan motor(s). A pressure differential switch is used to signal the controller to increase or decrease the motor speed from 0 to 100% to maintain the pressure set point.

The VSM controller eliminates the need for flooding the condenser coil thus reducing the refrigerant charge and receiver size. Fan cycling is also eliminated.

VSM controllers can also be used with single or multiple fan motors and maintain a steady pressure control (i.e. eliminates sudden reductions or increases in airflow associated with cycling the fan on and off).

See Figure 3-24 for typical piping with fan cycling or VSM controls. For the type of head pressure control used on a unit, refer to the manual cover sheet.

VSM Control Panel Winterizing

Ambient temperatures can affect many of the electronic controls in the VSM control panel. In general, the devices TURBO uses operate properly in temperatures between 32°F and 140°F. In operating ambients under 40°F, TURBO recommends that a source of heat be available in the control panel to maintain a temperature above 40°F. This will ensure continuous, reliable operation of all components (even in severe applications*). A winterizing kit consisting of a heat source and control thermostat can be provided as a factory installation or as a retrofit to existing control panels.

* The control panel winterizing kit is designed for equipment operations in ranges from 0 to 40°F. Consult TURBO for equipment operations in conditions below 0°F.

Installation

All components are factory installed and pre-wired.

Operating Sequence

As the control panel temperature drops below the set point of 40°F, the contacts of CPHT thermostat close to energize the panel heater coil. As the temperature rises above the differential setting of the thermostat, the contact opens to turn off the heater. The thermostat continues to maintain the interior temperature above 40°F. Refer to Figure 3-25.

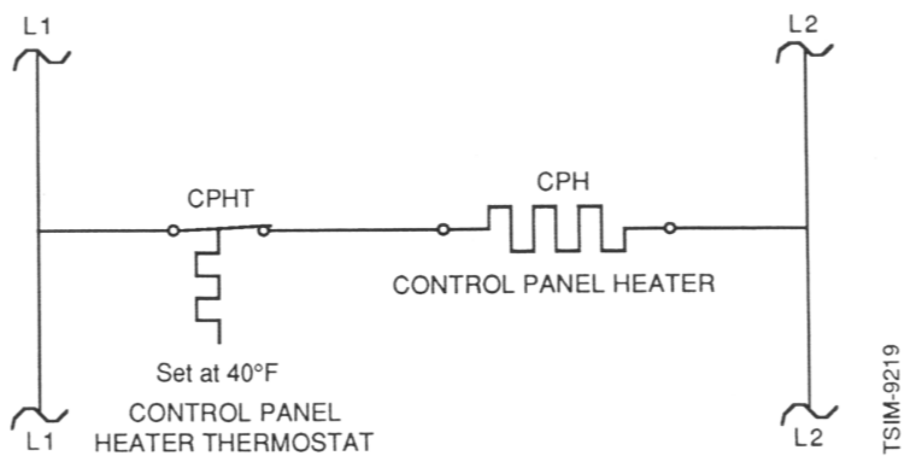


Figure 3-25 VSM Control Panel Winterizing Wiring

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

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15. EVAPORATIVE-COOLED CONDENSERS

Mounting

Evaporative condensers supplied with SCE models are based on 78°F design wet bulb and 95°F condensing (181.8 psig) for R-22. The condenser is mounted on a common base frame with the evaporator section. A receiver is mounted on the same frame (below the condenser outlet) at a distance that ensures free flow of the liquid from the condenser to the receiver without traps. Pitch the drain line down from the condenser to the receiver. Control of the evaporative condenser fan(s) and water pump is wired into the unit control panel.

Equipment Furnished

Self-contained evaporative-cooled (SCE) models are furnished with a properly sized condenser to reject the total heat of rejection (THR) of the evaporator and the heat of compression. A receiver, isolation valves, safety relief valve, and head pressure controls are supplied. The piping and wiring are factory installed.

For remote air-cooled (SCAR) models, the receiver, isolation valves, and relief valves are shipped loose for field installation. Motor starter(s) for the condenser fan(s) can also be furnished.

Head Pressure Control

Two types of head pressure control are available on icemakers:

1. Variable speed fan motor control (VSM)(optional).
2. Flood-back control (standard).

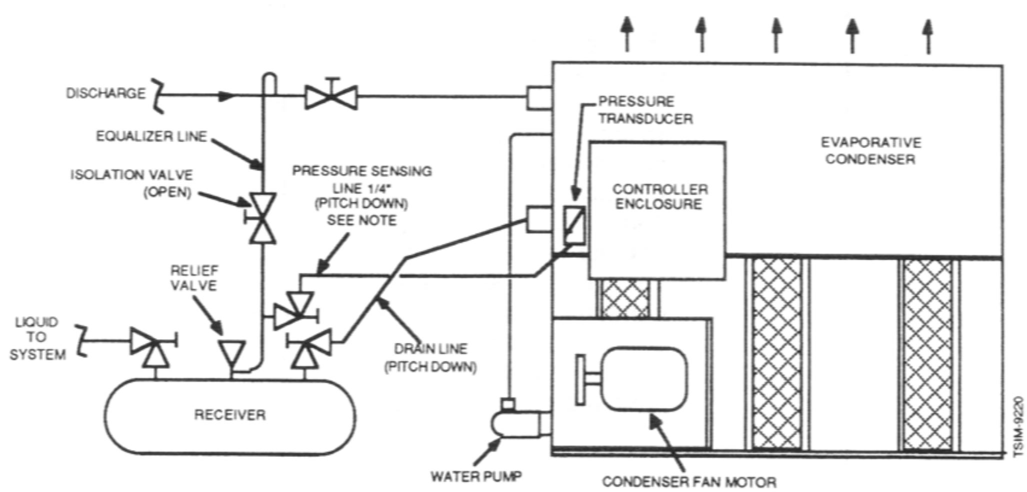
Refer to Figure 3-26.

VSM Controls

A solid state variable frequency constant torque drive monitors the pressure at the inlet to the condenser. This signal is directed to the frequency control to adjust the fan motor rpm either up or down to maintain the pressure at the set point.

A PID controller connected transducer mounted with a discharge sensing line is used to transmit a signal to the VSM drive.

1. As the pressure reaches the upper setpoint, the PID transmits a signal to the controller to increase the fan rpm.



NOTE: THE SENSING LINE FOR THE VSM PRESSURE SWITCH SHOULD ALSO BE PITCHED DOWN TO PREVENT TRAPPING OF LIQUID OR OIL IN THE LINE.

Figure 3-26 Typical VSM Controller Installation

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

2. As the pressure falls back below the setpoint, the PID holds the rpm constant.
3. If the discharge pressure falls below the set point of the PID, the PID signals the controller to reduce the fan rpm, allowing the pressure to either raise or hold steady.

The above sequence continues maintaining the discharge pressure between the two set points or in the PID controller.

On SCE models, the PID controller settings (although they are factory set) should be checked and adjusted as required during start-up.

Adjustment

The discharge pressure can be increased or decreased by changing the setting of the PID controller.

Flood-Back Controls

Refer to step 14 – Air-Cooled Condensers on page 81.

VSM Controls VS Flood-Back Controls

Flood-back controls are used on smaller systems where:

- the system refrigerant charge is relatively small.
- adequate elevation between the condenser outlet and receiver is available to prevent the liquid refrigerant from stacking in the condenser during operations when flood-back is not required.

Flood-back controls require higher refrigerant charges and larger receivers.

VSM controls are more practical on larger systems to reduce the refrigerant charges.

Notes:

1. Cycling the condenser water pump is not recommended due to scale build-up on the condenser coils (caused by the residue of solids left on the tubes by evaporation of the water).
2. In some low ambient conditions, it may be practical to drain the condenser water sump and operate the evaporative condenser as an air cooled condenser (this does not contradict note #1 because the coil is not alternately wetted and then dried).
3. Sump heaters or indoor sumps should be considered in installations when the system is operated frequently in low ambient conditions.

Variable Speed Motor Controller Specifications

Power, Input - Voltage
208, 220, 230, 240 VAC

380, 415, 440, 460 VAC

Power, Input - Phase
3-phase

Power, Input - Frequency
50 or 60 hertz

Power, Output - Voltage
208, 220, 230, 240 VAC

380, 415, 440, 460 VAC

Power, Output - Phase
3-phase

Power, Output - Frequency
30, 50, 60, 75, 90, 100, 120, 180 hertz can be selected. Standard switch setting is 60 hertz.

Power, Output - Temperature Operating Limits
32°F to 104°F

Power, Output - Temperature Storage Limits
–4°F to 140°F

VSM Control Panel Winterizing

Ambient temperatures can affect many of the electronic controls in the VSM control panel. In general, the devices TURBO uses operate properly in temperatures between 32°F and 140°F. In operating ambients under 40°F, TURBO recommends that a source of heat be available in the control panel to maintain a temperature above 40°F. This will ensure continuous, reliable operation of all components (even in severe applications*). A winterizing kit consisting of a heat source and control thermostat can be provided as a factory installation or as a retrofit to existing control panels.

* The control panel winterizing kit is designed for equipment operations in ranges from 0 to 40°F. Consult TURBO for equipment operations in conditions below 0°F.

Installation

All components are factory installed and pre-wired.

Operating Sequence

As the control panel temperature drops below the set point of 40°F, the contacts of CPHT thermostat close to energize the panel heater coil. As the temperature rises above the differential setting of the thermostat, the contact opens to turn off the heater. The thermostat continues to maintain the interior temperature above 40°F. Refer to Figure 3-27.

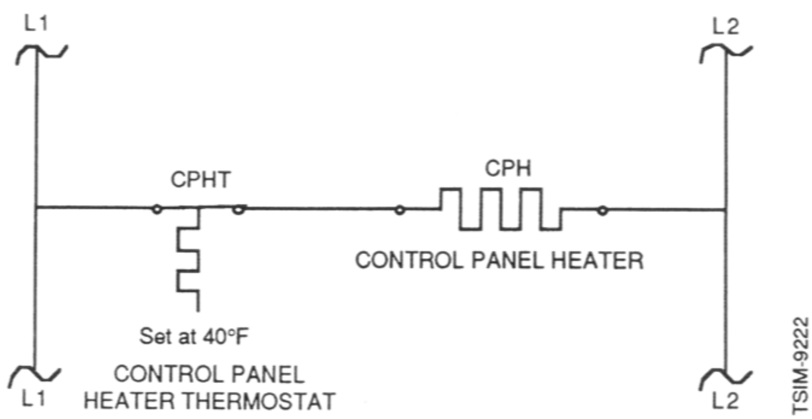


Figure 3-27 Control Panel Winterizing Wiring

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

16. WATER-COOLED CONDENSERS

Water-cooled condensers are supplied with SC models. The condenser is located below the ice slide/evaporator upper section. A compressor discharge line is piped to the condenser inlet and a liquid line connection is piped to the evaporator above.

Design Conditions

The selection of a water-cooled condenser is dependent on the evaporator load, refrigerant used, the source and temperature of the cooling water, the amount of water circulated, and the desired operating pressure.

All SC condenser selections are based on the following conditions (for R-22):

- 85°F water entering condenser
- 95°F water leaving condenser
- 105°F saturated condensing temperature, SDT (210 psig)
- 20°F saturated evaporator during defrost
- 0°F during icemaking

THR (total heat of rejection) = (evaporator load at 20°F SET and 105°F SDT in BTUH) + (heat of compression in BTUH)

Example:
Icemaker with 5H60 compressor:

Compressor capacity @ 20°F SET and 105°F SDT = 40.2 tons = 482,400 BTUH

Compressor BHP @ 20°F / 105°F = 51.3

THR = (482,400) + (51.3) (2,545) = 612,958 BTUH

Tower gpm = (THR ÷ 15,000 BTUH / tower ton) (3.0 gpm / tower ton) = (612,958 / 15,000) (3.0) = 122.6 = 125 gpm

THR calculations for highest SET condition.
SET = saturated evaporator temperature.
SDT = saturated discharge temperature.

Equipment Furnished

Self-contained water-cooled (SC) models are furnished with a properly sized condenser to reject the THR (total heat of rejection) of the evaporator and the heat of the compressor. A safety relief valve and isolation valves for the inlet and outlet are also provided. Piping and wiring of the components are factory installed. Water regulating valves for head pressure control are shipped loose for field installation.

Optional cooling towers, and cooling tower pumps can also be supplied.

Water Treatment

For maximum operating efficiency and equipment life of the condenser and cooling tower, TURBO recommends that a local water treatment supplier be consulted to analyze the water system to be used.

Fouling caused by scaling results in high head pressure, higher operating cost, and lower capacity.

Operation

Superheated discharge gas enters the shell side of the water cooled condenser. Water is circulated through the tubes to remove the heat from the gas. The amount of surface area in the condenser, the flow rate (gpm) of the water, and the temperature of the water entering the condenser are all sized to remove the heat of compression and the heat absorbed by the refrigerant in the evaporator and converts the gas back to the liquid phase at the condenser pressure. Shell-and-tube (horizontal) condensers are used for this purpose.

A typical water cooled system operates as follows.

For a system with:

- Water-cooled condenser
- Pressure-actuated water regulating valve
- Cooling tower with fan cycling thermostat
- Cooling tower pump
- Low discharge pressure switch

1. A switch sensing the discharge pressure closes at 150 psig to start the cooling tower fan and pump (starters, pump, and cooling tower are all optional equipment).
2. The water pump runs all the time (i.e. do not cycle water pump on and off).
3. As the water temperature in the cooling tower sump reaches the set point (usually 80–85°F) of the thermostat, the contacts close to energize the cooling tower fan motor magnetic starter. The fan runs until the temperature of the water drops below the differential of the thermostat and the contacts open to turn the fan off.
4. The water flow through the condenser is controlled by a pressure actuated water regulating valve that modulates open or closed in response to the discharge pressure. Water regulating valve kits are available from TURBO. As the discharge pressure increases, the water regulating valve opens to increase the water flow through the condenser. Conversely, as the discharge pressure drops, the valve modulates closed to reduce the water flow.

Note:
As the water temperature available from the cooling tower increases, the flow rate through the condenser must also increase to maintain the desired pressure setting. Therefore, for the controls to work properly, the settings of both the water regulating valve and cooling tower sump temperature thermostat must both be properly adjusted.

5. The setting of the water regulating valve and the resulting discharge pressure can be changed by turning the adjusting stem located on the top of the valve clockwise to raise the pressure and counterclockwise to reduce the discharge pressure. By turning the valve in, the spring in the bonnet is compressed, requiring a greater discharge pressure to move off its seat, thus allowing the water flow to decrease. As the stem is turned out, the compression of the spring is decreased and the force required to open the valve is also decreased. Thus, water flow through the valve increases and the discharge pressure is lowered.

Refer to Figure 3-28 and Figure 3-29 for typical water-cooled condenser piping and wiring.

Safety Relief

A safety relief is provided on each condenser. Refer to step 13 – Refrigerant Charging on page 73 for guidelines on relief valve venting.

General Information

Water condensers supplied on icemakers are the conventional condenser/receiver combination type. They feature shell and tube type construction, cleanable with removable heads. The water in and out connections are sized to permit maximum water flow at peak requirements. All models are furnished with the water connections piped to the outside of the unit for ease of installation.

Water Requirements

Condenser water requirements are based on 85°F water to the condenser, 95°F water off the condenser, and 105°F condensing. The condensers design water flow rate is based on 3 gpm/ton of

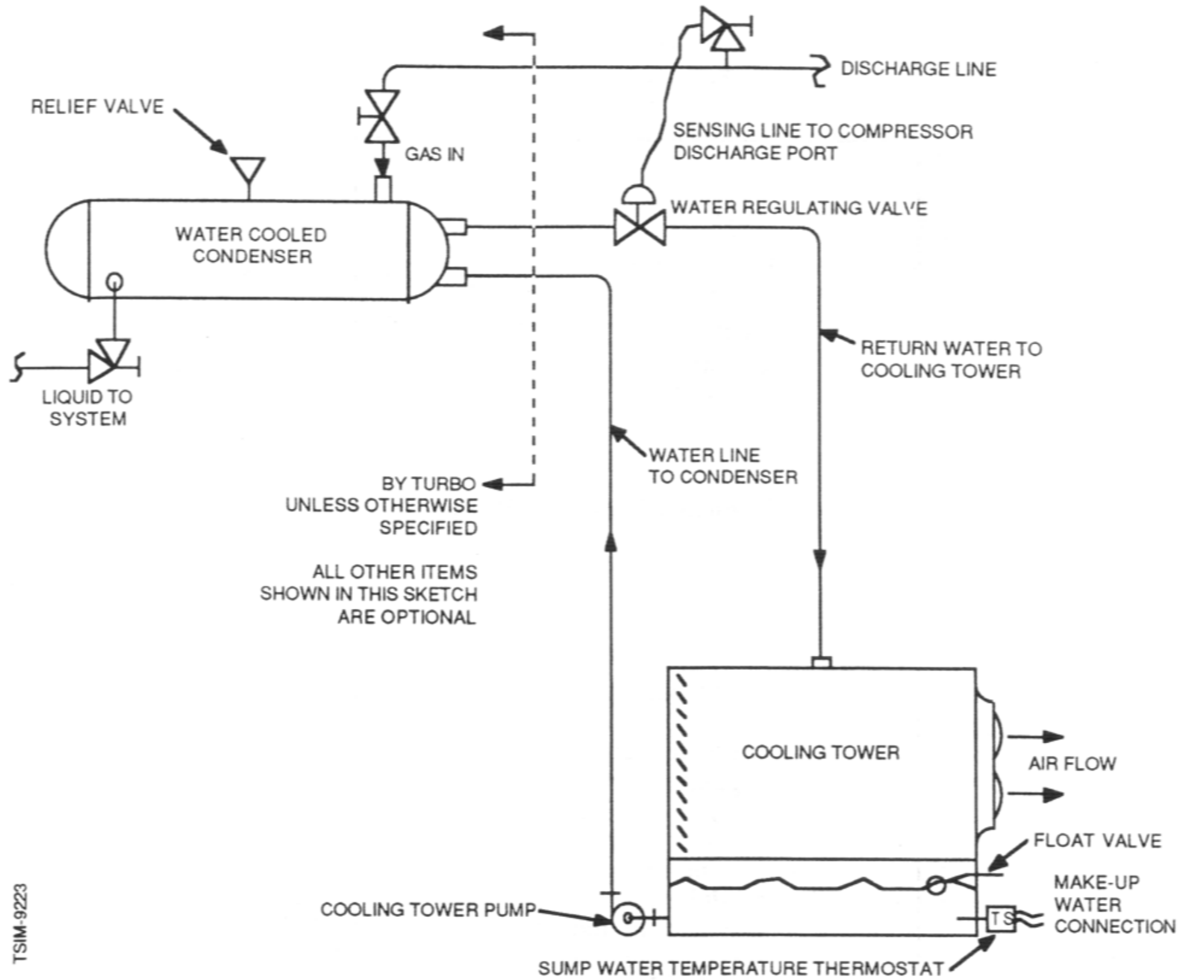


Figure 3-28 Typical Water-Cooled Condenser Piping

refrigeration*. The actual rate of flow is wholly contingent on the water temperature and evaporator load but will not exceed the design flow.

* Tons of refrigeration = total heat of rejection @ 20°F SET/105°F SDT divided by 15,000 BTU/ton.

Water Regulating Valve (SC Models Only)

A water regulating valve is furnished in the icemaker and must be field installed external of the unit in the outlet water line of the condenser piping to the cooling tower. A 1/4" SAE flare type valve is provided on the water-cooled condenser for the water regulator high pressure gas connection that provides the signal that modulates the water flow through the condenser.

Note:
Refer to section 10 – Appendix B on using three-way water regulating valves.

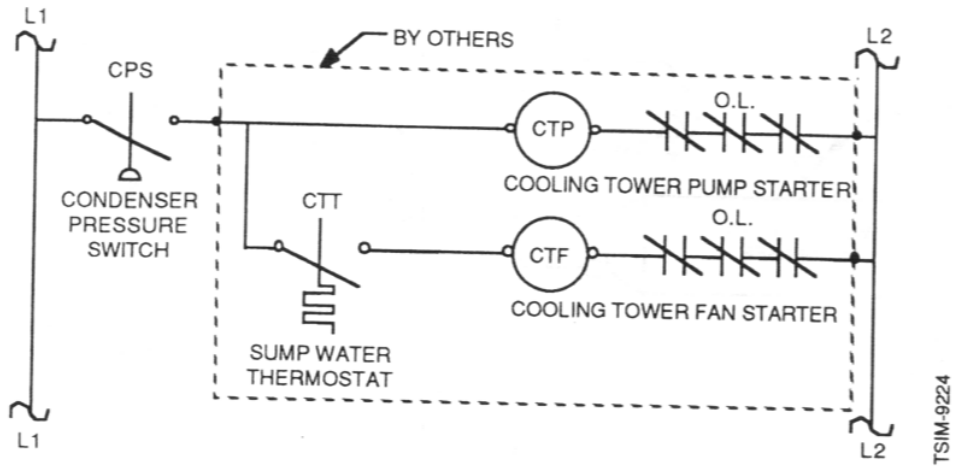


Figure 3-29 Typical Wiring For Water-Cooled System

Systems With Multiple Condensers

On systems utilizing a single cooling tower and cooling tower pump for multiple water-cooled condensers, the piping shown in Figure 3-28 may have to be modified if all of the units (condensers) are not operated. For a system with three icemakers piped to a single cooling tower and cooling tower pump suitable for handling all three systems, it may require a condenser water bypass if only one system is operated. Excessive pressure drops across water regulating valves or changes in the pump operating curve may prevent proper operation. Figure 3-30 shows a typical multiple condenser installation. As the idle system(s) cools, the water regulating valve will close in response to the decrease in pressure (sensed by the water regulating valve sensing line). As the valve closes, the pressure in the condenser water line increases. A pressure modulating bypass relief is installed in the discharge of the cooling tower pump and piped either to the suction of the pump or directly into the cooling tower sump to maintain a constant head on the pump.

Figure 3-30 shows a cooling tower located above the condenser. On installations with the cooling tower located below the multiple condensers, a check valve should be installed in the pump discharge to prevent drainage of the water during the off cycle (resulting in excessively high discharge pressure at start-up due to lack of water flow).

As an alternative to a bypass relief, separate cooling tower pumps may be used with a single cooling tower. This is generally limited to systems with 2 to 3 condensers since the cost of the additional pumps and piping is not attractive for larger systems.

Optional heat tracing of the condenser water line and a cooling tower sump heater may be required for operations in low ambient conditions (below 40°F) to prevent freeze-up during shut down.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

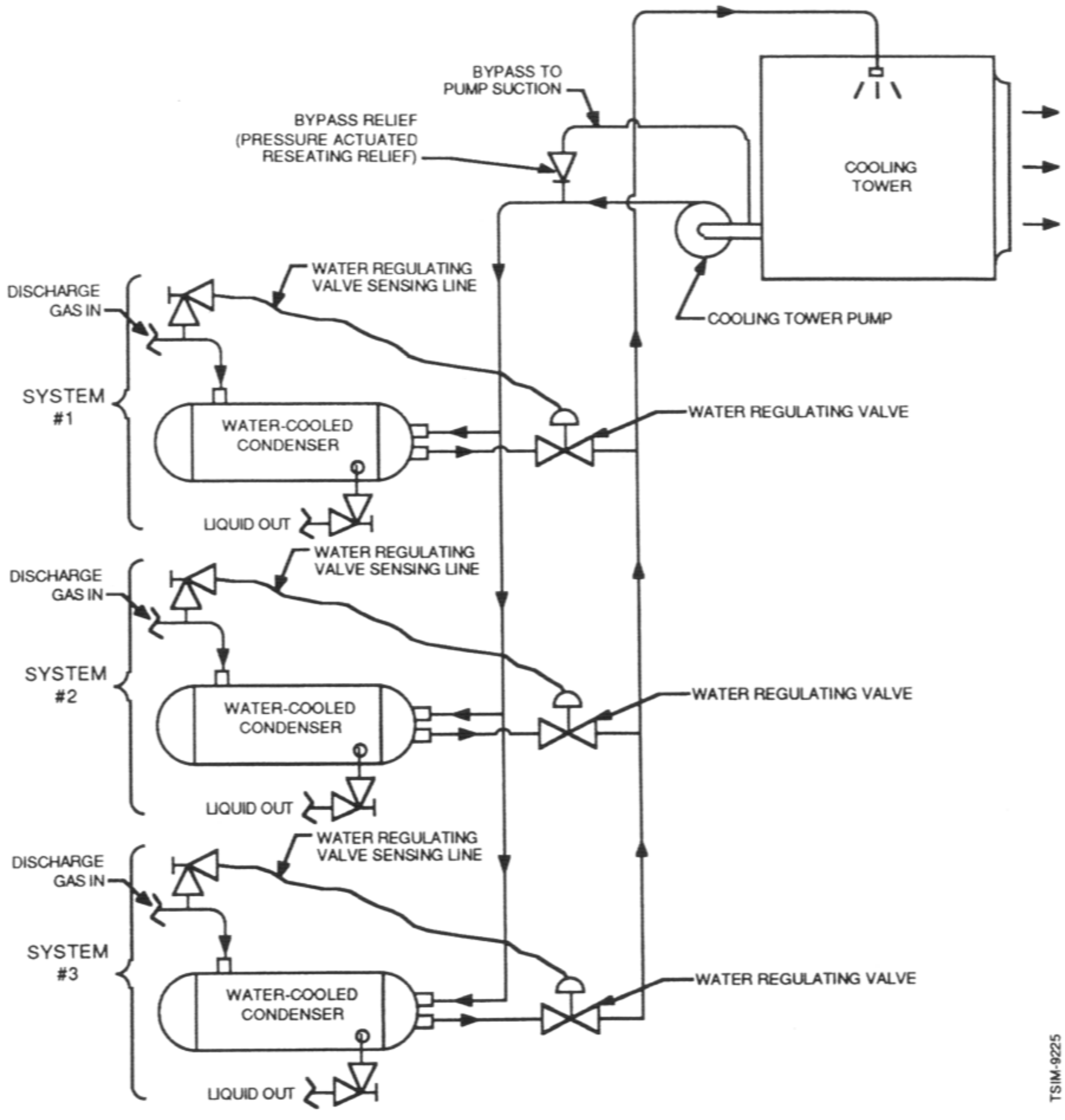


Figure 3-30 Multiple Condenser Installation

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

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17. STANDARD PREHEATER KITS

The water make-up preheating package is designed to provide the necessary amount of heated defrost water required for an icemaking unit. This package uses the readily available superheat from the compressor discharge gases without appreciably increasing the operating cost of the unit.

Piping

When ordered with the icemakers, a counterflow heat exchanger is piped between the compressor discharge line and condenser inlet. The gas flow is in the outer tube chamber and is piped to allow any condensed refrigerant to flow by gravity to the condenser. The water connections to and from this heat exchanger are tagged "in" at the bottom and "out" at the top. Refer to Figure 3-31.

Note:
For proper operation, condensing should not occur in the desuperheater. Only superheat is removed from the discharge gas.

1. Connect the fresh water connection into the check valve and strainer and install near the bottom of the tank (approximately 8" up). Do not reduce the size of the incoming water pipe because the strainer and check valve are sized to fit the requirements of the icemaker.
2. Connect the tank to the suction of the pump. This pipe connection should be made at the opening in the tank approximately 4" up from the bottom.
3. A one inch IPS connection must be made from the discharge of the pump to the inlet bottom connection of the heat exchanger. Use standard unions to facilitate draining for winter storage.
4. Connect a pipe from the outlet of the heat exchanger (top connection) to the solenoid valve. Connect with standard unions. Install a schrader valve in this line to purge water for winter storage.
5. Mount the cross in the opening provided at the top of the tank and assemble the relief valve to the high point of the cross.
6. Run the pipe between the solenoid valve and one of the horizontal openings in the cross.
7. Connect the remaining horizontal opening of the cross to the icemaker make-up water connection. Do not reduce the size of this pipe.
8. Install 1/2" pipe nipple and reducing tee in 1/2" coupling at lower portion of tank.
9. Install 1/4" pitcock drain valve in branch of tee for drain purposes.

Electrical Connections

A simple wiring job is required to place the preheating assembly in place for operation.

The package is wired so that the circulating pump circuit can only be energized while the icemaker is in operation (manufacturing ice). This is accomplished by taking a hot lead through the normally open interlock switch of the water circulating pump (M2-1). With this starter energized, the M2-1 contact of the water pump starter will close, providing power to the preheater water thermostat (PHWT). This thermostat will control the preheater water pump and solenoid, depending upon the temperature of the water in the auxiliary tank.

Wiring Connections

1. Run wire from the terminal shown in the control panel to the defrost water thermostat, and from there, to the pump motor and defrost water solenoid. Wire the pump motor and defrost water solenoid in parallel.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

2. Connect the return (neutral) from the motor and solenoid to L2 in the control panel.

Operation

Initially, it may be necessary to bleed the air from the auxiliary tank to allow the incoming water to fill the tank completely. This is accomplished by opening the relief valve.

While the icemaker is making ice and if the incoming water temperature is below 70°F, the circulating pump and defrost water solenoid will be energized. The water in the tank will then circulate through the heat exchanger, removing heat from the discharge gas, until the tank water temperature reaches 70°F. At this time, the thermostat will cycle off the defrost water pump and solenoid. Normally, this occurs when the icemaker is approximately 50% through the icemaking cycle.

When the unit is ready for harvesting (defrosting), the water solenoid (WS) will open and the tap water pressure will force the preheated water from the auxiliary tank to the defrost tubes. The cycle will repeat itself again as required.

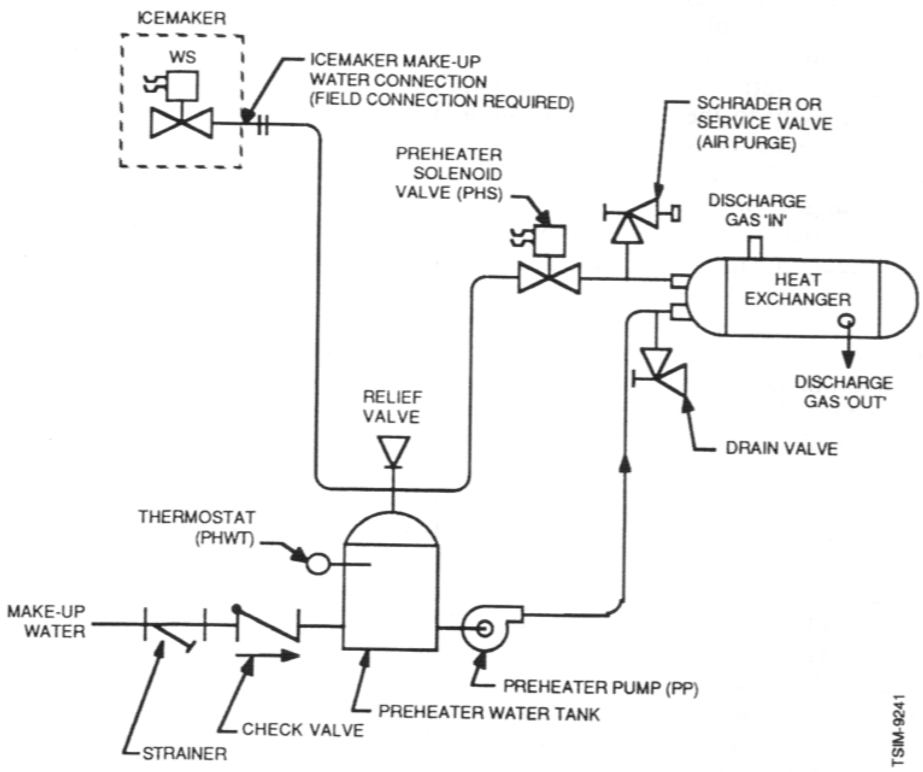

Figure 3-31 Typical Icemaker Preheater Piping

18. ALTERNATE PREHEATERS

When it is desired to use some other means to obtain 70°F or warmer water, several alternative methods may be used. However, it should be kept in mind that defrost water flows for only a short period of time but at a high rate (consult specification sheets for a particular model). If a large amount of heat is available, an instantaneous method of heating can be used. If the amount of heat available is limited, a continuous method of heating is required with a suitable storage tank.

Common Methods Of Preheating

Hot Water Blending

Hot water blending is used when there is a limited amount of hot water available. A blending valve of proper size is employed to mix fresh water and hot water to obtain a 70°F blended water temperature. This reduces consumption of the hot water in storage.

CAUTION

Ice made from some waters made of blended hot and cold water may not be clear due to chemical changes occurring in heating the hot water.

Electrical Or Gas Heating

This method is similar to the method described in step 17 – Standard Preheater Kits on page 97, except that the heat exchanger is external to the icemaker and the source of heat is electricity or gas. Many times, domestic or commercial electric or gas hot water heaters are successfully applied.

Instantaneous Gas And Steam Heated Heat Exchangers

Less frequently used are instantaneous gas and steam heated heat exchangers. Here the defrost water flows on one side of the heat exchanger with steam or fired gas on the other side. Water flow and the flow of heating fluid are initiated simultaneously during defrost. This type of heating is used only in large plants where a large quantity of steam or gas is available for a short period.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

19. WINTERIZING

When TURBO® icemakers are installed in an area where the ambient falls below freezing, it is necessary to provide precautionary measures to prevent freeze-up of the water pump, water circulating tank, and condenser.

Insulated lower panels and electric forced air heat can be furnished for areas where the ambient falls below 15°F. When the ambient is between 15°F and 40°F, only an electric forced air heater is furnished. The electric heaters are factory installed in the lower section of the icemaker and are thermostatically controlled.

For long periods of down time in low or below freezing ambients, it is advisable to drain the water tank, water pump, and water-cooled condenser. 1/4" drain valves are provided on the water pump head and water-cooled condenser head. The water tank can be drained by removing the overflow stand pipe. Provisions need to be made to drain the preheater, heat exchanger, and piping.

Condenser water lines and make-up water lines should be properly protected from freezing by insulating and applying electric heating tape to the pipe surface.

Consult TURBO for additional details.

Note:
A switch is not provided in the control wiring to the winterizing to prevent accidental interruption of the system or loss of protection during unexpected freezing conditions. Power should be left on at all times.

Refer to Figure 3-32.

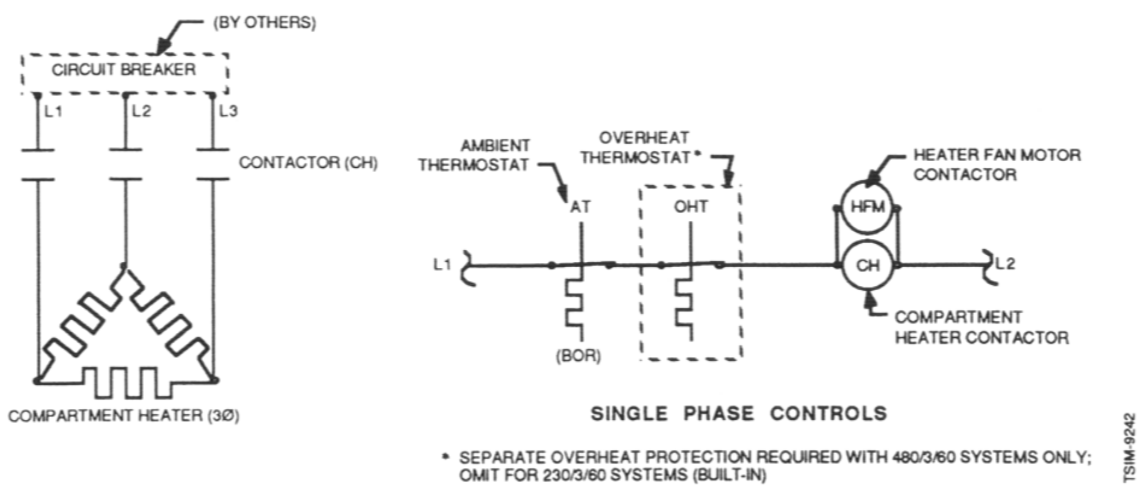

Figure 3-32 Typical Preheater Wiring

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

20. PRE-START-UP CHECKLIST

Before starting the TURBO® icemaker for the first time or after extended equipment shut-down, this pre-start-up checklist must be completed. The items should be checked off and initiated by the person who does the start-up.

1. Visually inspect the unit:

   - ❑ Check that all guards, covers, and panels are in place and are properly secured.
   - ❑ Check that screw conveyors are clear of obstructions and covers are in place.
   - ❑ Check that the ice discharge opening is free of obstructions and is properly covered.
   - ❑ Inspect all relief valves for signs of leakage (i.e., oil around the outlet of the discharge piping).
   - ❑ Check the receiver refrigerant level (if equipped with receiver with level indicator).
   - ❑ Close all water drain cocks on water pumps that were opened to drain water from the water pump during water shutdown.
   - ❑ Inspect the ice slide located below the evaporator plates inside the unit. If necessary, the lower access panel on the front of the unit above the ice discharge open chute may be removed for cleaning the ice slide.

WARNING

All electrical power must be disconnected and locked out if the access cover is removed. Failure to carefully folllow these instructions could result in permanent injury or loss of life.

   - ❑ On air cooled and evaporative condenser models, check all fan drive belts for wear and tension.
     - ❑ On evaporative condenser models, check the strainer and sump for debris. Clean if necessary.
     - ❑ Verify that the drift eliminators located on the air discharge are properly aligned and secured.
   - ❑ On water cooled systems, check the cooling tower fan drive belts for wear and tension.
     - ❑ Check the strainer and sump for debris. Clean if necessary.
     - ❑ Check drain cocks on water lines and condenser water heads that may have been opened to drain water during winter shut-down. Close and drain cocks and purge air during start-up.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

2. Verify the setting of all safety switches:
   - ❑ High/low pressure cut-off
   - ❑ Oil pressure failure switch
   - ❑ Oil temperature switch (if so equipped)
   - ❑ Switches or controls field installed by others

3. ❑ Complete the Electrical Checklist on page 58 (step 7 – Electrical Connections).

4. ❑ Check the rotation of all motors.

5. ❑ Align the compressor(s) and install the coupling(s). Refer to the compressor manufacturer's owner's manual for alignment procedures.

   Note: Omit this step for models with semi-hermetic compressors.

6. ❑ Install the drier cores unless they were installed at the factory. Drier cores are installed only for units which require no field refrigerant piping.

   ❑ Check the liquid line sight glass(es) for a normal green eye. If the eye is not green, refer to section 6 – Maintenance for instructions on changing drier cores (page 171).

7. Check the water system:
   - ❑ Clean the water line strainer.
   - ❑ Check the water tank(s) for debris. If necessary, remove the water tank stand-pipe and flush out the tank interior.
   - ❑ Inspect the O-rings and snap-tite water plugs on the make-up and defrost water tubes. Replace worn O-rings or water plugs.
   - ❑ Clean the interior of the make-up and defrost water tubes with the tube cleaning brush supplied. With the water tank stand-pipe out, manually open the defrost supply to flush out all of the water lines and water tubes (open the water circuit cross-over valve).

     Note: Close the water-circuit cross-over valve after flushing the water tubes. This valve must be closed for normal operation.
   - ❑ Replace the water tank stand-pipe and fill the water tank.

     Note: The defrost water solenoid (make-up) water supply should be returned to the automatic position after filling the water tank.
   - ❑ Check the water tank stand-pipe and all other drain connections for leaks.

8. ❑ Check the tags on all valves to ensure that they are in the correct position (open or closed as indicated on the tag). Solenoid valves should be in the automatic position if equipped with manual open operators.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

9. ❑ If the equipment is being restarted after an extended shut-down (winter, etc.), section 6 – Maintenance (page 169) should be reviewed for any maintenance procedures that can be performed before returning the unit to regular service.

10. Verify that all accessory equipment has also been checked out and is ready for normal operation.

    ❑ Screw conveyors, shakers, ice storage system, rakes, preheater systems, ice sizer, block press, baggers, bailers, etc.

WARNING

When conducting the pre-start-up checklist procedures above, follow all precautions and safety practices as detailed in each previously outlined installation step. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

21. START-UP CHECKLIST

The following items must be checked off prior to starting unit.

Customer ______________________ Date __________ Model __________ Serial # __________

CHECK ITEM	INSTALLED BY	CHECKED BY	DATE	COMMENTS
Compressor/Motor Alignment				
Refrigerant Lines				
Pressure Test __________ psig				
Evacuated __________ in water				
Charged __________ lb.				
Drier Cores				
Oil Level				
Pressure Control Set				
Control Settings (psig)	**COMP #1**	**COMP #2**	**COMP #3**	
OPTD Cut Out				
Low Pressure Cut Out				
Low Pressure Cut In				
High Pressure Cut Out (SC and SCER 250 psig, SCA 275 psig)				
Condenser Fan Cut Out				
Condenser Fan Cut In				
Suction Pressure Cut Out				
Suction Pressure Cut In				
Water Connections				
Water Flow (gpm)				
Electrical Power				
Control Power				
Motor Rotation				
Tags Removed				
Safety and Operation Instructions Performed				

MOTOR PERFORMANCE DATA								
MOTOR	VOLTAGE	PHASES	AVERAGE OF 3 PHASES					
			#1	#2	#3	#4	#5	#6
Compressor Motor								
Water Pump								
Condenser Fan Motor								
Condenser Pump Motor								

COMPONENT DATA						
	#1	#2	#3	#4	#5	#6
Component						
TEV Setting - Turns Open						
Evaporator Pressure at Suction During Defrost						
Super Heat @ Evaporator Plate Suction Tube Line						

TSIM-9262

______________________ ______________ ______________________

ACCEPTED BY DATE COMPANY

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

OPERATING INSTRUCTIONS

This section describes the operating sequence, the components and controls of TURBO® icemakers. Operation hints are provided for safe, efficient, and reliable operation of the equipment.

All TURBO® icemakers use stainless steel evaporator plates. Although typical icemaking and defrost cycles are the same regardless of the unit size or type of refrigerant used, only equipment using the refrigerant R-22 (Freon®) is described here.

Standard features will be discussed. For optional features and accessories, refer to section 8 on page 187.

Small Icemakers

Small icemakers have capacities of ten (10) or less tons of ice per day. Typically, these models use a semi-hermetic compressor (open compressors are available as options) with either a water-cooled, air-cooled, or evaporative-cooled condensing unit.

Capacity is based upon 70°F make-up (defrost) water temperature, 0°F evaporator temperature, and 105°F condensing temperature. The evaporator section consists of a single icemaking section and is harvested in a single defrost cycle.

Refer to Figure 4-1 and Figure 4-2.

Models

Model Number	Tons of Ice
CF2*	1
CF4*	2
CF6	3
CF8	5
CF12*	6
CF14	7
CF16	10
CF88	10

* These models are no longer in production.

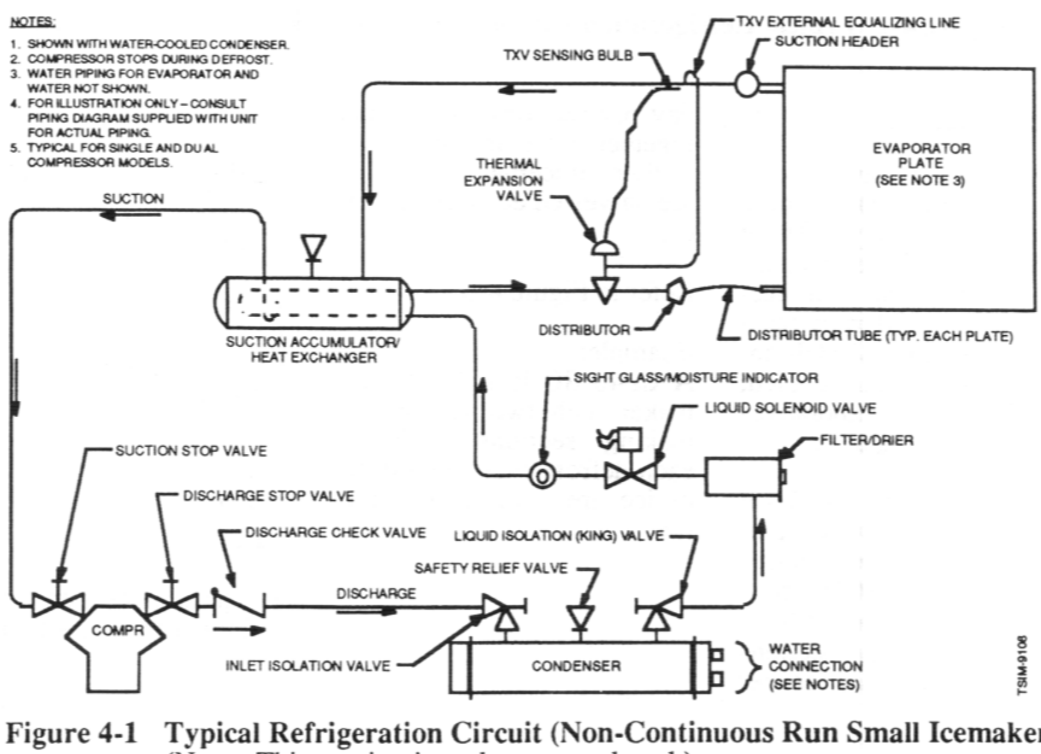

Figure 4-1 Typical Refrigeration Circuit (Non-Continuous Run Small Icemakers)
(Note: This version is no longer produced.)

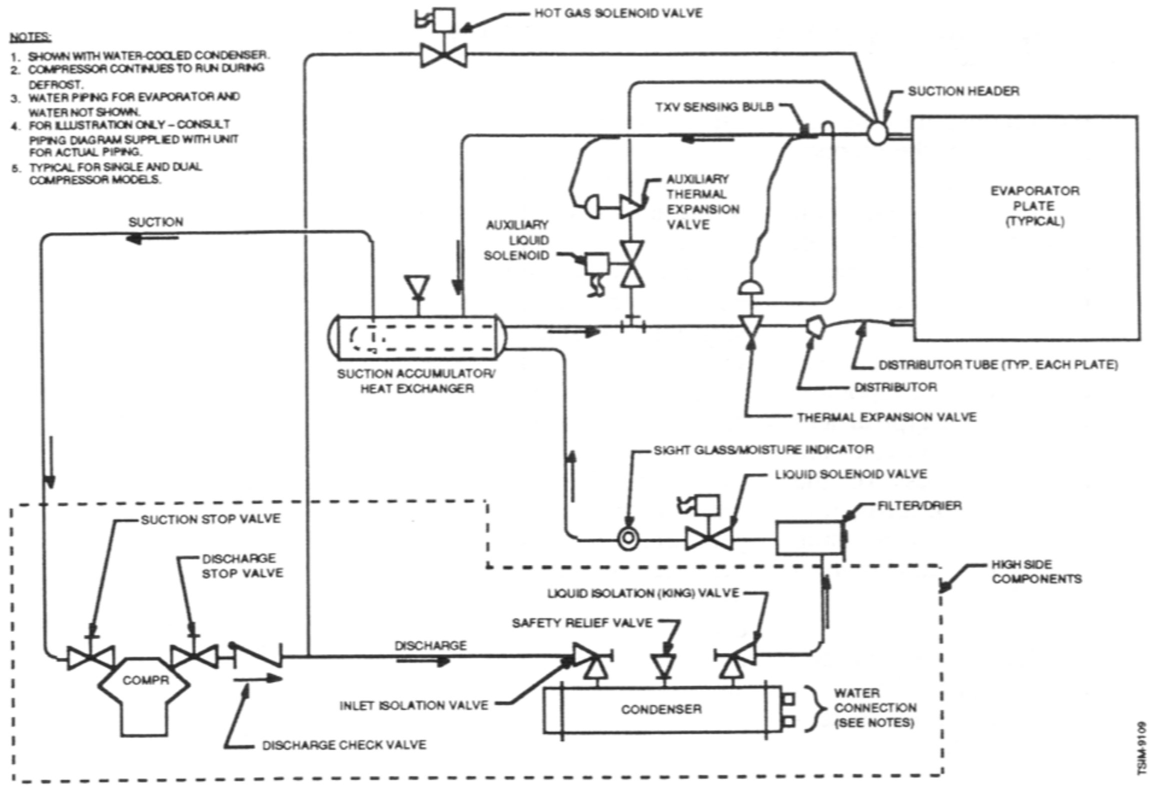

Figure 4-2 Typical Refrigeration Circuit (Continuous Run Small Icemakers)

Large Icemakers

Large icemakers have capacities of fifteen (15) or more tons of ice per day. These models typically use an open-drive reciprocating compressor with an 1800 rpm open drip-proof motor. Models are available with water-cooled, air-cooled, or evaporative-cooled condensing units.

Capacity is based on 70°F make-up (defrost) water temperature, 0°F evaporative temperature, and 105°F condensing temperature. Multiple evaporator plate sections (7 1/2 or 10 tons of ice per day per section) are grouped together in a common frame. Individual icemaking sections are harvested each defrost cycle.

Refer to Figure 4-3.

Example:
A CF40 SC is a 20 ton icemaker with two 10 ton icemaking sections. During each defrost cycle, two drops of ice are made at different times.

Models

Model #	Tons Of Ice	Harvests Per Cycle
CF24*	11	2
CF28	14	2
CF28	15	2
CF36*	18	2
CF40	20	2
CF48*	24	2
CF56	30	4
CF72*	36	4
CF80	40	4
CF96*	48	4
CF120	60	6
CF144*	72	6

* These models are no longer in production.

Self-Contained R-22 Models

There are four self-contained R-22 models:

1. SC water-cooled
2. SCA air-cooled
3. SCE evaporative-cooled
4. SCER/SCAR remote condenser

All of these models have the same basic refrigeration system.

SC Models

SC models have a complete refrigeration system within the unit frame. The liquid refrigerant charge is stored in the lower shell portion of the combination condenser/receiver. A "king" valve is provided in the liquid line leaving the condenser receiver.

1. Liquid refrigerant flows from the condenser/receiver through a filter drier, sight glass, and liquid solenoid valve.
2. It enters a liquid-to-suction gas heat exchanger where the liquid refrigerant is subcooled.
3. The subcooled liquid enters a thermostatic expansion valve where it is metered to a refrigerant distributor and delivered to the evaporators (ice-making plates).
4. The liquid refrigerant enters the evaporators where the refrigeration load is applied via the water flowing over the outside of the plates.
5. The refrigeration load applied to the plates causes the liquid refrigerant to evaporate into a gas.
6. The refrigerant gas is drawn from the evaporators and flows via the suction line through the liquid-to-suction gas heat exchanger.
7. The heat exchanger introduces a small amount of superheat into the suction gas to ensure that no liquid droplets of refrigerant enter the compressor.
8. The suction gas enters the compressor where it is discharged to the water-cooled condenser.

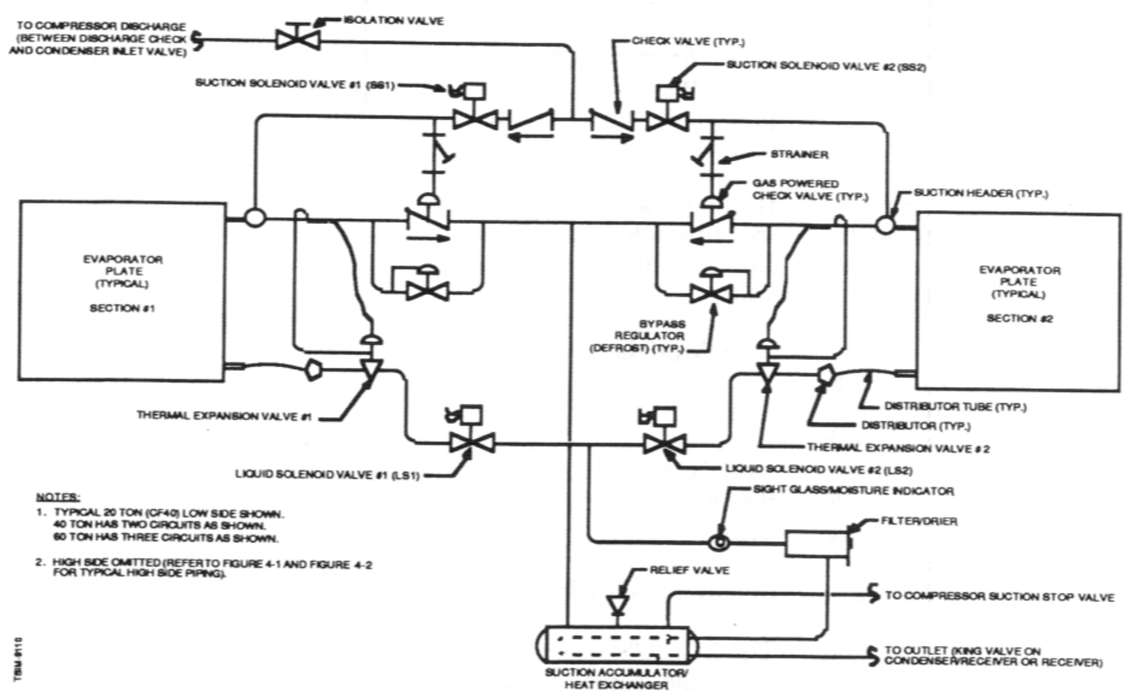

Figure 4-3 Typical Refrigeration Circuit (Large Icemakers – 20 Ton Shown)

9. The water-cooled condenser removes the heat of rejection (induced by the refrigeration load at the evaporators) and the heat of compression.

10. The hot gas is condensed back to a liquid and stored in the lower half of the condenser shell, ready for passage through the system again.

11. The thermostatic expansion valve is controlled by a superheat sensing device (temperature actuated) which is placed on the suction header to regulate the area of the expansion valve orifice opening through which the liquid flows.

12. During the icemaking cycle, the liquid solenoid valve is energized. During the harvest cycle, the liquid solenoid valve is de-energized.

Note:
On continuous run models, the main liquid solenoid remains open during defrost and the auxiliary liquid opens during defrost.

Models CF2, CF4, CF6, CF8, CF14, and CF16 have a single compressor circuit with one liquid solenoid valve. Model CF88 has two separate compressor circuits and two liquid solenoid valves. Models CF28 and CF40 have a single compressor circuit with two liquid solenoid valves. Models CF56, CF80, and CF120 have two separate compressors each with two liquid solenoid valves.

Older models three through ten tons are arranged to have the compressor cycle on and off with the icemaking and harvest cycle. Newer models three through ten tons are set up for continuous run. On models fifteen through forty tons, the compressors continue to run during the harvesting cycle because only 50% of the machine is harvested at any one time.

Note:
Versions with compressor cycling are no longer produced.

SCA Models

The SCA models operate the same as the SC models. The SCA model has a receiver instead of a combination condenser/receiver and includes an air-cooled condenser piped into the refrigerant circuit on the discharge side of the compressor. The hot gas is condensed into a liquid in the air-cooled condenser and flows to the receiver located below.

SCE Models

The SCE models operate the same as the SC and SCA models but are furnished with the evaporative-cooled condenser.

SCER/SCAR Models

The SCER/SCAR models operate the same as the SCE and SCA models but are furnished without the air-cooled or evaporative-cooled condenser. A receiver is furnished with the icemaker but must be field installed and connected to the remote condenser.

Remote R-22 Models

The operation of the remote R-22 models is the same as the SC, SCA, and SCE models, but they are furnished without the condensing unit (compressor motor, related piping, starters, etc.).

It is necessary for the customer to supply a condensing unit or to connect into a central system in order to operate the icemaker. When connecting into either system, there are two refrigerant piping connections to be made, liquid and suction, in addition to power and water connections. The remote R-22 units are furnished with suction to liquid heat exchangers, liquid line driers, sight glasses, and liquid solenoids.

Electric Motors

Standard, open drip-proof 230/460/3/60 motors are used for the compressor, water pump, and breaker bar.

Optional 208 or 575 voltage motors are available for 60 hertz systems and 50 hertz frequency is available. Each motor is bottom wired from the magnetic starter to the motor at the factory. Starter top wiring (incoming power) and motor disconnects and/or circuit breakers should be furnished by others to meet all local electrical codes.

Controls

All models are supplied with single phase controls and magnetic starters for the three-phase motors. The typical variation between the control panels (for the various models) is the number of relays or starters supplied in the panel. Older models are supplied with electromechanical controls. Later models manufactured after October, 1991, are supplied with a standard programmable controller.

Note:
All models can be upgraded to programmable controllers.

Electromechanical Controls

Each control panel consists of:

- A mechanical cam sequence timer for control of refrigeration and defrost times as well as the operation of the water pump(s) and breaker bar(s).
- Standard gear racks for the cam timer (gear racks for 20, 25, and 30 minute cycles are provided).
- Control relays, time delays, and interlocks for the logic control.
- Magnetic starters for the:
  - Compressor(s) (magnetic contactor is used for semi-hermetic models)
  - Water pump(s)
  - Breaker bar(s)
- Evaporative condenser fan and pump motors on the SCE models only.
- Air-cooled condenser fan(s) motors on the SCA model only.
- Master control switch.
- Overload and safety controls.

Programmable Logic Controller (PLC)

Each control panel consists of:

- Programmable controller with programmer, power supply, CPU, input/output models, and rack.
- Magnetic starters for the:
  - Compressor(s) (magnetic contactor for semi-hermetic compressor)
  - Water pump(s)
  - Breaker bar(s)
- Master control switch.
- Overload and safety controls.

On models with PLC, control relays, and the cam sequence timers are replaced by the PLC. Refrigeration and defrost times and other operating sequences are controlled by the program logic in the PLC.

Complete documentation of the controller ladder logic is provided. Refrigeration and defrost times are set as "presets", which can be changed with the programmer provided.

Note:
Controls necessary for accessory components (screw conveyors, augers, etc.) used to convey the ice to points of use are not furnished by TURBO.

Control Panel Door Components

Electromechanical Controls

- Master control switch "on/off".
- Manual defrost switches for "auto/off/manual" defrost.
- 10-amp circuit breakers.
- Reset buttons for the magnetic starter overload relays.
- Momentary push button to energize refrigerant (liquid) solenoid valve at start-up.
- Warning labels.
- Data nameplate.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

PLC Controls

The same components (as described in Electromechanical Controls) are provided. In addition:

- Pilot lights to indicate the status of the control (i.e. water pump "on", breaker bar "on", etc.).

Warning Labels

Refer to section 2 – Safety on page 11 for a listing of all warning labels that should be on the control panel door. If any labels are missing, contact TURBO immediately to obtain the missing labels.

THINK SAFETY !

Note:
The serial number on the data nameplate should be referred to when inquiring about the controls. A file is maintained under this serial number which enables us to assist you quickly and accurately if you have any questions.

Electrical Components Description

Master Control Switch (MCS) – On/Off

A two position cam operated switch with a normally closed (N.C.) contact block and a normally open (N.O.) contact block are provided to input a signal to the PLC or electromechanical control circuit. These signals initiate the logic required to start the icemaker, and to terminate ice production. Turning the selector switch to the "off" position initiates a shutdown sequence that includes pumpdown of the system refrigerant charge into the receiver or combination condenser/receiver. Actual termination of operation occurs when the low pressure safety switch opens at a preset suction pressure.

- Turn the switch to the "off" position to pumpdown the system before restarting to avoid slugging the compressor with liquid refrigerant.
- If the system is off for over thirty (30) minutes, allow the crankcase heaters to warm up the compressor crankcase before restarting. (Refer to compressor manufacturer's specifications).

WARNING

The master control selector switch (MCS) is not a service disconnect. Lockout electrical power to controls before performing service. Have a qualified electrician perform all service. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Control Circuit Breaker

A 10-amp circuit breaker or fuse is located in each leg of the single phase control circuit power to the control panel. On panels using control circuit step down transformers (220/1/60 primary, 110/1/60 secondary), the circuit breakers or fuses are located on the secondary side of the transformer. Separate circuit breakers (by others) are required for the transformer and electrical panel service.

Control circuit overloads or shorts can cause the breakers to trip. In the tripped mode, the circuit breaker "reset" pops up. Reset is accomplished by pushing the "reset" button on the panel door "in". Before resetting:

- Have a qualified electrician check all components in the electrical panel and on the machine to determine the overload cause. Correct all defects or problems immediately.
- Never bypass the circuit breaker or overload protection.

Magnetic Starters With Overload Relays

Each electrical motor used in the icemaker is provided with a magnetic starter to start and stop each motor. Each starter contains an adjustable trip overload relay or a melting alloy type overload relay to protect the motor from overloads. The wiring of the starter coil is connected in series with the overload relay. As a result, the starter will de-energize when the overload relay contact opens.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Melting Alloy Type
Overload Relay

Overloads produce high ampere that exceed the rating of the melting alloy overload causing it to produce enough heat to open a circuit in the overload relay.

Three melting allow heater elements are factory sized and supplied to match the motor horsepower and voltage.

Adjustable Trip Type
Overload Relay

Overloads produce amphere exceeding the rating of the bi-metallic strip causing it to open a normally closed contact on the overload relay.

A reset mechanism is located on both types of relays and a reset button is on the control panel door to operate the "reset" mechanism on the starter overload relay.

WARNING

- **Have a qualified electrician determine the cause of the overload before resetting.**
- **Never bypass the overload relay.**
- **Never use an overload size larger than the size specified by the factory.**

Failure to carefully follow these instructions could result in permanent injury or loss of life.

All magnetic starters are supplied with dual voltage/dual frequency coils (115 or 230 VAC; 50/60 hertz).

Auxiliary interlocks with normally open and/or normally closed contacts are mounted on the magnetic starters to control auxiliary operations (i.e., the compressor crankcase heater is interlocked to the compressor(s) motor starters). A normally closed interlock turns the crankcase heater(s) on when the compressor is off.

Additional auxiliary interlocks can be provided. Consult TURBO for information.

Momentary Push Button (PB)

A momentary push button operates with a normally open contact block. It is mounted on the control panel door. This button is used to electrically open the liquid solenoid valve for start-up. Refer to "Typical Start-Up Sequence" on page 119.

Mechanical Cam Sequence Timer

On units with electromechanical controls, a sequence timer is used to control the icemaker's operation. The sequencer timer consists of:

- Micro-switches with one (1) normally closed contact, one (1) normally open contact, and a common connection.
- A timer motor.
- A gear rack.
- A timer rack.

This timer controls the refrigeration/defrost sequence, water pumps, breakers, and compressors.

Refer to the appendix for a list of gear racks that are supplied to control the refrigeration/defrost cycle "time". Time is changed by using different gear racks. The "on/off" sequence of each microswitch is controlled by the cam setting that operates the microswitch. A full description of adjustment and cam timer settings is described later.

Time Delay (TD)

On two (2) compressor models, a solid state "on" time delay relay is used to prevent both compressors from starting at the same time. The time delay is a plug-in type with an adjustable knob on top. A mounting base is attached to the control panel back plate and the time delay relay is plugged into the base.

Hand Switches (HS-'X')

On two (2) compressor models, "on/off" hand switches are provided to allow operation of either or both compressors.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Cam Timer Switches (TM-'X')

A series of micro-switches are mounted on a common shaft that drives the cam timer motor. Each switch has one (1) normally open contact, one (1) normally closed contact, and a common connection.

These switches are connected to the input/output devices in the control circuit used on systems with electromechanical controls. Each switch is typically rated for a maximum of ten (10) amps and is actuated by a cam disc on the cam shaft.

Each switch is labeled on the wiring diagram supplied with the unit. Starting with the switch next to the timer motor is TM1, the next switch would be TM2, etc. A maximum of ten (10) switches are used on standard Turbo icemakers.

Timer Motor (TM)

Electromechanical controls use a mechanical cam sequence timer. This sequence control device drives a motor (typically Industrial Timer Model MC-7) at a constant rpm.

Bin Level Switch (BLS)

Although the bin level switch is an optional item, all control systems (electromechanical and PLC) are provided with a set of terminal block connections in the master control switch line for connection of a field installed bin level switch (by others) or other controls. A set of normally closed contacts are wired to the terminal strip connections provided. These contacts provide the same "on/off" sequence of operation as the master control switch. The bin level switch is typically mounted in the ice storage bin (TURBO® rake system) and opens when the ice storage is full to terminate operation of the icemaker.

Note:
The controls are shipped with a jumper installed between the terminal connections. If the terminals are used, the jumper wire must be removed.

Control Relays (CR-'X')

On electromechanical controls, two (2) to six (6) pole control relays are used to provide a control sequence in response to activation by the cam timer or other input devices.

Control relay CR1 is used in the master control switch circuit on all models and is often referred to as the master control relay.

Each relay contains from two (2) to six (6) normally open and/or normally closed relay contacts. On most models, these contacts are convertible from normally open to normally closed and vice-versa.

Control relays are also located in the refrigeration/defrost (RD) circuit of the controls.

Contacts of control relays are denoted as follows: the first contact of CR1 would be CR1-1, contact number 2 would be CR1-2, etc.

Compressor Magnetic Motor Starter (CM)

A magnetic motor starter is used to start and stop the compressor in response to the control logic sequence.

The magnetic starter is bottom wired from the starter overload relay module to the compressor motor. Top wiring to the starter is not provided and must be field installed per electrical codes. A manual reset overload module is mounted to the starter to provide overload protection of the motor.

Reset of the overload relay is required by pushing the reset button located on the control panel door.

Either melting alloy type or adjustable trip solid state type overloads are provided for each of the three phases. Setpoint is determined by the full load amps (FLA) of the motor. Refer to the equipment data nameplate for the FLA of all motors supplied.

On models with two (2) compressors, the starters will be labeled CM1 for compressor number one and CM2 for compressor number two.

Water Pump Magnetic Motor Starter (WP)

Each water pump provided with the icemaker is supplied with a magnetic motor starter that has the same features as the compressor motor starter. Water pump number one represents WP1, WP2 represents number two, etc. A maximum of six (6) water pumps (WP1 – WP6) are used on standard Turbo models.

Breaker Bar Magnetic Motor Starter (BBM)

Each breaker bar motor included with the icemaker is supplied with a magnetic motor starter that has the same features as the compressor motor starter. BBM1 represents breaker bar number one, BBM2 represents number two, and BBM3 represents number three. A maximum of three (3) breaker bars are used on standard TURBO® icemakers.

Typical Wiring Diagram Symbols

Liquid Solenoid (LS)

LS represents the coil on the solenoid valve used to start the unit (open) and for pump-down (closed) of the system. Models with two (2) compressors will have two (2) liquid solenoid valves labeled LS1 and LS2.

Suction Solenoid (SS)

SS represents the coil on the solenoid valve(s) used to isolate the evaporator section in defrost. SS may also be noted as a defrost pilot solenoid (DPS) on models that use a pilot solenoid valve to close a gas powered check for defrost or a pressure regulator with an electric actuator (i.e., wide open in icemaking mode; closed in defrost mode to act as an upstream pressure regulator).

On small icemakers that stop the compressor during defrost, a suction solenoid is not required.

Compressor Crankcase Heater (CCH)

CCH represents the controls to an electric resistance heater located in the compressor crankcase. During the "off" cycle, the heater is "on" to keep the compressor crankcase warm. This prevents refrigerant migration to the compressor. With the compressor operating, the heaters are not used and are turned "off".

A crankcase heater is supplied with each compressor on models with two (2) compressors.

Safety Circuit Components

Dual Pressure Switch (LP/HP)

All TURBO® icemakers are supplied with safety switches to terminate operation in the event of low or high pressure.

LP

Low pressure (LP) is used to terminate operation based on the suction pressure at the compressor. During normal operation, the normally closed contacts open if the suction pressure drops below the setpoint of the switch. On most models, low pressure cut-out is set at 5–8 psig and cut-in is typically 30–33 psig (i.e., switch differential is 25 psig).

LP is also used to terminate operation of the unit at the conclusion of operation by either the master control switch or bin level switch.

Cut-in and cut-out are field adjustable.

HP

High pressure (HP) is used to terminate operation in the event that the compressor discharge pressure exceeds the setpoint of the switch. On most models, the HP switch is set to trip at 275 psig (relief valves on pressure vessels trip at 350 psig). On evaporative-cooled or water-cooled units with lower condensing temperatures (pressure ranging from 180–210 psig), a lower setting can be used. However, below 250 psig nuisance tripping may occur during start-up or after defrost.

A common housing and actuator mechanism operates both the LP and HP side of the switch.

Oil Pressure Switch (OPS)

All models are equipped with an oil pressure switch to ensure adequate oil pressure is available to provide proper lubrication of the compressor. If the pressure differential between the suction (LP) and the compressor pump pressure connection is below the required pressure differential, the OPS mechanism closes to "make" a circuit to the switch heater circuit. After sixty (60) seconds on Carrier and Copeland compressors, and thirty (30) seconds on Royce compressor, the heater circuit (OPTDH) warms up and trips a bimetal contact (OPTD or OPTD-'X') to terminate operation of the compressor.

The oil pressure switch (OPS) is a manual reset device. After the switch heater cools, the red reset button on the safety gauge panel must be depressed to reset the switch.

CAUTION

Never reset the oil pressure switch without determining the cause of the trip (low oil level, etc.) or monitoring the compressor operation after restart. Failure to do so could result in failure of the compressor due to inadequate lubrication.

Oil Pressure Time Delay Heater (OPTDH)

If the required oil pressure differential (net oil pressure = oil pressure – suction pressure) is below the required minimum, a heater with the oil failure switch is activated. After the heater is "on" (for 30 seconds on Royce compressors and for 60 seconds on all others), the time delay contacts open to terminate operation.

Oil Pressure Time Delay Contact (OPTD)

OPTD is a normally closed contact located in the safety circuit. As the bimetal switch "heats" up and trips, this contact opens to terminate compressor operation.

Oil Temperature Switch (OTS)

Oil temperature switches are located in the crankcase of open-driven compressors only. If the oil temperature increases above the setpoint of the thermostat (due to inadequate suction gas return (cooling), lack of oil, or other deficiencies), the normally closed contacts open to terminate operation of the compressor.

The typical setting of the OTS is 150–165°F.

Cylinder Head Switch (CHS, CHS-'X', or HDTS)

Cylinder head switches are used on Royce compressors in place of oil temperature switches (OTS) on open-driven compressors. Cylinder head switches sense discharge gas temperature in the compressor discharge deck. They terminate operation in the event discharge gas and oil temperatures exceed factory specification.

These switches are factory set and nonadjustable. A normally closed contact, encapsulated in the switch, is wired to the safety circuit.

Icemaker Variations

Since TURBO® icemakers are available in several configurations and changes have been made over the years these models have been manufactured, some variations in the controls exist and all configurations may not be covered in this section. For actual wiring and controls, refer to the wiring and piping diagrams supplied with this manual and with the equipment. If you have any questions concerning these variations, contact the service department of:

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Turbo Refrigerating Company
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TURBO® Electromechanical Control Wiring Operation

A manual control switch (MCS) is provided to manually turn the unit on or off.

Note:
It is normal for the icemaker to continue to run after this switch is placed in the "off" position. When this occurs, the length of time the unit will run is not definable because this depends upon what point in the cycle that the MCS switch was turned off.

Terminals are provided in the panel for connection to a bin level device (BLS) when required. These terminals are in series with the MCS to provide the same function as when the unit is shut off manually.

When the icemaker is started, either manually (MCS) or automatically (BLS) (this is dependent upon how the machine was stopped), a relay (CR) will be energized in the electromechanical control panel. Energizing CR causes a circuit to be made in the timer circuit and starts the timer motor. With the timer motor running, the cams start to rotate counterclockwise when viewed from the motor end.

The unit should now be in the icemaking cycle with the cam switch arms riding on the outer periphery of the cams. In this position, the compressor, circulating water pump, and liquid solenoid valve will be energized and running.

The breaker bar motor and water defrost solenoid will be de-energized and off. As the cams rotate and the defrost (detent) position of the cams approach the cam switch arms, the following will take place:

1. The breaker bar motor switch arm drops into the recessed position of the cam to start the breaker bar rotating. This should occur approximately thirty (30) seconds before the icemaking cam switch drops into its recess (detent). While the breaker bar is running, the timer motor continues to rotate the remaining cams.
2. The water pump switch arm drops into its recess and shuts off the water circulating pump. This should occur twenty (20) seconds before the refrigerating cycle is shut off to allow the water on the ice to dry.
3. The refrigerating cycle switch arm falls into its detent cam position and stops the refrigeration cycle. Simultaneously, the water defrost solenoid valve energizes and opens to allow make-up water to enter the machine to start the defrost.
4. The timer recycles through this process continually until it is manually shut down (MCS) or automatically shut down (BLS).
5. When the unit is shut down at any point in the icemaking cycle, CR will de-energize. Due to certain interlocks, the icemaking cycle will continue until defrost is completed.
6. With CR de-energized, the circuit to the icemaking cycle is open and cannot start again until CR is energized. CR is energized by closing the switch leg of MCS or BLS to restart the unit.
7. The breaker bar motor will run through its cycle and "time off". Then the unit will stop.

   Note:
   The breaker bar and unit operation should occur at the same time. The breaker bar keeps the unit running until the unit is clear of ice from the final defrost.

Typical Start-Up Sequence

The following start-up sequence is typical for all models:

1. The master control switch is turned to the "on" position.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

2a. Through the PLC, a signal energizes the refrigerant liquid solenoid valve for a preset time interval.

2b. For electromechanical systems, the momentary push button is depressed and held to open the liquid solenoid valve.

3. With the liquid solenoid open, the refrigerant charge enters the system causing the pressure to rise above the low (evaporator) pressure safety switch setting.

4. If all other safety switches are in a "non-trip" status, the compressor motor and water pump motor energize and the liquid solenoid remains open.

5. All sections are in the refrigeration mode.

6. After a preset time, a defrost sequence is initiated.

Note:
The refrigeration time which controls the ice thickness can be easily and quickly adjusted through the PLC programmer or with a gear rack change.

If the unit fails to start, refer to section 5 – Trouble-Shooting on page 155.

Typical Refrigeration Cycle

All TURBO® icemakers use the same refrigeration cycle:

1. During the defrost cycle or by manually opening the water solenoid valve (during initial start-up or after winter shut-down), the water tank(s) are filled through the make-up water line.

A stand pipe located in the tank limits the amount of water that can be added and also provides for blowdown to eliminate the concentration of impurities or solids. Blowdown will be discussed in detail later.

Note:
The icemaking process tends to "freeze-out" or separate the suspended solids found in water sources. Blowdown is used to remove these solids to prevent contamination of the system as well as "cloudy" ice.

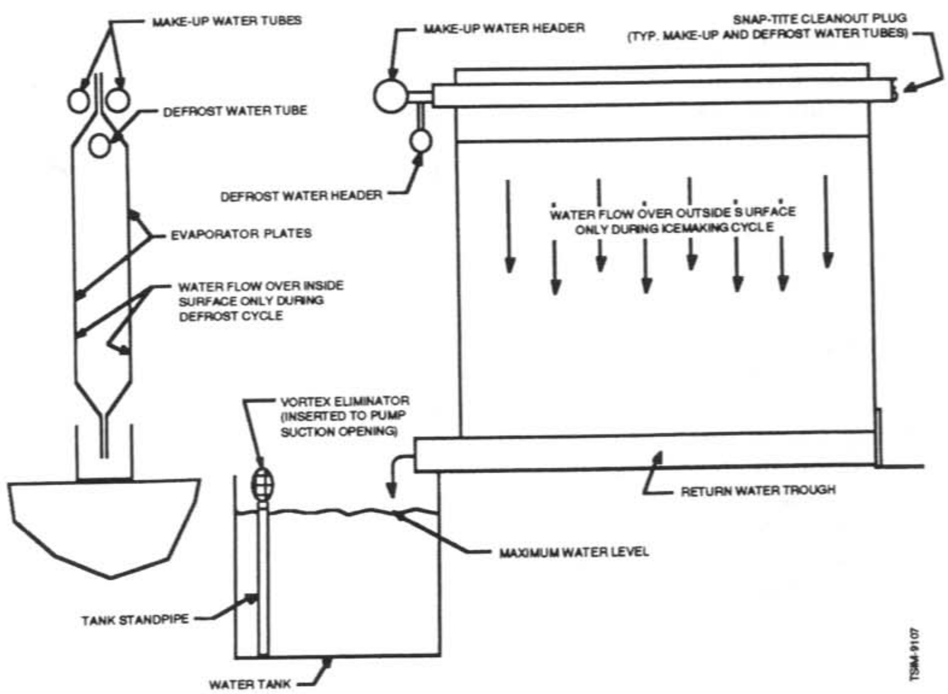


Figure 4-4 Typical Plate And Trough Assembly

2. After the tank is full, the refrigeration cycle is initiated with the water pump "off".

3. A short delay is provided to allow the evaporator temperature to drop.

4. The water pump is turned "on" and water is circulated over the outside of each set of evaporator plates through the make-up water tubes.

   Several evaporator plates are connected to a common water tank to form a section (typically seven (7) or ten (10) tons of ice per day). Water is not circulated over the inside plate surface during the refrigeration or icemaking mode. Refer to Figure 4-4.

5. As the water flows over the refrigerated evaporator plate, ice is formed on the plates within the active area of the plate.

6. After a preset time, a sheet of ice is formed on the plate surface. The thickness of the ice is determined by the length of time the icemaker is left in the refrigeration or icemaking mode.

Cycles (minutes)	*Ice Thickness
20	3/8"
25	1/2"
30	5/8"
35	3/4"
40	7/8"
45	15/16"

* Nominal ice thickness based on 0°F evaporative temperature, 70°F make-up water, and 105°F condensing temperature. Actual thicknesses may vary.

7. During the icemaking process, the make-up water solenoid valve is "off" and water is recirculated continually from the water tank over the evaporator plates and back to the tank. As the process continues, the water level in the water tank drops as water is converted to ice on the plates. This feature will be described later in determining the ice production of the icemaker.

8. At the termination of the icemaking cycle, the ice sheet is removed by a defrost sequence, after which a new icemaking cycle is started.

   Note:
   At the end of the icemaking cycle, water flow to the evaporator plate section is terminated for a short time interval (typically 15–20 seconds) to allow the ice to dry before it is harvested. This is called the "drying cycle".

Typical Defrost Cycle

All TURBO® icemakers use a water defrost to remove (or harvest) ice from the evaporator plates. This defrost or harvest cycle is basically the same for all models:

1. At the conclusion of the refrigeration (icemaking) cycle and the drying cycle, water is circulated on the inside of each set of evaporator plates through the defrost water tubes. Refer to Figure 4-4.

2. The breaker bar drive (on models so equipped) and harvest screw conveyor (used to transport the ice away from the icemaker) are turned "on" before the make-up (defrost) water is turned "on" to ensure that ice is removed from the icemaker as soon as it is harvested (drops from the evaporator plates into the ice slide).

3. The evaporator plate section in defrost (harvest) is isolated from the rest of the section still in refrigeration by a gas powered check or "suction solenoid" valve. As the warm defrost water flows over the inside of the plates, the pressure rises. Due to the pressure-temperature relationship of the refrigerant, the temperature also increases.

   Note:
   On small icemakers and all single section icemakers, the evaporator section cannot be isolated from the main suction. On these models, hot gas bypass is used to maintain a "false" load on the compressor thus allowing continuous operation.

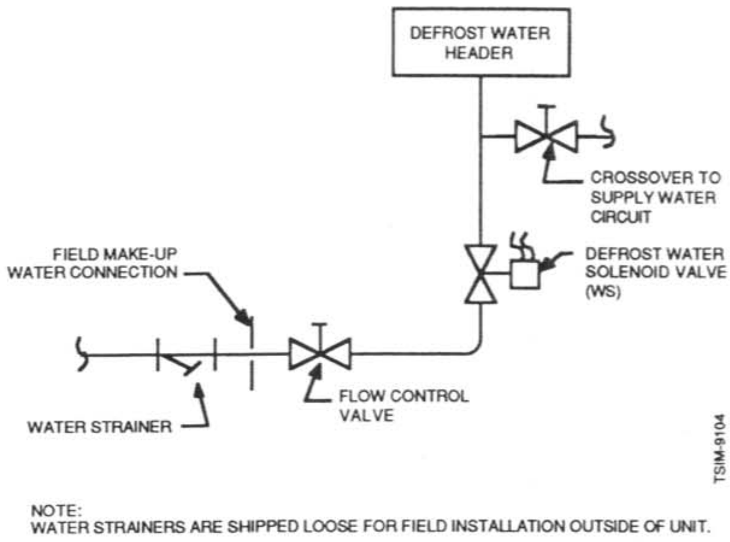


Figure 4-5 Defrost Water Piping

perature reaches 40°F (68.5 psig for refrigerant R-22), the ice bond between the ice sheet and evaporator plate melts. The ice sheet drops by gravity (due to its weight) into the ice slide located below it.

As the ice flows down the ice slide into the breaker bar mechanism, it is fragmented by the ice sizing grates and breaker bar into dry ice nuggets.

Note:
The breaker bar mechanism and sizing of the ice within the icemaker can be eliminated. In these installations, the ice is conveyed to a rake storage bin or directly to an external TURBO® ice sizer for the final ice sizing. Refer to "Sizing The Ice" on page 145 for additional details.

5. Defrost water flowing over the plates is collected in a U-shaped trough located at the bottom of the plate set. The defrost water is returned to the water tank by the water trough and the water tank is refilled with water to be used for the next icemaking cycle. Refer to Figure 4-5 for typical return water trough details.

6. As the warm defrost water flows over the evaporator plates, the heat from the water is used to melt a small layer of ice between the ice sheet and evaporator plate surface. In this process, the defrost water is prechilled for the next icemaking chilling.

Note:
Icemaker capacities are based on a 70°F defrost (make-up) water temperature. Higher defrost water temperatures will decrease ice production since the "prechilled" water at the end of the defrost cycle will be at a higher temperature. Additional refrigeration and time are required to pull the water temperature down to the 32°F freeze point. The additional time results in less time for ice to build on the evaporator plates after ice build-up begins.

7. After all of the ice has dropped from the evaporator plates during the fixed defrost time, the evaporator section is returned to the icemaking mode. The water pumps are not turned "on" for 20–30 seconds to allow the evaporator plate temperature to drop after the defrost sequence.

8. The breaker bar drive (if so equipped) and harvest screw conveyor (used to transport the ice to a TURBO® ice rake storage system or bagging line) continues to run for a short time interval after the icemaking cycle starts. This is done to:

   - Ensure that all ice has time to be purged from the icemaker and the entire conveyor system.

- Remove any ice that might drop late, due to a low defrost water temperature or other harvest cycle deficiencies.

Typical Shut-Down Sequence

Icemaker operation can be terminated in several ways. Normal shut-down is accomplished by either:

- Turning the master control switch to the "off" position which initiates a "pump down" cycle.
- Tripping any normally closed contact in series with the master control switch contact blocks.

  This can include:

  - a bin-o-matic
  - remote "on/off" switches
  - limit switches in remote ice storage bins or hoppers
  - process controls
  - time clocks
  - remote delivery equipment
  - remote safety interlocks.

Pump-Down

Pump-down consists of closing the liquid solenoid valve supplying refrigerant to the evaporator.

With the liquid solenoid valve closed, the refrigerant feed to the evaporator is stopped.

The refrigerant in the evaporator plates is pumped out of the plates into a refrigerant receiver (on air-cooled and evaporative-cooled models) or a combination condenser/receiver (on water-cooled models).

Pump-down allows storage of a majority of the refrigerant operating charge in the receiver. This minimizes the possibility of refrigerant migration to the compressor or slugging during start-up.

After a normal shut-down sequence is initiated, the following events occur:

1. Since the unit is continually building ice on the plates, this ice must be removed before the unit terminates operation.
2. After the signal from the master control switch (or bin level switch) to the programmable controller or electromechanical controls is terminated, the units continue to operate until the ice is removed from all evaporator plates.

CAUTION

Turning off the master control switch does not immediately stop operation of the compressor or unit. The master control switch should never be used as a service switch or service disconnect. Failure to carefully follow these instructions could result in damage to the equipment and serious injury to personnel.

3. As each section goes through a harvest sequence, the ice is removed and that section is removed from operation (i.e., the water pump remains off and ice production on that section is discontinued).
4. After the last section has completed defrost and ice has been removed from all of the evaporator plates, the liquid solenoid will close to begin the pump-down cycle.

WARNING

Operation of the unit continues until the breaker bar drive on the last section to defrost stops. This ensures that all ice is removed from the plates and is transported to a suitable storage location before the controls terminate operation. Do not attempt to service or access the unit until the compressors are off and the controls have been locked out. Failure to carefully these instructions could result in permanent injury or loss of life.

5. When the suction pressure drops below the setpoint of the low pressure safety cut-out switch, the switch opens a contact in the master control circuit and the compressor and unit operation stops.

Note:
See warning on the next page.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

WARNING

Icemakers are equipped with a continuous pump-down cycle and the compressor can restart automatically even if the master control switch is "off". Never attempt service of the compressor without locking out the electrical service. Failure to carefully follow these instructions could result in permanent injury or loss of life.

6. On most models, the compressors will automatically restart after a short delay to complete the pump-down cycle. It is not unusual for the compressor to restart two to three times to obtain and hold the pump-down cycle.

   Note:
   If the compressor restarts more than two to three times or restarts rapidly after each pump-down, the liquid solenoid should be checked for:

   - The manual operator in the open position, preventing the solenoid valve from closing.
   - A defective liquid solenoid valve that is allowing refrigerant to leak by in the closed position.

7. If the suction (evaporator) pressure rises on models with electromechanical controls, it will restart the compressor regardless of how long it has been since the unit was shut-off.

   - On models with programmable controllers, the pump-down sequence can occur only for a preset number of times (usually three (3) times), after which the programmable controller locks out the compressor.

   After three resets, the compressor will not restart to maintain pump-down. However, the programmable controller does periodically monitor the status of the low pressure switch. If the low pressure switch has been reset (pressure rises), the compressor goes through one pump-down sequence.

   Note:
   On models with programmable controllers, the program is set to allow only three (3) compressor restarts in a fifteen minute time span. This is to prevent short cycling of the compressor. Short cycling could result in excessive wear or damage to the compressor.

8. After the compressor is off, a compressor interlock closes to turn on the compressor crankcase heater to keep the oil in the crankcase warm.

IMPORTANT

The crankcase heater and compressor interlock should be periodically checked for proper operation. The absence of heat in the compressor crankcase prevents the "boil-off" of any refrigerant in the crankcase at the termination of operation. Migration of refrigerant to the compressor can result in the absence of a source of heat. Either case can result in "liquid slugging" of the compressor upon restart.

Extended Shut Off

If the equipment is to be shut off for extended time periods (more than 48 hours):

- Close the hand valve in the water make-up line to prevent loss of water through the tank overflow drain.
- Close the isolation valve ("king" valve) on the outlet of the receiver or combination condenser/ receiver.
- Turn off the three-phase electrical power to the compressor(s), water pump(s), and harvest screw motors (disconnect or circuit breakers furnished by others).

- Do not turn off the single phase control circuit power. This turns off power to the compressor crankcase heater and optional winterizing equipment (if furnished).

IMPORTANT

If the control circuit power has been turned off, it should be turned on for a minimum of twenty-four (24) hours prior to use. This is to ensure that any liquid refrigerant that migrates to the compressor crankcase is eliminated prior to start-up. Failure to follow these instructions could result in failure or damage to the compressor.

Typical Water System

Make-Up Water Circuit (Defrost)

Icemakers are provided with a make-up water connection on the cabinet exterior. A water strainer is shipped loose for external installation. The internal piping consists of:

- Water solenoid valve (s)
- Flow control valve(s)
- A make-up water header with PVC make-up tubes connected to it
- A return water trough
- A water tank.

Figure 4-5 shows a typical water make-up circuit for each evaporator section in the icemaker.

In this arrangement, fresh water from a city water supply, RO system, or other water treatment system enters through the water strainer connected to the icemaker. Water proceeds through the flow control valve when the water solenoid valve (WS) is opened during defrost. As the water flows through the defrost water header, the following occurs:

1. Water is distributed between each set of evaporator plates by the PVC defrost water tubes.
2. Water flows down the entire interior surface of both plates resulting in a warming of the plates. This results in a pressure increase and heat transfer through the refrigerant inside the plates to the surface on which the ice is formed.
3. As the water leaves the bottom of the plate, it is collected by a water trough that routes it back to the water tank.
4. The water flow rate is controlled by adjusting the manual flow control valve to obtain the minimum flow required to produce a full flow from the water defrost tubes over the plates.
   - Low flow (too much throttling) will result in the flow leaving the tubes wicking and not reaching the evaporator plate. It will still be collected by the water trough, but defrost will not occur since the water is not flowing over the plates.

   The flow control valve is opened until adequate flow is obtained over the entire back side of the plate.

   - High flow (valve open too much) will result in splashing and excessive loss of water through the blowdown line. Higher flow over the plates cannot be used to compensate for low temperature make-up water. Low make-up water temperature will require extended defrost time and, as a result, reduce ice production.

   Note:
   Minimum 15 psig pressure is required at the make-up connection and 70°F water is required.
5. Make-up water continues to flow into the water tank to refill it.

   Remember:
   The water level is lowered during the icemaking cycle.
6. When the water level reaches the top of the stand-pipe located in the water tank, it begins to overflow. This is called blowdown and is required to prevent the concentration of solids and other impurities found in the water.

Note:
The icemaking process will concentrate or "freeze out" the solids in the water circulated over the evaporator plates. The solids collect in the water. The solids must be removed to prevent them from settling in the bottom of the tank where they are picked up by the circulation water pump suction. If allowed to remain in the tank, these solids will eventually cause the ice to become white and rubbery.

7. Overflow water carries the suspended solids and impurities from the tank to the drain. Due to variations in water quality, blowdown rates can be varied:

   - Through the flow control valve.
   - By adjustment of the defrost time: use the shortest time that is reliable to reduce blowdown; extend the time to increase blowdown.

     Note:
     Extended defrost time will reduce ice production.

   - By modifying the standpipe in the water tank. Consult factory for details.

8. At the conclusion of defrost, the defrost water solenoid closes to terminate water flow to the tank.

9. The water tank should be full to the top of the standpipe.

   - For a typical system using 70°F make-up water and standard defrost time, the water in the tank will be approximately 45–50°F. This is a result of mixing with the 32°F water in the tank at the start of defrost and the chilling effect of the water flowing over the evaporator plate at 0°F (i.e., heat is transferred from the water to the plate and refrigerant in the plate; the water temperature of the make-up water is in turn pre-chilled).

Note:
Using high defrost water (above 85°F) to obtain a "faster" defrost will reduce ice production. The temperature of the water in the tank at the end of the defrost will be higher than 45–50°F. This requires more time to chill down the water to 32°F.

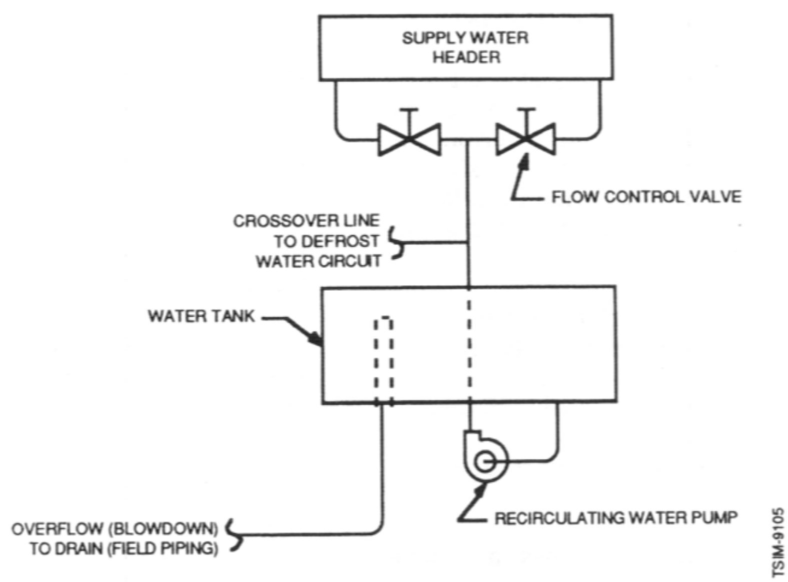


Figure 4-6 Circulating Water Piping

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Circulating Water Circuit (Icemaking)

The circulating water circuit consists of:

- A recirculating water pump
- A water tank
- A supply water header with PVC supply water tubes connected to it
- A set of flow control valves.

Figure 4-6 shows a typical circulating water circuit for each evaporator section in the icemaker.

In this arrangement (after the water tank is refilled during the defrost cycle or is filled manually during initial start-up), the following sequence occurs:

1. The circulating water pump is turned on to circulate water through the flow control valves, supply water header, and supply water tubes over the outer surface of the evaporator plates.

2. Manual flow control valves are provided at the inlet to the supply water header to allow the flow to be adjusted until the entire outer surface of the plate is covered without splashing.

   – High flow rates will produce excessive splashing which will not be collected by the return water trough. This results in excessive water loss and wetting of the ice slide below the plates.

   – Low flow will result in a wicking of the water leaving the supply water tubes, resulting in erratic water flow.

   – The flow control valves should be adjusted (from the closed position) until an adequate flow is observed from the tubes to the plate surface over the entire length of the evaporator plate outer surface.

3. As the water is circulated over the plate, a layer of ice is continually formed. Thickness of the ice sheet is controlled by the cycle time.

4. Since the water is recirculated only (i.e., no make-up water is added during icemaking), the water level in the tank gradually drops as the ice thickness on the plates increases.

5. This process occurs until the defrost cycle is initiated to remove the ice.

6. The circulating water pump is shut off prior to the defrost cycle to allow the ice to dry before harvest. This is called the drying cycle.

Crossover Water Piping

Figures 4-5 and 4-6 show crossover water piping between the supply and defrost water circuit. During normal icemaker operation, the crossover valve is closed.

Water System Cleaning

Thorough cleaning of the water system is required periodically. This includes the:

- Evaporator plates
- Water piping
- Supply and defrost water headers
- Defrost water tubes
- Supply water tubes

Use the following procedure:

1. Drain the water tank and remove any sediment in the bottom of the tank.

   Note:
   To drain the water from the circulating water tank, the PVC standpipe is removed.

   – On older models (prior to 1986), the stand-pipe is threaded. Two (2) slots are provided on the top of the standpipe to allow a flat bar to be used to unseat the standpipe and screw it out.

   – Newer models have a groove and O-ring arrangement on the bottom of the standpipe. To remove the standpipe, simply wiggle the standpipe back and forth while pulling up.

2. Replace standpipe and refill the tank with fresh water and a dilute acid (typically muriatic acid). Refer to guidelines on the acid container for relative concentrations and circulation time.

3. Open the crossover valve between the supply and defrost water circuits.

4. Turn the wash cycle switch (WCS) on the control panel door "on" to turn on the circulating pump.

5. With the crossover valve open, circulate the acid solution through both the supply and defrost water circuits for the time specified on the acid container directions.

   Note:
   Mild muriatic acid solutions (less than 10–15% by volume with water) can be circulated for up to twenty-four (24) hours without damage to the PVC tubing or other water piping. Acid for icemaker cleaning must be mixed per instructions on the acid container.

6. Remove the standpipe to drain the acid and flush the bottom of the tank.

7. Replace the standpipe and refill the tank.

8. Circulate the water for approximately thirty (30) minutes and then drain.

9. Wash down all exterior areas that could be affected from splashing (with the cleaning agent) during the cleaning process.

10. Replace the standpipe.

11. Refill the tank.

12. Close the crossover valve.

13. The unit is now ready for normal use.

Circulating Water Pump Connection

An open impeller centrifugal pump is connected to the bottom of the water tank. One pump is used on each tank.

Pan Drains

A steel drip pan is installed in the frame of all TURBO® icemakers to collect water or condensate that is formed inside the evaporator compartment under the ice slide.

This pan is typically supplied with two or more 1 1/4" drain connections located on each end of the unit and/or the bottom of the pan. These drains are plugged when the units are shipped. Select the drain connection best suited for your installation or connect all the connections to a common line that is routed to a suitable sewer drain.

Optional Dump Valve Connection

On units furnished with the optional dump valve, the connection is located in a PVC tee installed in the circulating pump suction line (between the water tank outlet and the pump suction inlet). The dump valve is opened during the drying cycle to drain the water and concentrated solid remaining in the tank at the end of the refrigeration cycle.

Refrigeration Components

The refrigeration components include the low side (evaporator plates) and the high side (condensing unit). All TURBO® icemakers include the following components:

- Compressors (1 or 2)
  - Small (10 tons or less) semi-hermetic refrigerant-cooled compressor
  - Large (15 tons or more) open-reciprocating compressor direct coupled to an open drip-proof motor
- Discharge line check valve
- Condenser
  - SC models - water-cooled condensers (options: cooling tower and cooling tower pump)

  - SCA models - air-cooled condenser with separate receiver (SCAR models: only receiver is furnished)
  - SCE models - evaporative condenser with separate receiver (SCER models: only receiver is furnished)
- Head pressure controls
  - SC model - two-way pressure actuated water regulating valves
  - SCA & SCAR models - flood-back controls
  - SCE & SCER models - dampers with modulating control
- Filter/drier
- Liquid solenoid valve
- Sight glass (liquid/ moisture indicator)
- Thermal expansion valve (TXV)
- Refrigerant distributor with orifice
- Distributor tubes
- Evaporator plate assemblies
- Small machines (continuous run):
  - Auxiliary liquid solenoid valve
  - Auxiliary thermal expansion valve
  - Hot gas solenoid valve
  - Suction pressure regulator
- Small machines (without continuous run):
  - Compressor stops during defrost
  - Valves and controls to build back pressure in evaporator are not required
- Large machines (continuous run):
  - Gas powered check valve (suction)
  - Pilot solenoid valve to actuate gas powered check valve
  - Bypass pressure regulator to control evaporator pressure during defrost
- Suction accumulator/heat exchanger

Note:
R-models are not supplied with a condensing unit.

Purpose Of Each Component

Compressor

All types of compressors compress the return gas from the evaporator and pump it to a condenser where the heat of compression and evaporator load are rejected.

Semi-Hermetic
Semi-hermetic models are cooled by the return suction gas. The refrigerant actually flows over the motor winding. The motor heat is rejected to the refrigerant. An internal oil pump is used for lubricating the compressor.

Note:
Motor failures can contaminate the oil and refrigerant system. Motor failures require replacement of the compressor.

Open-Reciprocating
Open-reciprocating compressors are direct coupled to an open drip-proof motor. Compressor cooling is provided by the return suction gas and a water-cooled oil cooler. Motor heat is rejected to the surrounding ambient. An integral oil pump is used to lubricate the compressor.

Notes:

1. Motor failures do not contaminate the system oil or refrigerant, and the motor can be replaced without replacing the compressor.
2. Alignment of the motor/ compressor assembly is required.
3. On larger models and multiple units, screw compressors are available. Consult the factory for details.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Discharge Line Check Valve

An inline spring actuated check valve is installed in the compressor discharge line. The primary purpose of this valve is to prevent the migration of refrigerant to the compressor when the unit is off.

Condenser

Since high pressure gas is discharged from the compressor, some means must be provided for condensing this gas to a liquid that can be used to feed the evaporator plate.

Water-Cooled Condenser

A shell and tube condenser consists of a vessel with a tube bundle mounted inside. The discharge gas is circulated through the shell of the condenser where it comes in contact with the tube bundle. Water is circulated through the tubes to remove the heat from the discharge gas. As the gas cools, it changes to a liquid which is stored in the bottom of the condenser. The condenser is also used as a receiver during pump-down.

All condensers are supplied with a 300 or 350 psig non-reseating atmospheric relief valve.

Each condenser has a discharge inlet and liquid outlet located on the shell. Water inlet/outlet connections are located in the condenser head. All condenser heads can be removed for field cleaning.

Standard design parameters for the total heat of rejection (based on 20°F evaporator following defrost cycle and for initial pull-down) are:

- 85°F water "in" condenser
- 95°F water "out" condenser
- 105°F saturated condensing temperature (SCT), 210 psig

Cooling tower heat rejection and cooling tower pump flow rates must be sized to obtain the above conditions or lower to make rated capacity. The standard wet bulb temperature for optional cooling towers supplied by TURBO is 78°F.

Cooling Tower

For water-cooled units, a separate cooling tower is required to reject the heat removed from the water circulated through the condenser. Cooling towers can be furnished as an option. A cooling tower consists of a:

- Sump
- Circulating water pump
- Make-up water connection
- Spray water system
- Internal fiber fill

Water is pumped from the cooling tower sump to the condenser inlet. Return water from the condenser is routed to a spray header on top of the cooling tower. The water is distributed over a fiber fill inside the tower. The water is drained to the bottom of the sump after it works it's way through the fill material. Air is drawn through the fiber fill by a fan(s) to remove the heat from the water. The water evaporation and airflow through the tower fill material are used to remove the heat from the water in the same manner as an evaporative condenser.

Make-up water is fed to the tower automatically through a float valve, located in the cooling tower sump. This is required to make up for the water lost through evaporation during normal operation.

A blowdown line is also provided to prevent the concentration of solids and minerals (as a result of the evaporation process). This is required to prevent fouling the fill material in the cooling tower and in the tower sump.

The cooling tower pump runs continually during operation to prevent the concentration of solids and minerals, due to repeated wetting and drying of the fill material. Fan cycling is typically used to control the water temperature in the sump.

Standard design parameters for cooling towers are based on rejecting the total heat of rejection of the evaporator and heat of the compressor based on a 20°F saturated evaporative temperature (SET) at 105°F at 78°F wet bulb.

Note:
Other wet bulb design temperatures can be provided to reduce the cooling tower size in areas with lower wet bulbs. Geographic areas with higher wet bulbs can either run higher condensing pressures or select a larger cooling tower based on the actual design wet bulb in order to maintain the standard 105°F SCT. Larger cooling towers that allow lower saturated condensing temperatures can also be provided to provide lower operating costs and higher ice production.

Air-Cooled Condenser

Fin and tube condensers are used. Each condenser consists of a fin and tube (usually copper) condenser coil mounted in a galvanized housing suitable for outdoor installation. Belt driven or direct coupled fan(s) are mounted in Ventura openings above the coil to draw ambient air over the coil to remove heat from the higher temperature refrigerant.

Inlet and outlet headers are located on the front of the condenser. Due to the large surface area required for condensing, liquid is drained to a separate receiver during pump-down.

Standard design parameters for the total heat of rejection (based on 20°F evaporator temperature during defrost cycle and for initial pull-down) are:

- 100°F ambient (air entering coil)
- 120°F saturated condensing temperature (SCT), 250 psig

Evaporative-Condenser

A pipe coil through which the high pressure discharge gas passes is housed in a galvanized cabinet suitable for outdoor installation.

Water is pumped from a sump, located in the bottom of the condenser, to a spray header system that wets the entire pipe coil. At the same time, air is circulated over the pipe coil by fan(s) drawing air in through the fan section, located below the coil. This air is discharged through the draft eliminator, located at the top of the condenser housing.

The water pump is never cycled, preventing the coil from being repeatedly wetted and dried. Rapid fouling of the pipe coil occurs from the solids and minerals that are left on the coil surface after the water evaporates. Dampers are used to modulate the airflow over the pipe coil by constant speed fans.

The water evaporation and airflow over the coil are used to remove the heat from the discharge gas and to condense the gas to a liquid. The liquid is free drained from the condenser to a separate high pressure receiver, due to the large coil surface required to condense.

Make-up water is fed to the condenser automatically through a float valve located in the condenser sump. This is required to replace the water evaporated during normal condenser operation.

A blowdown valve and line is supplied on the condenser to continually release a small amount of water to a drain. This is required to prevent concentration of solids and minerals in the tank due to evaporation of the water on the coil. If these solids and contaminants are not removed, fouling of the pipe coil and spray headers will result. Fouling reduces heat transfer and results in higher discharge pressure and operating cost.

Standard design parameters for the total heat of rejection (based on 20°F evaporator during defrost and for initial pull-down) are:

- 78°F wet bulb
- 95°F saturated condensing temperature (SCT), 185 psig

IMPORTANT

As noted above, 20°F evaporator temperature should be used to determine the total heat of rejection for condenser sizing. This is to allow for the defrost load and initial pull-down (start-up with warm water in the tanks). Icemaker compressor selections are based on evaporator tons of refrigeration at 0°F saturated evaporator temperature (SET), 24 psig for R-22.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Receiver

Receivers are installed on SCA and SCE models and are supplied separately on SCAR and SCER models. The high pressure receiver is used to store the liquid during pump down and provide an adequate liquid supply during operation.

Head pressure controls result in a variation in the liquid level in the receiver. The flow-through type receiver provides a means of storing the various refrigerant levels. Liquid free drains from the condenser into a liquid inlet located on the top of the receiver. A liquid outlet (often referred to as the "king" valve) is typically located on the bottom. Some models use a dip tube which enters from the top of the receiver and extends to the bottom of the receiver. The bottom of the dip tube is opened to allow liquid flow.

In order to maintain a liquid seal in the receiver, a 15–20% level in the receiver is required to ensure that the dip tube inlet is covered with liquid.

WARNING

Do not attempt to service the liquid level indicator without first removing all refrigerant and pressure from the receiver. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Receivers are sized to hold the entire refrigerant charge during pump down.

Note:
If a refrigerant level indicator is installed on the receiver, a reading of 100% indicates that the receiver is actually 80% full. The additional volume is required to allow changes in refrigerant volume without creating dangerous hydraulic pressure if the receiver is isolated (inlet and outlet valves closed).

Receivers should be located as far below the condenser outlet as possible. This is to ensure that sufficient head is available to overcome pressure drops through the condenser coil, isolation valves, etc. Valves should be located at the condenser inlet.

IMPORTANT

Condensers that can not free drain into the receiver will result in liquid being "stacked" in the condenser. This reduces the condenser active surface. Higher discharge pressure and operating costs will result.

Drain lines from the condenser outlet to the receiver inlet are sized for sewer flow and should be pitched down without traps in the line.

All high pressure receivers are provided with a non-reseating atmospheric safety relief device set to relieve at 300 or 350 psig.

Filter/Drier

The filter/drier installed in the refrigerant liquid line leaving the receiver or combination condenser/receiver has two purposes:

1. To filter solids or debris from the system to prevent them from entering the TXV and evaporator plates.

2. To remove moisture in the system.

TURBO® icemakers are evacuated at the factory before shipment to ensure a dry system. When the refrigerant system is opened for service, moisture could contaminate the refrigerant system.

Notes:

1. Moisture in a refrigerant system can result in the formation of acid as a result of contact with the refrigerant and/or other contaminants (copper shavings, etc.) in the system.

2. Moisture can affect evaporator performance by freezing at the inlet to the TXV or distributor orifices.

3. Water is also noncompressable and will cause damage to the compressor if present in the system.

Replaceable drier cores are typically changed out after the initial start-up (after approximately ten (10) hours of operation) and as required thereafter.

If the outlet connection of the filter/drier is cooler than the inlet, this is an indication of a pressure drop through the drier. Change the drier cores when this occurs.

Sight Glass (Moisture Indicator)

A combination liquid flow glass and moisture indicator is installed in the liquid line after the filter/drier. The sight glass has two purposes:

1. The refrigerant level in the sight glass can be observed to determine if sufficient liquid refrigerant is available to the thermal expansion valve inlet. A properly charged system will show a solid liquid flow through the sight glass. Bubbles in the sight glass indicate that the refrigerant level is low and refrigerant should be added until the sight glass "clears" of bubbles (i.e., no flashing).

   Note:
   The source of the refrigerant loss should be determined before replacing the refrigerant.

2. The moisture indicator in the center of the sight glass should be green, indicating a "dry" system (no moisture). If the indicator is yellow, the drier cores should be changed.

Thermal Expansion Valve (TXV)

Metering of refrigerant to the evaporator plates is controlled through a device consisting of the thermal expansion valve, an external equalizer line, and a power head with a remote sensing bulb. The remote sensing bulb is mounted on the suction line to sense the temperature of the refrigerant gas leaving the evaporator.

TURBO® evaporators require the use of an external equalizer line to compensate for the pressure drop through the evaporator plates thus allowing for a true reading of the saturated evaporator pressure at the evaporator outlet.

A gas charged sensing bulb transmits a pressure to the power head of the TXV in response to increases or decreases in suction temperature. As the suction temperature decreases, the corresponding refrigerant pressure also decreases, producing a lower pressure at the power head. This pressure is opposed by the evaporator pressure, and the superheat spring in the TXV.

As the temperature/pressure decreases at the outlet of the evaporator, the pressure exerted by the evaporator (plus spring pressure) is now less than the decreasing outlet pressure and the TXV closes to reduce refrigerant flow to the evaporator.

If the temperature/pressure increases at the evaporator outlet, the superheat of the suction gas is higher, indicating that the refrigerant feed is low. In this case, as the temperature/pressure increases, the pressure in the sensing bulb increases thus exerting a greater force on the power head. This increase in pressure drives the diaphragm down applying force to the push rods causing the TXV to open and feed additional refrigerant to the evaporator.

As the suction gas superheat (temperature) increases, the TXV opens to supply more refrigerant and as the superheat drops, the TXV throttles the refrigerant flow to prevent the evaporator from flooding.

Superheat is defined as the difference in the actual temperature leaving the evaporator and the saturated temperature of the suction gas at the measured evaporator pressure. For example, a typical TURBO® icemaker operates at a 24 psig evaporator pressure which corresponds to a saturated temperature of 0°F. If the temperature of the suction line from the evaporator at the location of the TXV sensing bulb is measured at 5°F, the superheat would be 5°F.

Typical TURBO® icemakers should operate between 5-8°F. Too high a superheat setting will result in reduced evaporator capacity and possible overheating of the com-

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

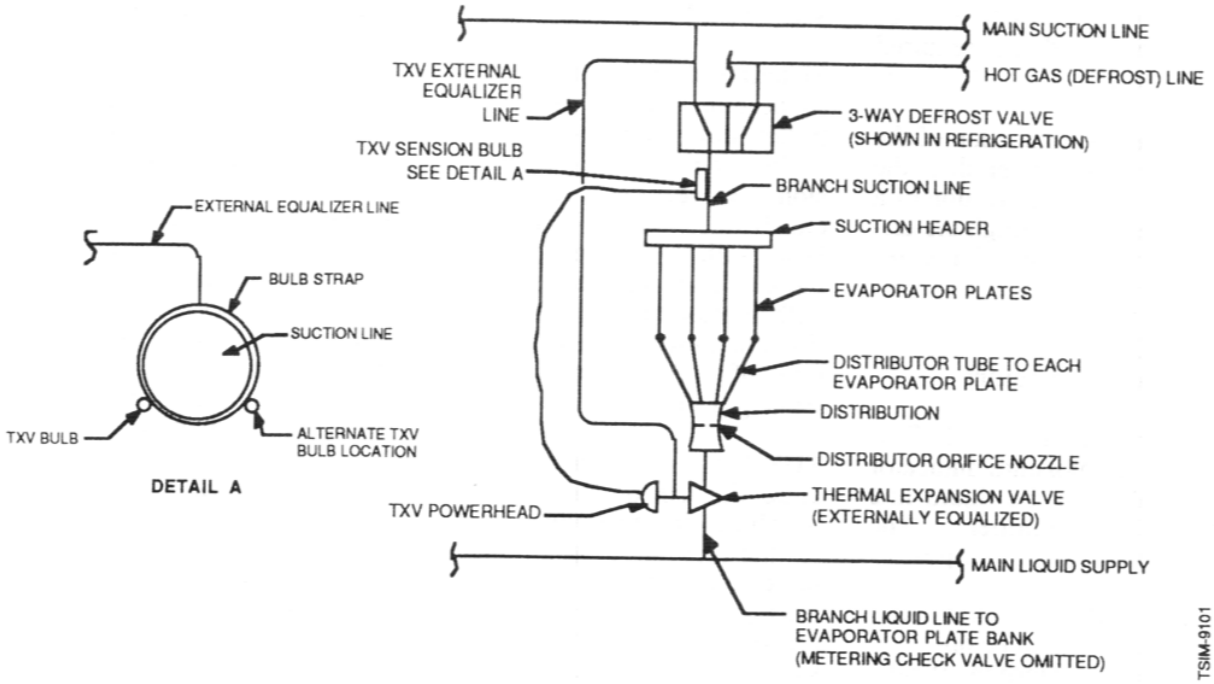


Figure 4-7 Thermal Expansion Valve Installation

pressor or suction cooled compressor. A low setting may result in an overfeed of refrigerant which could result in compressor damage as a result of liquid carryover.

IMPORTANT

TXV superheat adjustments should be made by a qualified refrigeration technician or engineer. Improper adjustment of superheat can result in overfeed of the evaporator causing liquid slugging of the compressor. Liquid slugging will cause damage and/or failure to the compressor.

The TXV sensing bulb must be firmly strapped to the suction line in the 4 or 8 o'clock position to ensure proper sensing of the evaporator suction gas. Emory paper should be used to clean the area the bulb is to be mounted on to ensure proper contact with the surface. Refer to Figure 4-7 for TXV installation.

Figure 4-7 shows the installation of the external equalizer line and sensing bulb. The TXV also requires the use of a refrigerant distributor and distributor tubes to properly distribute the liquid feed of the TXV to each plate.

Distributor

A refrigerant distributor is installed on the outlet of the TXV valve. The distributor consists of an orifice nozzle and multiple outlet for connection to each evaporator plate. For each evaporator, an orifice nozzle is selected to match the load and operating parameters of the system. A distributor has two purposes:

1. To reduce the pressure of the liquid refrigerant, thereby reducing the refrigerant temperature.

2. To provide uniform refrigerant feed to all the distributor outlet openings.

Distributor Tubes

Refrigerant is fed into the outlet of the refrigerant distributor and into an individual tube for each evaporator plate. The OD and length of the distributor tube is selected for each evaporator section to provide a uniform balanced flow to each plate. In addition, the pressure drop through the distributor tube is used to drop the liquid refrigerant pressure to the final evaporator pressure and corresponding evaporator temperature.

The TXV, distributor, and distributor tubes operate together to produce the valve capacity and refrigerant distribution required.

Note:
For the rated capacity of the thermal expansion valve to be obtained, the inlet to the TXV (or TEV) must have a solid liquid flow. Flash gas or bubbles in the liquid line will reduce the TXV capacity and cause erratic operation.

Evaporator Plates

The heat transfer surface on which the ice is produced is constructed entirely of corrosion resistant stainless steel. Each plate has an outer and inner surface as shown in Figure 4-8.

Ice is formed on the outer surface at a design evaporator temperature of 0°F. Defrost water flows over the inner surface to harvest the ice on the outer surface.

Two evaporator plates are assembled together along with a water return trough to form a plate and trough assembly. An icemaking section consists of several plate and trough assemblies mounted on a common evaporator mounting rail. For example, a 20 ton CF40 model will consist of 40 plates divided into two 20 plate sections. Each 20 plate section contain 10 plate and trough assemblies.

Significant Variations

The most significant variation in terms of refrigeration components and operation is found in the suction piping from the evaporator outlet to the suction accumulator/heat exchanger inlet.

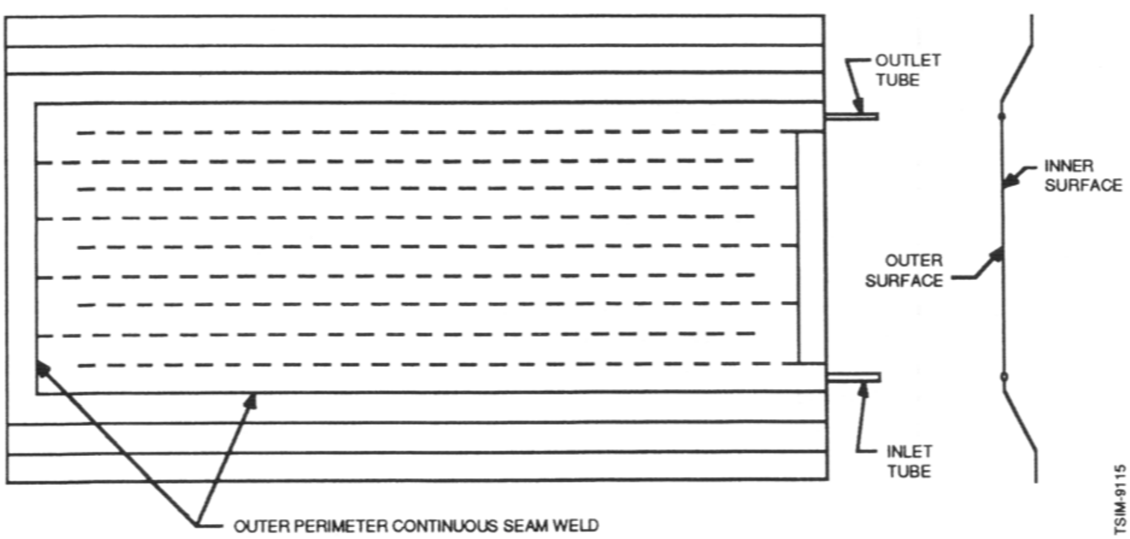


Figure 4-8 Typical Evaporator Plate

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Hot Gas Assist

TURBO® icemakers have hot gas "assist" rather than hot gas defrost.

As fresh water is introduced for the defrost cycle, it gives up heat as it flows across the evaporator plates. This raises the temperature of the plates to harvest the ice and also cools the water. The load on the compressor required to cool the water for icemaking is thus lessened.

The make-up water must be at least 70°F. In some instances, this might require the use of a hot water heater and blending valve or the installation of a preheater. This can best be done when manufactured or if necessary, field installed.

On double drop R-22 units, a certain amount of hot gas is already used to close the CK-2 check valves. The excess is piped to the suction header, assists in the defrost, and raises the evaporator temperature.

Enough hot gas is introduced during defrost to aid in ice harvesting and to keep the compressor on line. This process prolongs compressor life and reduces the start-up load imposed every time the compressor starts up. This reduces the amp draw and the electrical operation cost as well.

Hot gas introduction is controlled by the RD timer switches, which open an electric solenoid valve. On small icemakers, hot gas is introduced into the suction header. Large icemakers are regulated by a bypass regulator in parallel with the gas powered check in the suction line from the evaporator to the compressor. The regulator valves are adjustable to maintain the needed evaporator pressure during defrost.

Small Machines (without continuous run)

Icemakers of ten (10) or less tons of ice per day were for many years manufactured to cycle the compressor off during defrost. With the compressor off and warm defrost water flowing over the inner evaporator plate surface, the evaporator pressure quickly rises in the evaporator plates and the ice drops off. Since the compressor is off and the system pressure rises, the entire icemaker is harvested at once. Therefore, this method was limited to small, single section units.

In this configuration, no suction isolation valves or pressure bypass valves are required and the suction outlet piping is connected directly to the inlet of the suction accumulator/heat exchanger.

Small Machines (continuous run)

On later model icemakers, features were added to the suction piping to allow harvest without turning the compressor off. Such a configuration reduces wear on the compressor and compressor electrical switch gear due to repeated starts and stops.

For continuous run small icemakers, an auxiliary liquid solenoid valve, an auxiliary thermal expansion valve, a hot gas solenoid valve, and a suction pressure regulator are added to the system.

Hot Gas Solenoid Valve (HG or HGS)

A line is connected from the discharge line to the suction header of the evaporator section through a solenoid valve. During defrost, the solenoid valve is energized (opened) to introduce hot gas into the suction header.

The solenoid valve consists of a valve, a coil, and a manual operator to allow the solenoid valve to be opened without electrically energizing the coil.

Introduction of hot gas helps raise the pressure and temperature of the evaporator and creates a load to allow the compressor to continue to run during defrost.

Since the discharge gas introduced is superheated, an auxiliary TXV is used to desuperheat the suction/hot gas before it returns to the compressor.

Auxiliary Liquid Solenoid Valve (ALS)

During defrost, the main liquid solenoid remains energized. Without the evaporator load, the compressor must either be shut off or a bypass load created. An auxiliary liquid solenoid valve is opened when the defrost cycle starts to bypass liquid to the suction header where it is used to de-superheat the hot gas introduced by the hot gas solenoid valve.

Auxiliary Thermal Expansion Valve

Metering of the liquid to the suction header is controlled by a thermal expansion valve (TXV) located in the liquid line after the auxiliary solenoid valve. The TXV is the same type (usually with less capacity) as the main TXV used for icemaking.

Since the TXV is used to de-superheat the refrigerant gas returning to the compressor, it is adjusted to feed enough refrigerant to maintain approximately a 40°F evaporator temperature to the compressor. Overfeed produces a liquid carryover to the compressor. Underfeed results in excessive return gas temperature that can affect the compressor which is cooled by the return suction gas.

On the small icemaker with continuous run, the following occurs:

- Main liquid solenoid valve remains open
- Auxiliary liquid solenoid valve opens
- Hot gas solenoid valve opens
- Auxiliary TXV modulates
- Compressor is on

The false load created by the hot gas bypass, in addition to the defrost load, allows the compressor to continue to run during the defrost cycle. All evaporator plates are harvested at the same time.

Large Machines (continuous run)

On multiple evaporator section models, all of the evaporator plates are not harvested at the same time. Each section is harvested individually.

For example, a CF40 has two 20 ton ice sections. During a defrost cycle, section one is harvested while section two continues to build ice. During this same defrost cycle, section two is harvested next while section one is building ice. Spacing defrosts will be discussed later. Since all of the evaporator plates are not harvested at the same time, the compressor always has a load to allow it to continue to run.

The section in defrost must be isolated from the common suction line in order to raise the pressure. Remember, the other section is still in icemaking and the compressor is trying to hold a 0°F evaporator temperature instead of the 40°F evaporator temperature required for defrost. If the section in defrost is not isolated, the evaporator temperature of both sections will rise. Although the section in icemaking will not harvest, it will cease to build ice because the evaporator temperature will be above 32°F.

To isolate the section in defrost, a gas powered check valve is used to close the branch suction line during defrost. Since a gas powered check valve is used, a source of high pressure is required to drive the valve closed during defrost.

Gas Powered Check Valve

The gas powered check valve is a full port valve that allows normal connection of the evaporator to the main suction during the icemaking cycle. High pressure introduced at the top overcomes the spring force on the bottom of the power piston and drives the piston to the closed position. Upon removal of the high pressure source, the spring force on the power piston drives the check to the full open position.

Note:
A small bleed hole is in the piston to allow equalizing across the piston when the high pressure source is eliminated.

Each gas powered check valve has a manual operator located on the bottom of the

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

valve to allow the valve to be manually closed. A check valve is located in the branch suction line of each section.

Suction Solenoid Valve (SS)

Large icemakers include a small solenoid valve that is used to introduce high pressure (hot gas) to the gas powered check valve. A small line (usually 1/4 or 3/8" O.D.) is connected to the discharge line. From the discharge line, it is connected to the inlet of the suction solenoid valve, and from the outlet of the suction solenoid valve to the inlet of the gas powered check valve.

Note:
A strainer is also installed at the inlet to the gas powered check valve. The hot gas connection is made to the strainer inlet.

During defrost, the suction solenoid valve opens (energizes) to drive the check valve closed, and closes (deenergizes) at the end of defrost to allow the check valve to open. This sequence will not occur without a continuous gas flow. A tee is located in the gas line after the SS. One branch goes to the check valve as described above. The other goes to the suction header where the check valve is attached. In addition to allowing a continuous flow for operation of the valve, the small amount of hot gas introduced assists in increasing the evaporator pressure required to achieve defrost.

IMPORTANT

The primary source of heat for defrost is 70°F defrost water. Without the required water pressure and temperature, the section will not harvest. The time can be changed (lengthened) in the absence of proper water temperature but the hot gas introduced into the suction header will not defrost the evaporator without excessive defrost time and subsequent reduction in capacity.

Check Valve (Suction Solenoid Line)

A check valve is located in the line from the outlet of the suction solenoid to the suction header. This check valve is used to prevent the migration of refrigerant from the evaporator plates to the hot gas line during the off cycle.

Note:
The suction solenoid valve will not act as a check valve in the reverse flow direction, thus allowing migration back to the discharge line.

An isolation valve is located in the line to allow service of the check valve and suction solenoid valve.

The above components allow isolation of the evaporator section in defrost. Since the suction line is closed and warm water is flowing over the plate's inner surface, pressure will begin to rise in the evaporator plate. Since only 40°F evaporator temperature is required for harvest of the ice, the pressure in the plates is relieved to the suction after 40°F (68.5 psig for R-22) is obtained.

Although higher pressure will not damage the evaporator plates, pressures above 70–75 psig and their corresponding saturated refrigerant temperatures result in additional heat input into the defrost water flowing over the evaporator plates, as well as the heat input into the evaporator plate material itself. This heat must be removed before icemaking can start after the defrost cycle is over.

Note:
High defrost water temperature has the same effect. Additional heat must be removed and ice production is reduced since additional time is required to pull the temperature down after defrost.

Bypass Regulator

To maintain the evaporator pressure at the desired setpoint, an upstream pressure regulator is installed parallel with the gas powered check valve. When the pressure in the evaporator section reaches the setpoint of the bypass regulator, it begins to open to maintain the pressure at the regulator setting (i.e., the regulator opens to reduce pressure and closes to increase pressure). The regulator modulates continuously to hold the pressure desired.

To increase the pressure setting, the stem located on top of the regulator is turned clockwise to increase the spring tension in the pilot assembly. This increase in spring tension means a higher pressure (force) is required to open the regulator. The control pressure is increased. To lower the control pressure, the adjusting stem is turned counterclockwise.

During defrost when the gas powered check valve is open, the bypass regulator remains closed.

Each evaporator section on large icemakers (15 ton and up) will include a gas powered check valve, a bypass regulator, and a suction solenoid valve. The above refrigerant component description for the suction outlet covers all standard versions of icemakers (B and C series).

Suction Accumulator/ Heat Exchanger

The main suction line leaving the evaporator valving is routed to a suction accumulator/heat exchanger. Liquid carryover from the evaporator section is collected in the shell of the accumulator to prevent liquid carryover and/or liquid slugging of the compressor.

Liquid carryover can result from a variety of causes, including:

- Incorrect superheat setting of the TXV
- Defective TXV (power head and/or internal parts wear)
- Loose TXV sensing bulb
- Loss of load – poor water flow over plates or loss of recirculating water pump.

As the liquid carryover accumulates, some means of removing the liquid must be provided since the vessel would eventually fill to capacity and liquid would begin to flow to the compressor suction. Therefore, the high pressure liquid line supplying liquid refrigerant to the TXV is connected to the vessel. A liquid coil is located inside the vessel, on or near the bottom. High pressure liquid enters the coil and as the liquid in the return suction gas separates (due to the low velocity in the accumulator shell), it drips or flows over the outside surface of the liquid coil and is evaporated. Only refrigerant gas returns to the compressor.

Two other features of the suction accumulator/heat exchanger:

1. A small weep hole in the bottom of the accumulator outlet tube is used to entrain the refrigerant oil that accumulates in the bottom of the separator.
2. The liquid entering the accumulator is subcooled by the suction gas and evaporation of the liquid on the outside surface of the heat exchanger coil. Under normal operating conditions, the liquid subcooling temperature difference between the liquid inlet and outlet should be 5–10°F. Excessive subcooling (above 15°F) or sweating of the liquid line leaving the accumulator indicates excessive liquid carryover and should be corrected to prevent compressor damage.

In general, suction inlet and outlet connections are located on the top of the accumulator shell. Liquid inlet and outlet connections are located at the bottom of one of the vessel heads. Suction accumulator/heat exchangers do not have removable heads since cleaning is not required.

Suction Accumulator/ Heat Exchanger Relief Valve

Pressure vessels above one cubic foot internal volume and greater than 6" in diameter require a safety relief valve. On suction accumulator/heat exchangers requiring such a device, a non-reseating, atmospheric relief valve is supplied. Since the relief is used on the low-side of the refrigeration system, a 250 psig factory set relief device is used. These non-reseating type relief devices must be replaced once they have tripped.

Electrical Components

Cam Timers

In electromechanical icemakers, cycling is controlled by a recycling cam timer. The cams make one revolution (cycle) every 20, 25, or 30 minutes depending on the gear rack being used. Each revolution of the cams is made up of two periods – a complete freezing cycle and a complete defrost or harvest cycle for each evaporator section.

Timer Adjustment

The cam switch arms fall into the recess (detent) portion of the cams for the defrost cycle and ride on the raised portion of the cam for the freezing cycle.

A total cycle is one complete revolution of the cam. The defrost cycle and the freezing cycle make up the total cycle. The shorter the defrost cycle, the longer the freezing cycle.

One of the factors that determines the length of the defrost cycle is the defrost water temperature. If the water temperature is 75°F, it will defrost in about 5% of the total cycle, leaving 95% for freezing. If the water temperature is 70°F, it may take 10% to 12% of the total cycle to defrost. Adjustment of the thermal expansion valve can also affect defrost time. This will be described later.

The thickness of ice may be varied by changing the total cycle time, which in turn requires resetting the defrost cycle. The total cycle is altered by changing the gear rack on the cam timer. The gear ratio between the timer motor and gear rack determines the rotating speed and therefore, the cam cycle time. Slower gear ratios produce a slower rotating speed and thicker ice. Faster gear ratios produce faster rotating speed and thinner ice. This may be accomplished by removing the 1/4" gear rack retaining screw, replacing the gear rack, and then replacing the screw.

Note:
A 1/4" open end wrench is required to change gear racks.

The defrost cycle may be adjusted from 2% to 50% of the total cycle. The defrost adjustment consists of loosening screw "A" on the face of the cam, rotating the moveable cam segment to the percent of defrost cycle desired, and then retightening the screw. Refer to Figure 4-9.

Single Drop Units

A single drop unit (1 to 10 ton) with electromechanical control will have three cams labeled TM1 through TM3. The functions of these cams are:

<u>TM1</u>
Operates refrigerant circuit in raised position. (RD)
Operates defrost water solenoid in detent position.

<u>TM2</u>
Operates breaker bar in detent position. (BB)

<u>TM3</u>
Operates water pump in raised position. (WP)

Double Drop Units

A double drop unit (14, 15 and 20 ton) with electromechanical control will have five cams labeled TM1 through TM5. The functions of these cams are:

<u>TM1</u>
Operates refrigerant on section #1 (left hand circuit) in raised position. (RD1)
Operates defrost water solenoid in detent position.

<u>TM2</u>
Operates breaker bar in dentent position. (BB)

<u>TM3</u>
Operates refrigerant on section #2 (right hand circuit) in raised position. (RD2)
Operates defrost water solenoid in detent position.

<u>TM4</u>
Operates water pump on section #1 (left hand section) in raised position. (WP1)

<u>TM5</u>
Operates section #2 (right hand) water pump. See TM4 above. (WP2)

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Four Drop Units

Units with four (4) icemaking sections will have two (2) compressors. Each compressor will have two (2) sections. Five (5) cams on the cam timer will control the compressor and two (2) icemaking sections as described under "Double Drop Units". Therefore, the cam timer will have ten (10) cams for the entire unit. Half of the unit (one compressor) can be operated without the other half. However, all cams will rotate even if the compressor is off.

A four drop unit (30 to 40 tons) with electromechanical control will have ten (10) cams labeled TM1 through TM10. The functions of these cams are:

TM1
Operates water pump motor (section #1). (WP1)

TM2
Operates refrigeration (section #1) in raised position.
Operates defrost water solenoid (section #1) in detent position. (RD1)

TM3
Operates water pump (section #2). (WP2)

TM4
Operates refrigeration (section #2) in raised position.
Operates defrost water solenoid (section #2) in detent position. (RD2)

TM5
Operates breaker bar (sections #1 and #2) in detent position. (BB1)

TM6
Operates breaker bar (sections #3 and #4) in detent position. (BB2)

TM7
Operates refrigeration (section #3) in raised position.
Operates defrost water solenoid (section #3) in detent position. (RD3)

TM8
Operates water pump motor (section #3). (WP3)

TM9
Operates (section #4) in raised position.
Operates defrost water solenoid (section #4) in detent position. (RD4)

TM10
Operates water pump motor (section #4). (WP4)

Notes:

1. Each section as described here includes two of the four evaporator sections. TM1 through TM5 controls the refrigeration defrost of both evaporator sections.
2. Before starting the unit, make sure that the liquid king valve, the compressor discharge valve, and the compressor suction valve are open because all TURBO® icemakers are shipped in a pumped down condition. All of the above valves are closed for shipping purposes.

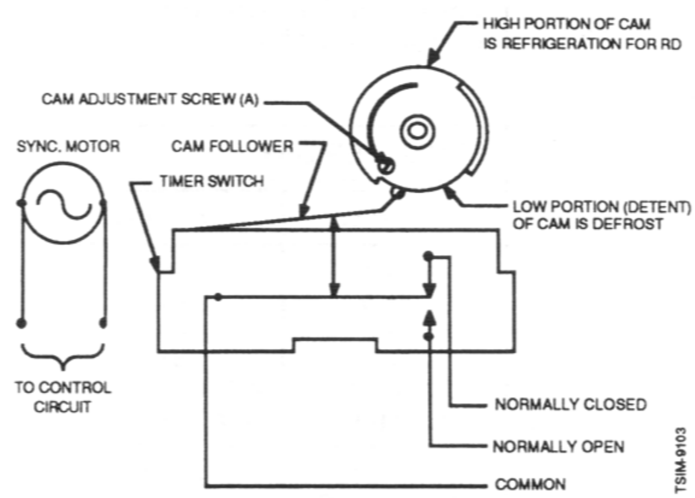


Figure 4-9 Typical Timer Wiring And Cam Configuration

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

IMPORTANT

1. **TM2, TM4, TM7, and TM9 operate defrost water solenoid valves while in the detent portion of the cam. No two of these four switches should be in the detent position at any one time.**
2. **Adjustments can be made to increase or decrease the length of the defrost and/or drying time of each section.**

When adjustments are made, be certain not to violate rules 1 and 2 above.

After the above settings are made on the refrigerant cycle cams, it will be necessary to adjust the breaker bar motor cam. The recessed portion of this cam is the only portion used and it should be adjusted so that the breaker bar motor starts approximately 10–20 seconds before the refrigerant cycle stops and defrost begins. The breaker bar motor should continue to run after the defrost cycle has been completed and the next refrigeration cycle starts.

The breaker bar must run long enough for all ice to clear the icemaker ice slide, discharge chute, and screw conveyors to the ice delivery point (TURBO® rake systems, etc.). This cam also ensures that the timer motor continues to run until the next refrigeration cycle starts (i.e., the RD cam returns to the refrigeration mode and the cam is not in detent). If the breaker bar stops before RD returns to refrigeration, the unit will stop.

CAUTION

When it is necessary to rotate the entire cam assembly manually, do not attempt to move the cams by pushing the cam periphery in either direction. There is a manual adjusting wheel on the extreme right hand side of each timer for this purpose. Failure to use the manual adjuster to turn the cams will result in misadjustment of the other cams on the shaft and the unit will not operate correctly. The cams are not locked to the driving shaft and therefore, must only be moved via the manual adjuster.

Refer to Figure 4-9.

Unless otherwise ordered, all icemakers are shipped with a 25 min (B15) gear rack installed. Initial cam setting of detent opening should be as follows:

1. All RD cams: 7.5%.
2. All WP cams: 7.5%.
3. All BB cams opened enough to allow the breaker bar to run at least 30–45 seconds after the last section has gone back into refrigeration.

Table 4-1 Gear Rack Selection For TURBO® MC-7 Cam Timer And Typical Ice Thickness

CYCLE PER DAY		
GEAR RACK #	60 CYCLE	50 CYCLE
A-14	41.1	35.1
A-12	48.0	41.0
B-15	57.6	49.2
B-12	72.0	61.9

GEAR RACK #	5 CYCLE TIME	ICE THICKNESS
A-14	35 MINUTES	3/4" - 13/16"
A-12	30 MINUTES	5/8" - 11/16"
B-15	25 MINUTES	1/2" - 5/8"
B-12	20 MINUTES	3/8" - 1/2"

BASED ON 0°F EVAPORATOR TEMPERATURE AND 70°F DEFROST WATER.

TSIM-9102

Timer Settings

Three Cam Timer

Proper timer adjustment is essential for trouble free operation of your TURBO® icemaker. Your timer should be adjusted as follows:

Cam #1 (RD)
First cam on left.
Set cam detent on 7.5%.

Cam #2 (BB)
Center cam.
Set cam detent on 7.5%.

Cam #3 (WP)
Left cam.
Set cam detent on 7.5%.

Refer to Table 4-1.

BB and WP cams should drop into detent at the same time and RD cam should drop into detent about 10–20 seconds later and stay in detent for at least ninety seconds. When WP goes into detent, the water pump stops to allow the water on the ice sheet to dry. This is referred to as the drying cycle. If all other adjustments are correct, this timer setting should be sufficient for a complete harvest.

Five Cam Timer

Cam #1 (RD1)
First cam from left.
Set cam detent on 7.5%.

Cam #2 (BB)
Second cam from left.
Set cam detent on 25%.

Cam #3 (RD2)
Third cam from left.
Set cam detent on 7.5%.

Cam #4 (WP1)
Fourth cam from left.
Set cam detent on 7.5%.

Cam #5 (WP2)
Fifth cam from left.
Set cam detent on 7.5%.

Refer to Table 4-1. BB and WP1 cams should drop into detent at the same time and RD1 should drop into detent about 10–20 seconds later (drying cycle) and stay in detent for ninety seconds. Approximately ten seconds later, WP2 should drop into detent and ten seconds later, RD2 should drop into detent and stay in detent for ninety seconds. BB time needs to stay in detent long enough to run the breaker bar to clear the ice out of the equipment.

Ten Cam Timer

Cam #1 (WP1)
Set detent on 7.5%.

Cam #2 (RD1)
Set detent on 7.5%.

Cam #3 (WP2)
Set detent on 7.5%.

Cam #4 (RD2)
Set detent on 7.5%.

Cam #5 (BB1)
Set detent on 24%.

Cam #6 (BB2)
Set detent on 24%.

Cam #7 (RD3)
Set detent on 7.5%.

Cam #8 (WP3)
Set detent on 7.5%.

Cam #9 (RD4)
Set detent on 7.5%.

Cam #10 (WP4)
Set detent on 7.5%.

Refer to Table 4-1. BB1 and WP1 should drop into detent at the same time. RD1 should drop into detent about 20–30 seconds later for ninety seconds. Ten seconds after RD1 completes defrost, WP2 should drop into detent. Ten to twenty seconds later, RD2 should drop into detent for ninety seconds to defrost section #2. Shortly before RD2 comes up out of detent, BB2 should drop into detent, so that for a brief time, both breakers bars will be on at the same time. Ten seconds after RD2 comes out of detent, WP3 should drop into detent. Ten to twenty seconds later, RD3 should drop into detent for ninety seconds. Ten seconds later, after RD3 completes defrost, WP4 should drop into detent to defrost section #4. Ten to twenty seconds later, RD4 should drop into detent for ninety seconds. BB2 should stay in detent long enough to clear all of the ice in the screw conveyor.

The cam opening (detent) may be adjusted by loosening the cam screw (A) and turning the moveable cam to the required degree of opening and then retightening the screw.

The switches used on the cam timer series are snap action, single pole-double throw totally enclosed microswitches. Each switch is marked normally open (N.O.), normally closed (N.C.), and common (C). These markings designate the condition of the switch in relation to the low or detent position of the cam. A circuit is completed between the C and the N.C. contact of the switch when the actuator arm is in detent. Therefore, by setting the cam opening at 10%, the contacts will be closed for 10% and opened for 90% of the total time cycle. By wiring the switch to either N.O. or N.C., the "on time" can be adjusted for a total of 2% to 98% of the total overall time cycle.

Checking Rotation

Make sure the crusher bar is clear of all obstacles and warn all personnel to stay clear of the crusher bar at all times.

The crusher bar should be rotating in a counterclockwise direction when viewed from the end with the ice discharge chute facing to the right. Refer to Figure 4-10. As long as the crusher bar is rotating in the proper direction and the incoming power wiring is properly phased, all other components will be rotating correctly due to the proper phasing of the internal wiring at the factory.

Adjusting The Water Flow

Place the timer at the beginning of the defrost cycle and allow water to flow into the machine. Observe the spray pattern from the defrost tubes to be sure that all of the tubes are being filled with water. Adjust the valve in the defrost water line to obtain the minimum flow necessary to completely wet the back of both evaporator plates (should be wetted entire length of active plate surface).

With the defrost water flow properly adjusted as described previously, the defrost cycle must be long enough to fill the water tank and result in some flow down the overflow or drain line (blow-down). If necessary, increase the defrost flow to obtain the desired blow-down. Some overflow is necessary to prevent the build-up of minerals in the tank water. The exact amount of overflow depends on the temperature and hardness of the make-up water and can be determined after observing the operation of the unit for several hours or in some cases, several days.

With the timer in the freezing position, adjust the water flow valve in the recirculating water line to provide maximum flow from all of the water tubes without splashing when the water strikes the top of the plates on the freezing side. Carefully note that all of the tubes are distributing water along their entire length.

Notes:

1. Defrost flow can be checked by manually opening the defrost water solenoid valve. The valve must be returned to automatic after the flow is set.
2. Recirculating water flow can be set by turning the WCS (wash cycle switch) "on" to start the water pump.

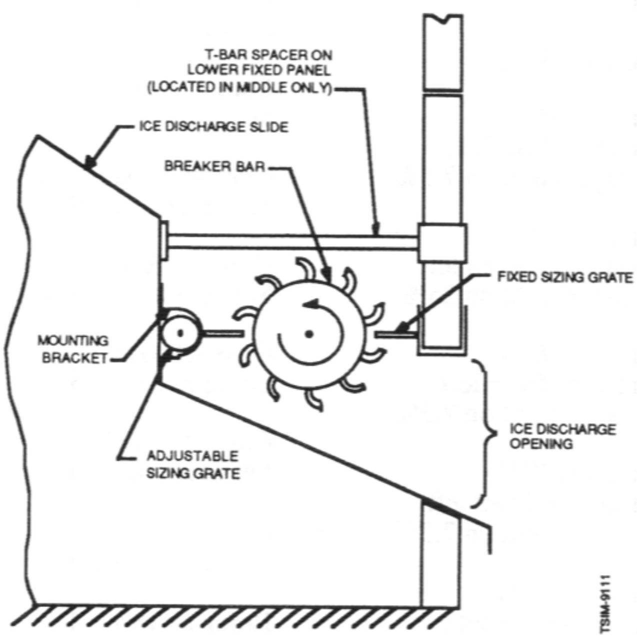


Figure 4-10 Typical Breaker Bar Arrangements

Freezing The First Ice And Adjusting The Defrost Cycle

Set the timer to the beginning of the freezing cycle and turn the unit "on". The first two cycles may not produce full capacity since it is necessary to cool down the interior of the freezing section and the water in the water tank. They should be observed in order to adjust the defrost cycle.

Initially, the defrost cycle should be factory set and not need adjusting. With this setting, observe if enough time is allowed to defrost all of the plates and drop the sheets of ice clear.

If all of the ice is dropping in this time, observe if the make-up water is filling the water tank with some overflowing down the drain line. If the water tank is not filling and draining some water, it is necessary to increase the defrost period or the defrost water flow. If the amount of overflow appears excessive, the defrost period can be reduced. It is best to start with too long a defrost period and make gradual small adjustments than to try too short a period, which will not give a complete defrost.

The defrost period should be set with the minimum contemplated make-up water temperature. If wide variations in make-up water temperature are experienced, due to seasonal changes, it is best to make seasonal adjustments of the defrost periods.

Sizing The Ice

The size of the ice fragments may be controlled by adjusting the cycle time to provide thinner or thicker ice. A sizing mechanism consisting of a fixed grate, an adjustable sizing grate, and a breaker bar are installed in the discharge of the icemaker.

Ice fragments ranging from "pea" sized small nuggets up to large nuggets can be obtained by adjusting the sizing grate. Figure 4-10 is typical for both high speed and slow speed breaker bar drives. Figure 4-11 represents the adjusting mechanism used on high speed breaker bar drives. Figure 4-12 shows the mechanism used on slow speed breaker bar drives.

As indicated above, two breaker bar drive speeds are available, high speed and slow speed.

High Speed Breaker Bar Drive

All icemakers are furnished (standard) with a high speed drive unless the optional slow speed drive is specified.

The high speed drive consists of an open drip-proof, 1800 rpm motor, a two-groove V-sheave on the breaker bar shaft extending from the breaker bar bearing, a two-groove sheave on the breaker bar drive motor, and two V-belts. An adjustable motor base is provided for the drive motor to allow adjustment and replacement of belts.

Note:
Belts should have a maximum deflection of one inch (1") when measured at the midpoint between the drive sheaves.

The nominal breaker bar speed for high speed drives is 750 revolutions per minute (rpm).

Selection for the high speed drive is based on the following factors:

- Requires less adjustment and maintenance.
- Belts protect the drive from damage – belts will slip in the event of momentary surging or bridging or a complete jam.
- Higher speed is less likely to jam due to the rapid discharge of the ice (less stacking of ice discharge slide).

High speed drives produce more snow and a smaller ice nugget due to the high speed and rapid discharge of the ice. Ice thickness is limited to 3/4" or less. For ice thicknesses greater than 3/4", slow speed drives and a heavy duty adjusting mechanism is required. Slippage due to momentary surges, jams, or loose belts results in excessive wear of belts.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

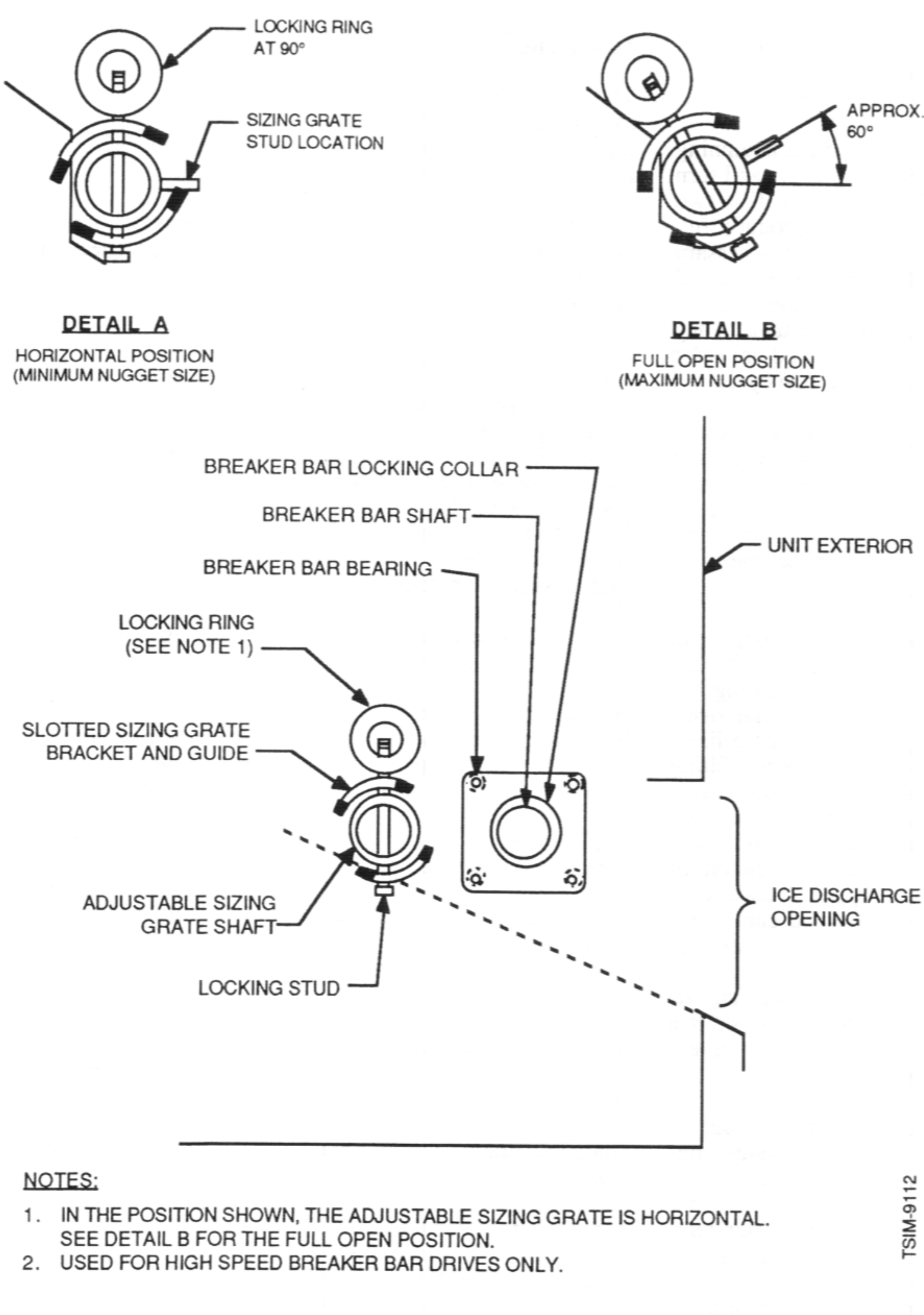
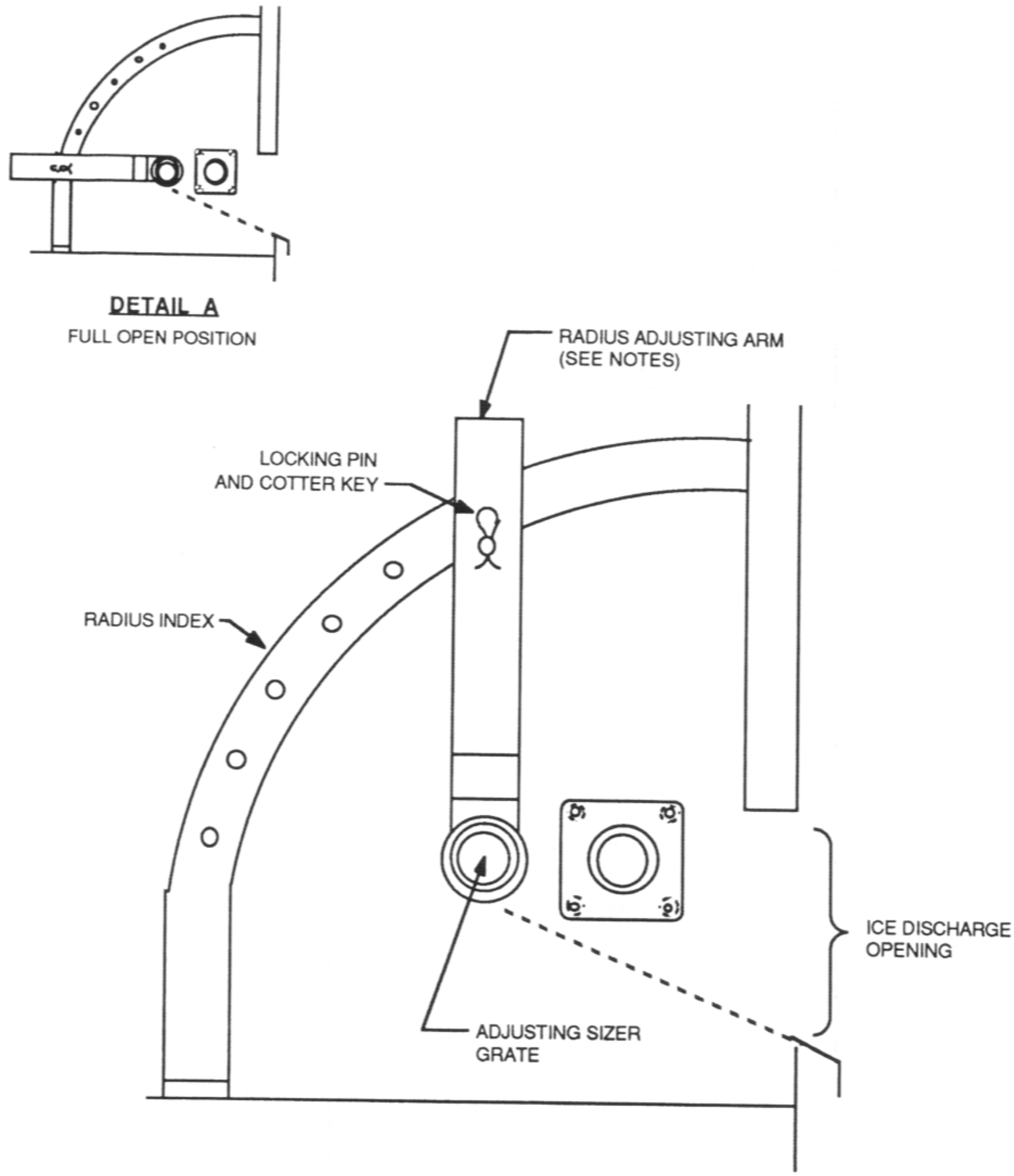


Figure 4-11 Adjustable Sizer Grate Adjustment Mechanism



NOTES:

1. SHOWN IN FULL CLOSED POSITION.
2. THE RADIUS ADJUSTING ARM IS TACK WELDED TO THE SHAFT OF THE SIZING GRATE.
3. STANDARD WITH SLOW SPEED BREAKER BAR DRIVE.

TSIM-9113

Figure 4-12 Heavy Duty Adjusting Mechanism

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

IMPORTANT

For ice thicknesses greater than 3/4", drive belts will break or become defective due to rapid wear. The standard lock ring adjustable sizing grate mechanism will also slip and cannot be used for these applications. A slow speed drive and a heavy-duty sizing grate mechanism are both required to obtain the proper operation.

Slow Speed Breaker Bar Drive

The optional slow speed breaker bar drive consists of a right angle single reduction gear motor, sprockets for the breaker bar drive shaft and gear motor output shaft, an adjustable motor base, and a drive chain.

The nominal speed for slow speed drives is 250 rpm and is required on icemakers making ice 3/4" thick or greater. The chain drive prevents drive slippage that would result with belt drives. Such slippage will result in periodic ice jams in the ice discharge opening.

Factors to consider in selecting the slow speed drive are:

- Produces less snow due to less impact force on ice.
- Produces a more uniform ice with the sizer grate setting.
- Less likely to jam due to momentary surges or jams.
- Can handle all ice thicknesses (up to one inch (1") maximum) and sizer grate settings.

Slow speed drives require:

- More maintenance.
- Frequent adjustment of the drive chain to prevent damage or breakage due to excessive chain slack.
- The chain will not slip if the ice discharge is jammed or a solid foreign object becomes lodged in the ice discharge (i.e., if the drive is totally stopped or jammed, the overload relays on the magnetic motor starter must trip to prevent breakage or damage to the chain and/or gear motor).

Once the breaker bar drive is selected, the ice sizing adjustment mechanism is selected.

Lock Ring Adjusting Mechanism

The lock ring adjusting mechanism shown in Figure 4-11 is used with the standard high speed breaker bar drive on small and large icemakers. Each breaker bar assembly has the adjusting mechanism.

Note:
All icemakers furnished with breaker bar drives have at least one breaker bar drive and adjustment assembly:

– 10 ton and less models - 1
– 15 and 20 ton models - 1
– 30 and 40 ton models - 2
– 60 ton models - 3

Only one locking mechanism is used per adjusting assembly. On the end of the adjusting sizing grate opposite the drive motor, an access cover is provided over an opening in the lower panel to allow access to the adjusting mechanism. The adjusting sizer grate on the breaker bar drive end is secured by a retaining collar that rotates freely (i.e., the opposite end does not use a locking collar that must be loosened to adjust the sizer grate).

To adjust the sizing grate, follow this procedure:

1. Turn the icemaker off and lock out the electrical power to ensure that the unit cannot start and is not in defrost.

WARNING

Before accessing the breaker bar drive or sizer adjustment, electrical power must be locked out. Failure to carefully follow these instructions could result in permanent injury or loss of life.

2. Remove the sizer adjustment access cover.
3. Loosen the locking ring on the locking collar enough to allow the mechanism to rotate.

4. To obtain small ice nuggets, rotate the adjusting ring towards the upright position (shown in Detail A of Figure 4-11). With the sizing grate studs horizontal, the only path for the ice flow is the narrow gap between the studs on the sizing grate and the breaker bar. With less clearance, the ice is broken into smaller fragments.

   Note:
   The horizontal sizer grate position produces pea sized ice and the most snow. It is typically not used on packaged ice applications but is used for top icing of produce, fish, etc.

   To obtain the maximum size ice fragment, rotate the sizing grate to the full open position (shown in Detail B of Figure 4-11). The maximum clearance between the sizing grate and breaker bar studs produce larger ice fragments and less snow.

   Adjust the sizing grate between the horizontal and full open position until the desired ice fragment size is obtained.

5. With the locking ring tight, turn the power on. If the desired nugget size is obtained, proceed to step 7.

6. Repeat steps 3 through 5 until the desired ice fragment size is obtained.

7. Make sure the locking ring is secure after the final adjustment is made.

8. Replace the sizer adjustment access cover.

9. Turn the electrical power on and resume normal operation.

Note:
After 24 hours of operation, it may be necessary to check the locking collar to ensure that it is still secure.

Heavy-Duty Adjusting Mechanism

On slow speed drives and applications where 3/4" or greater ice thickness is produced, a heavy-duty adjusting mechanism is used. This is typically used on 15 ton and up models only. Consult the factory for applications with small icemakers. Figure 4-12 shows a typical heavy-duty mechanism consisting of the radius arm and radius index.

Systems using the heavy-duty sizer adjustment have a locking ring mechanism to hold both ends of the sizer grate in place (only one is used on high speed drives).

To adjust the heavy-duty sizing grate, follow the same procedure just described.

WARNING

Before accessing the breaker bar drive or sizer adjustment, electrical power must be locked out. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Note:
On the heavy-duty mechanism, a cover is located on both ends to allow access to the radius arm and the locking rings.

Fixed Sizer Grate

To prevent ice fragments from falling through the space between the breaker bar and exterior panel of the unit (refer to Figure 4-10), a fixed sizer grate is attached to the bottom of the insulated fixed access panel. The studs and stud spacing are the same as the adjustable sizing grate to allow the breaker bar to rotate between the studs without interference.

Note:
If the fixed access panel is removed for service, the spacing of the fixed sizing grate and breaker bar studs must be checked to ensure free rotation without interference between the studs when the panel is replaced.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

WARNING

The breaker bar access panel and/or fixed access panel should never be removed without locking out the electrical power. Never use a stick or probe to clear ice or snow from the ice discharge without turning the unit off and locking out the electrical power. Failure to carefully follow these instructions could result in permanent injury or loss of life.

T-Bar Spacer

A T-bar spacer is mounted inside the ice slide and is attached to the fixed access panel and ice slide. This spacer is mounted at the midpoint of the ice discharge opening and is used to ensure that the panel does not bow in the middle. If the spacer is not properly installed, a gap and/or stud alignment may result in large fragments bypassing the breaker bar mechanism. Refer to Figure 4-10.

Ice Sizing Without The Breaker Bar

With the development of the TURBO® ice sizer, the breaker bar(s) can be deleted from the icemaker. The breaker bar, fixed sizing grate, adjustable sizing grate, and drive are either deleted at the time of manufacture or removed in the field. No change is required to the ice discharge opening or ice discharge transition between the icemaker discharge and screw conveyor.

The ice is fragmented to pieces the size of your hand by the screw conveyor itself and is conveyed in bulk directly to a single ice sizer or to an ice storage bin. Since the ice is discharged in large fragments, it is easy to handle and transport and less snow is produced. This means more ice in the bag for packaged ice applications.

Units without breaker bars have less maintenance because only one ice sizer and one starter for the ice sizer drive is required versus a drive and starter for each breaker bar (up to six in 60 ton models).

The ice sizer produces less snow and a uniform ice nugget.

Capacity Testing

Once the icemaker is properly adjusted and operating for two complete cycles, a simple test is performed to verify the tons of ice being produced. The following items are required:

- Yard stick or tape measure for immersion in the water tank.
- Thermometer or thermocouple for reading the make-up water temperature.
- Capacity test sheet.

The only other information required to calculate the capacity is the refrigeration/defrost time for a complete cycle. For units with electromechanical controls, this is determined by refering to the gear rack number used in the MC-7 timer to the gear rack chart provided. Refer to Table 4-1 on page 142. On units with programmable controllers, the icemaking cycle time is recorded on the controller ladder logic cover sheet. It can also be obtained by accessing counter C-601 and C-602 in the controller.

Cam Timer Cycle Time

All electromechanical icemakers are shipped from the factory with B-15 gear racks. Table 4-1 indicates a cycle time of 25 minutes or 57.6 cycles per day (60 hertz operation). The cycles per day are calculated as follows:

$$\frac{60\text{ min/hour}}{25\text{ min/cycle}} \times 24\text{ hours/day}$$

$$= 57.6\text{ cycles/day}$$

Programmable Controller Cycle Time

To determine the cycle times and number of cycles per day on a unit equipped with a programmable controller, refer to the controller ladder logic cover sheet furnished with the unit.

The cover sheet should list the refrigeration and defrost counters along with their presets.

Table 4-2 Water Temperature Correction Factors

WATER TEMP.	70	71	72	73	74	75	76	77	79
TCF	1.000	1.005	1.011	1.016	1.022	1.027	1.033	1.038	1.049

WATER TEMP.	80	81	82	83	84	85	86	87	88
TCF	1.055	1.060	1.066	1.071	1.077	1.082	1.088	1.093	1.098

TSIM-9106

Example:
A 20 ton unit with 2 drops per cycle:

C-601 refrig.	660 sec
C-602 defrost	90 sec
	750 sec

Since the unit has two sections, the cycle time is

750 seconds x 2 sections = 1500 seconds = 25 minutes

The number of cycles per day is calculated the same as the cam time:

$$\frac{60 \text{ min/hour}}{25 \text{ min/cycle}} \times 24 \text{ hours/day}$$

= 57.6 cycles/day

Water Temperature

The temperature of the water entering the icemaker during defrost is recorded to allow for correction of ice production due to water temperature variations.

Note:
The water temperature must be the specified 70°F for the entire defrost cycle to ensure proper defrost. If the temperature varies during defrost but stays above 70°F, a weighted temperature should be used for correcting the ice production. For example, if the water temperature is 79°F for the first 60 seconds of defrost and then drops to 70°F for the last 30 seconds, use 76°F for the correction:

$$\frac{(79)(60) + (70)(30)}{60 + 30} = 76°F$$

Make-Up Water Correction Factor (TCF)

Icemakers are rated on 70°F make-up water. If higher defrost water temperatures are used, additional refrigeration capacity is required to remove the additional heat in the make-up water (i.e., pull the water tank down to 32°F to begin icemaking). The correction factor for 70°F make-up water is 1.00. For 80°F make-up water, the ice capacity is reduced by the amount of refrigeration required to remove the additional 10°F of heat from the make-up water. The measured capacity has to be increased by this factor:

$$\frac{(80 - 32) + 144}{(70 - 32) + 144} = \frac{192}{182}$$

= 1.05495

where:

80°F	=	actual make-up water
32°F	=	freeze point of water
70°F	=	design make-up water
144	=	Btu/lb to convert water to ice

In the example above, the actual ice production is 5.495% less than the rated capacity at 70°F due to the higher water temperature. In the example, a 10 ton icemaker would produce 9.5 tons with 80°F defrost water.

Refer to Table 4-2 for correction factors.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Table 4-3 Icemaker Water Consumption (Icemaking Capacity)

ICEMAKER MODEL (TONS)	TANK NUMBER	NUMBER OF TANKS	NUMBER OF SECTIONS	TANK LENGTH (IN)	TANK WIDTH (IN)	OVERFLOW PIPE QTY - DIA (IN) TOT AREA (IN2)	WATER PIPE QTY - DIA (IN) TOT AREA (IN2)	NET AREA (IN2)	LB/IN PER SECTION
CF6,CF8,CF12 (3,5,6)	1024-05	1	1	29.904	16.404	1 3.50 9.62	NONE	480.92	17.37
CF14,CF16/88,CF24 (7,10,12)	1024-10	1	1	57.842	16.404	1 3.50 9.62	NONE	939.22	33.93
CF28,CF36,CF36-6 (15,18,19)	1024-36	1	2	83.356	16.404	2 3.50 19.24	2 2.875 12.98	1335.15	24.12
CF40,CF48,CF48-8 (20,24,27)	1024-2106	1	2	112.860	16.404	2 3.50 19.24	2 2.875 12.98	1819.13	32.86
CF56,CF72,CF72-6 (30,36,39)	1024-36	2	4	83.356	16.404	4 3.50 38.48	4 2.875 25.97	2670.29	24.12
CF80,CF96,CF96-8 (40,48,55)	1024-2106	2	4	112.86	16.404	4 3.50 38.48	4 2.875 25.97	3638.26	32.86
CF120,CF144 (60,72,75,85)	1024-5401	3	6	113.550	16.404	6 3.50 57.73	6 2.875 38.95	5491.34	33.06
OLD 15 TON	1024-1609	1	2	79.606	16.404	2 3.50 19.24	2 2.875 12.98	1273.63	23.01
OLD 30 TON	1024-1609	2	4	79.606	16.404	4 3.50 38.48	4 2.875 25.97	2547.26	23.01

DENSITY OF WATER USED TO CALCULATE LB/IN = 62.42746 LBS/FT3

MAKE-UP WATER TEMPERATURE CORRECTION FACTOR (TCF)
70 DF = 1.00000
71 DF = 1.00549
72 DF = 1.01099
73 DF = 1.01648
74 DF = 1.02198
75 DF = 1.02747
76 DF = 1.03297
77 DF = 1.03846
78 DF = 1.04396
79 DF = 1.04945
80 DF = 1.05495
81 DF = 1.06044
82 DF = 1.06593
83 DF = 1.07143
84 DF = 1.07692
85 DF = 1.08242
86 DF = 1.08791
87 DF = 1.09341
88 DF = 1.09890

MEASURING WATER LEVEL:

HIGH LEVEL: MEASURED AS SOON AS POSSIBLE AFTER END OF DEFROST. WATER PUMP SHOULD BE ON AND WATER LEVEL STABLE BEFORE TAKING MEASUREMENT.

LOW LEVEL: MEASURED IMMEDIATELY PRIOR TO ENTERING DEFROST. WATER PUMP SHOULD STILL BE RUNNING WHILE TAKING MEASUREMENT.

CALCULATING ICE PRODUCTION:

$$\text{TONS PER DAY} = \text{LBS/IN} \times (\text{HIGH LEVEL} - \text{LOW LEVEL})\ \text{IN} \times \frac{\text{(RUN TIME/DAY) MIN/DAY}}{\text{(CYCLE TIME) MIN}} \times \frac{1}{2000} \times \text{NUMBER OF SECTIONS} \times \text{TCF}$$

EXAMPLE:

5 TON – CF8 – 1 SECTION, 17.37 LB/IN, 80°F (DF) MAKE-UP WATER
25 MIN CYCLE TIME, HIGH LEVEL – 18 IN, LOW LEVEL – 8.5 IN
TONS/DAY = 17.37 x (18 – 8.5) x 1440/25 x 1/2000 x 1.05495 = 5.0136 TONS PER DAY

TSIM-9114

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Test Procedure And Measurements

1. Place a yard stick or tape measure in the water tank with the end resting on the tank bottom. The tape or yard stick should read zero at the bottom of the tank. The water level in the tank will be read as the number greater than zero. For most models, the water level in a full tank is eighteen (18) inches.

2. Start the icemaker and allow it to run two to three cycles to remove any residual heat as a result of the plates being at ambient temperature.

3. The tank refills during defrost. Since the water pump is off during this sequence, the water lines and headers are empty. Start the capacity test after the recirculating water pump starts and refills all of the water lines in the system.

   When the water pump starts, record the high water level reading on the tape.

4. The water level in the tank drops as ice is formed on the plates.

5. At the end of the refrigeration cycle, the water solenoid valve opens to defrost the section and refill the water tank.

   Read and record the low water level at the instant before the solenoid valve opens to ensure that all water lines are as full as they were at the start of the cycle.

   Record the low water level.

6. The difference between the high and low readings represents the total quantity of water that was converted to ice.

7. Record the defrost water temperature during defrost.

8. Calculate the ice production (uncorrected).

9. Locate the correction factor for the make-up water temperature.

   Multiply the correct factor to obtain the ice production at rated conditions.

Sample Calculations

A CF40SC consisting of two sections rated at 10 tons each will be used. Refer to Table 4-3 for icemaker water consumption.

A B-15 gear rack in the MC-7 timer will be used. There are 25 minute cycles or 57.6 cycles per day. Refer to Table 4-1.

The CF40SC has a single water tank that is divided into two halves. Capacity can be measured and calculated in two ways.

Method 1

Measure the water consumption in one-half of the tank (10 ton section) and assume that the other half is the same. To calculate the tons per day, the single water level reading is multiplied by two (2) since there are two sections.

Method 2

Measure the water consumption in both compartments of the water tank. Use one (1) for the number of sections since each section is measured individually. Add the tons per day for each section to determine the total unit ice production per day.

To illustrate both methods, the data required is as follows:

Section 1
(right compartment of tank)

High water level:
18 inches
Low water level:
7.5 inches
Change in water level:
10.5 inches

Section 2
(left compartment of tank)

High water level:
18 inches
Low water level:
7.25 inches
Change in water level:
10.75 inches

Make-up water temperature:
75°F
Correction factor (TCF):
1.027

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Using Method 1:

Water consumption:
10 1/2 inches

Note:
The water consumption of section 2 was not measured.

Water consumed:
18" – 7.5" = 10.5"
Number of cycles per day:
57.6
Number of sections: 2
TCF: 1.027
Pounds per inch per section:
32.86 (from Table 4-3)
Pounds per ton: 2000

Tons per day:

$$\frac{(18-7.5)(57.6)(2)(1.027)(32.86)}{2000}$$

= 20.4 tons of ice

Using Method 2:

Tons per day (section 1):

$$\frac{(18-7.5)(57.6)(1)(1.027)(32.86)}{2000}$$

= 10.2 tons of ice

Tons per day (section 2):

$$\frac{(18-7.25)(57.6)(1)(1.027)(32.86)}{2000}$$

= 10.4 tons of ice

10.2 + 10.4 = 20.6 tons total

Comparison

Comparing methods 1 and 2 indicates calculated capacities of 20.4 and 20.6 tons per day respectively. Method 2 is more accurate but requires reading each section and additional calculations.

To obtain higher accuracy without additional calculations, use the following procedure:

A six section (60 ton) machine is used with the following water consumptions:

Section 1: 10 1/2 inches
Section 2: 10 3/4 inches
Section 3: 10 3/8 inches
Section 4: 10 5/8 inches
Section 5: 10 1/2 inches
Section 6: 10 inches

Total inches of water:
62.75
Number of sections: 1(since all water used is totalled)
Pounds per inch per section (60 ton): 33.06 for all sections

Tons per day:

$$\frac{(62.75)(57.6)(1)(1.027)(33.06)}{2000}$$

= 61.5 tons of ice

Since the calculated tonnage is 61.5, the nominal rated capacity of 60 tons per day is met or exceeded. Scanning the data, note that section 6 is using less water than the other sections. To determine the production loss per day from section 6:

Average water usage
(sections 1-5): 10.55 inches

Tons per day (sections 1-5):

$$\frac{(10.55)(57.6)(1)(1.027)(33.06)}{2000}$$

= 10.3 tons of ice

Tons per day (section 6):

$$\frac{(10)(57.6)(1)(1.027)(33.06)}{2000}$$

= 9.8 tons of ice

Production loss per day:
0.5 tons of ice

Helpful Hints

The above calculations represent the total ice discharged from the icemaker. Counting bags, pallets, or baskets should not be used for the following reasons:

1. Does not reflect losses due to handling in the screw conveyors, storage system (rakes), hoppers, baggers, shakers, etc.
2. Does not reflect losses due to uninsulated screw conveyors located in above freezing environments.
3. Does not reflect broken bags.
4. Does not reflect variations in bag weights, pallets, or baskets upon which bags are stacked. Using the actual weight of bags, pallets, or baskets does not reflect losses described in the first three items.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

TROUBLE-SHOOTING

This section lists common problems and suggests solutions. Many problems are easy to solve - if you know what caused them.

If your problem is more complex and not stated in this section, contact Turbo Refrigerating Company at:

1-817-387-4301

Ask for the service department.

The following pages describe problems you might encounter and provide diagnostic instructions and solutions.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

PROBLEMS AND SOLUTIONS

Problem	Causes	Solutions
Compressor will not start.	No three phase or control circuit power. Tripped circuit breaker.	Check fuses and disconnect. Reset tripped circuit breakers.
	Blown fuse. Oil failure tripped.	Reset or replace manual reset. Determine cause of low oil pressure before restarting.
	Defective dual pressure switch.	Check switch wiring on controller. Replace.
	Improper signal at the programmable controller or master control circuit (CR1).	The run and power lights must be on for unit to operate. Check for loose connection and control circuit power to controller.
		CR1 coil defective. Replace.
	MCS turned off.	Turn switch to "on" position.
	Starter coil defective.	Check starter coil for burnout or loose wiring. Replace as required.
	Oil temperature safety.	Compressor off on high oil temperature. Determine cause of high oil temperature before resetting.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Problem	Causes	Solutions
Compressor will not start (continued).	Overload relay on magnetic starter tripped.	Determine cause of motor overload. Depress manual reset button.
	Breaker bar(s) overload relay tripped.	Determine cause of motor overload. Depress manual reset button.
Unit drawing high amps.	Loose terminal connections.	Tighten connections (qualified electrician).
	Defective motor bearings or motor.	Replace. Check compressor/motor alignment and mounting bolts before restarting.
	Refrigerant system overcharged causing high discharge pressure.	Determine actual refrigerant charge and remove refrigerant as required.
	Condenser inoperative - high discharge pressure.	Check condenser head pressure control operation. Check electrical and/or pressure connections to controls.
	Air or non-condensables in system.	Replace refrigerant charge.
		Change drier/filter cores.
		Purge air from high point in piping.

Notes:

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Problem	Causes	Solutions
Unit will not make ice or is not producing full sheet of ice.	High discharge pressure:	
	– Defective water regulating valve (water cooled).	Check pressure sensing connection to regulator. Replace.
	– Fouling at condenser (water cooled).	Clean condenser by brushing and/or acid treatment. Consult manufacturer for water treatment recommendations.
	– Faulty water pump (water or evaporative cooled).	Replace pump. Check pump suction and discharge for obstructions.
	– Fouling at condenser (air cooled).	Clean with air, water hose, or brushing. Remove debris from condenser inlet.
	– Flood back valves out of adjustment (air or evaporative cooled).	Adjust to maintain 180 psig.
	– Belt worn or loose causing belts to slip (air or evaporative cooled).	Adjust, replace belts.
	– Fan turning too slow (air cooled).	Change sheave to increase speed up to FLA of motor. Consult factory before restarting. Check for restrictions.
	Low on R-22.	Add refrigerant to eliminate bubbles in sight glass. Search for leak and repair.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Problem	Causes	Solutions
Unit will not make ice or is not producing full sheet of ice (continued).	Thermal expansion valve improperly adjusted.	Adjust expansion valve superheat to 8–10°F. Check thermal expansion valve power head. If defective, replace.
	Plugged or restricted filter drier.	Replaced drier cores.
	Moisture in system (yellow sight glass).	Replace drier cores. May require replacement of refrigerant charge. Determine source of water contamination.
	Air or other non-condensable in refrigerant system.	Bleed air from condenser. Replace refrigerant charge.
	Restriction in piping.	Check all isolation valves for proper position - open or closed.
	Power off to condensing unit.	Check power, breaker, and disconnects to all motors, starters, and control switches.
	Insufficient water flow to condenser (water cooled):	
	– Strainer plugged.	Clean or replace.
	– Float valve defective (make-up water line to cooling tower).	Check adjustment. Replace if required.
	Condenser pump prime lost - low water level in sump.	Add water to cooling tower. Determine cause of water loss.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Problem	Causes	Solutions
Unit will not make ice or is not producing full sheet of ice (continued).	Condenser water make-up valve closed or restricted.	Clean, repair, open, or replace valve.
	Recirculating water pump off:	
	– Motor overloads tripped.	Check pump for restrictions. Reset starter overload relay.
	– No water in tank.	Standpipe in tank missing or loose. Replace or tighten.
	– Strainer plugged.	Remove and clean.
	Crossover water valve open. Part of water flow going to backside of plate.	Close crossover valve.
	Flow control valve restricted or closed too much.	Clean and/or adjust valve to obtain complete wetting of evaporator plate.
	Strainer plugged, restricting flow to plates.	Clean strainer.
	Slushing at start of icemaking cycle.	Consult factory.
	Defrost water solenoid valve stuck open or in "manual" position.	Check manual operation for proper stem position.
		Remove and clean. Replace if necessary.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Problem	Causes	Solutions
Unit will not make ice or is not producing full sheet of ice (continued).	Manual defrost switch (MDS) in "off" or "manual defrost" position on models so equipped.	Return switch to "on" position. **Note:** Determine why switch was in "off" or "manual defrost" position before returning unit to automatic operation.
	Water supply tubes plugged or restricted.	Remove snap-tite cleanout plug and use tube cleaning brush supplied to clean tubes. If calcium or lime build-up is present, it may be necessary to clean the water system with icemaker cleaner (dilute muriatic acid).

Notes:

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Problem	Causes	Solutions
Unit will not defrost.	Water solenoid inoperative.	Check wiring to coil. Check for burned out coil and replace if necessary.
	Pilot solenoid for gas powered check inoperative.	Check wiring to coil. Check for burned out coil and replace if necessary.
	Insufficient water over plates.	Check defrost tubes for fouling. Clean. Clean strainer if so equipped, clean screen on pick-up at pump. Check pump for proper rotation.
	Too low water pressure.	Check water pressure at make-up water connection. A minimum of 15 psig is required.
	Gas powered check inoperative.	Clean or replace if necessary. Pilot solenoid may require cleaning or replacement.
	Thermal expansion valves improperly set causing evaporator plates to starve at the end of the icemaking cycle.	Adjust or replace thermal expansion valves. Check thermal expansion valve power head and replace if necessary.
	Refrigerant charge low.	Add refrigerant to clear the sight glass in the liquid line.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Problem	Causes	Solutions
Unit will not defrost (continued).	Units with electromechanical controls – timer micro-switch (cam) not making/breaking.	Adjust micro-switch arm using spline wrench (available from TURBO, contact the parts department). Replace switch if necessary.
		Suction pressure switch (SPS) fails to open to start timer during defrost (only if so equipped on small icemakers). Clean or replace if required. Adjust to proper setting (minimum setting is 70 psig).
	Supply water temperature too low.	Increase water supply temperature. Add preheater if necessary. Increase defrost time to compensate for low defrost water temperature.

Notes:

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Problem	Causes	Solutions
Low suction pressure.	Low on refrigerant.	Check for leaks, repair. Add refrigerant.
	Obstructed or dirty filter drier.	Replace filter drier.
	Low water flow over plates.	Check water supply tubes for dirt. Clean.
	Expansion valves improperly adjusted or defective (starving).	Check expansion valve adjustment. Replace if required.
High suction pressure.	Leaking defrost water solenoid valve.	Repair or replace.
	Expansion valve improperly adjusted (overfeeding refrigerant).	Check expansion valve adjustment (close to reduce refrigerant valve). Set superheat at 8–10°F.
	Compressor damaged internally – valve plate broken, etc.	Replace damaged valve plate(s). Consult factory.

Notes:

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Problem	Causes	Solutions
High discharge pressure.	Refrigerant system overcharged.	Verify actual charge. Reduce charge as required.
	Dirty condenser.	Clean.
	Non-condensables in refrigerant.	Air in system. Remove by purging.
	Head pressure controls improperly set.	Readjust to correct setting. Normally 180 - 210 psig for water cooled; 170 - 190 psig for evaporative cooled; 210 - 250 psig for air cooled.
	Discharge line check valve inoperative.	Check and replace if required.
	Incorrect position of isolation valves and pressure controls.	Position all valves correctly. Make sure all pressure controls are properly adjusted and pressure regulator are in automatic position.

Notes:

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Problem	Causes	Solutions
Low oil pressure.	Oil not returning from accumulator.	Weep hole in suction accumulator dry suction trap plugged. Replace.
	Low oil in crankcase.	Add oil, observe sight glass. Maintain 1/8 to 1/2 sight glass. If oil returns above 1/2 sight, remove excessive oil.
	Defective compressor oil pump.	Check rotation. Replace as required.
	Thermal expansion valve(s) improperly set, causing flooding.	Adjust thermal expansion valves to maintain 8–10°F superheat. If thermal expansion valve will not control, replace or rebuild internal parts. Check power head.

Notes:

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Problem	Causes	Solutions
Excessive vibration of motor and compressor.	Misalignment.	Realign to within specifications.
	Loose motor/compressor hold down bolts.	Tighten.
	Flooding of compressor.	Adjust thermal expansion valve. Check mounting of remote bulb and position on the suction line.
	Defective or worn bearing.	Remove coupling and check bearing. Replace as required.
	Structural support under unit insufficient.	Reinforce structural support. Shim as required.
Excessive motor temperature.	Voltage drop at motor starter/contactor.	Phase imbalance. Consult electric company.
	Loose connection at starter/contactor causing high amp draw.	Tighten connection (qualified electrician).
	Restricted air ventilation.	Clear obstructions.

Notes:

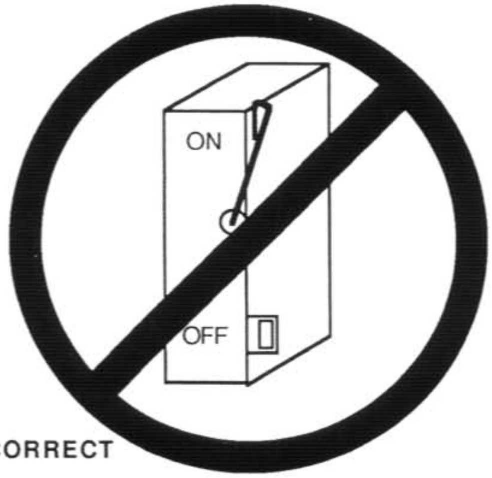
Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Problem	Causes	Solutions
Cloudy ice.	Inadequate blowdown – tank dirty.	Blowdown is required to prevent the concentration of solids. Increase defrost water flow or reduce standpipe height. – Add suitable water treatment or filtering system. – Clean tank. Remove standpipe and flush bottom of tank. – Add dump valves. Consult factory.
	Low suction.	Compressors oversized (R models). Consult factory. Thermal expansion valve improperly set (starving). Adjust. Filter/drier dirty. Replace. Refrigerant level low, add refrigerant.

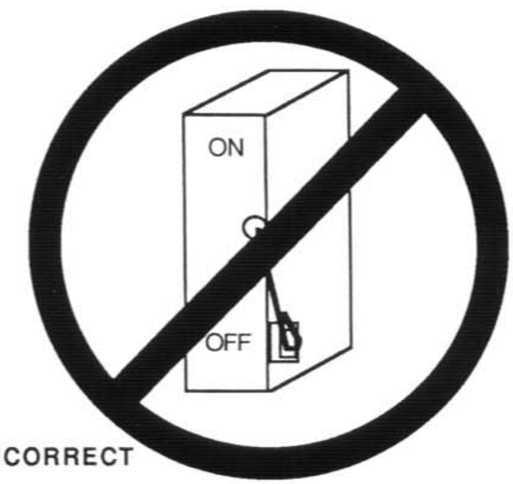
Notes:

DISCONNECTING POWER & LOCK OUT

Turbo Refrigerating Company insists that **disconnecting** and **locking out** the power to the motor driving the unit provides the only real protection against injury. Other devices should not be used as a substitute for **locking out** the power prior to removing guards, covers, or other safety devices. Turbo warns that the use of secondary devices may cause employees to develop a false sense of security and fail to **lock out** power before removing guards, covers, or other safety devices. This could result in a serious injury should the secondary device fail or malfunction.



INCORRECT



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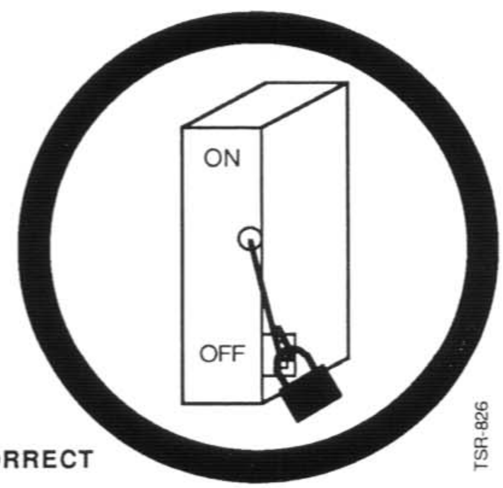

CORRECT

TSR-826

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

MAINTENANCE

TURBO® icemakers will give long years of dependable service with a minimum of maintenance. Regular maintenance will extend their life and efficiency.

If you have questions concerning the maintenance of your equipment, contact the service department of Turbo Refrigerating Company at : 1-817-387-4301.

Breaker Bar Belts

Inspect the breaker bar belts every sixty (60) days for wear and proper tension. Replace with matched sets to ensure that each belt is taking an even share of the load. Slow speed drives using chains should also be checked.

Compressor

Inspect for oil leaks around the seal monthly (open type compressor units only). Check the tightness of the mounting bolts twice a year. Change compressor oil annually.

Water Headers

Inspect the water headers monthly for evidence of mineral deposits clogging the spray holes in the recirculating and defrost water tubes. Clean the tubes by removing the pressure fitting at the far end of each tube and running a stiff brush through the tubes. The frequency of cleaning will depend on the hardness of the water used.

Ice Quality Problems

Problems encountered with icemaking equipment are:

- scale formation
- cloudy or milky ice
- objectionable taste or odor.

Factors affecting each of these problems are listed below.

Water Treatment

Consult a local water treatment company to determine if water treatment or filtration is required to produce the desired ice quality, reduce maintenance of the water distribution system, and prevent contaminants that may prevent proper operation of the equipment. Extremely hard water will tend to make cloudy, softer ice and leave deposits within the machine necessitating frequent cleaning. Water supplies in various parts of the country are unique in terms of acidity, solid content, and chemistry that may affect the water system.

Consultation with a qualified water treatment company can identify the needs for your system. After start-up, water samples should be taken regularly to evaluate biological, chemical, or other contaminants that may result from operation of the system.

Highly chlorinated water should be avoided during operation or cleaning due to the highly corrosive effect on all materials including stainless steel.

Scale Formation

Scale is caused by dissolved minerals in the water. Because water freezes in a pure state, these dissolved minerals concentrate in the unfrozen water. They eventually deposit on the machine's freezing surfaces and form scale. The ice tends to stick to the scale; this jams the machine.

The best way to prevent scale formation is to treat the water with polyphosphates.

A chemical analysis of the water will indicate serious problems, occasional problems, or negligible problems from the service standpoint.

Two main factors to consider are hardness (calcium and magnesium) and alkalinity (carbonate and bicarbonate).

Hardness and alkalinity combine to form relatively insoluble calcium carbonate or lime scale.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Before beginning a water treatment program, the ice-makers should be thoroughly cleaned. Clean water distributor holes and flush loose sediment from the system. Remove existing scale formations by circulating a liquid acid (icemaker cleaner) through the system. Clean the icemaker with warm water after the harvest cycle.

After cleaning, flush the system with fresh water and check all lines to see that they are not blocked by the loosened scale.

To prevent dissolved minerals from depositing on freezing surfaces during normal operation, use a slowly soluble polyphosphate. These keep dissolved minerals in solution and inhibit them from forming scale.

Cloudy Or Milky Ice

Cloudy or milky ice is caused by concentrations of dissolved minerals in the water.

With proper chemical treatment, the maximum mineral content that can be carried in the recirculating water and still produce clear ice is about 500 to 1,000 parts per million.

Increasing blowdown and reducing the thickness of the ice may help correct this condition.

Objectionable Taste Or Odor

When water containing an offensive taste or odor is used in an icemaker, the material causing the taste or odor is trapped in the ice.

The best way to eliminate this problem is to install an activated carbon filter on the make-up water line to remove the objectionable taste or odor from the water.

Occasionally, the cause of an odor problem in an icemaker may be slime growths. To control a slime problem in an icemaker, clean the machine on a regular basis. These slime deposits are stubborn and if they persist, sterilizing the ice machine may be necessary.

Feed water often contains suspended solids such as mud, rust, silt, and dirt. To remove these contaminants, install a water filter in the feed line. The water filter contains a special porous stone cartridge housed in a see-through filter body. In addition to improving the quality of the ice, the water filter will protect solenoid valves in the machine.

If deposits of minerals are found on the plates or in the water tank, remove them by filling the water tank with warm water and by adding a liberal amount of a mild detergent. Circulate this mixture over the plates by running the circulating pump without running the compressor until the deposits are washed off. Then flush away the mixture by allowing the make-up water to circulate until all of the mixture has been flushed out of the drain.

Electrical Apparatus (Motors)

The fundamental principle of electrical maintenance is to **keep the apparatus clean and dry**. This requires a periodic inspection of the apparatus (the frequency depending upon the type of apparatus and the service).

Helpful Hints

1. Windings should be dry and free of dust, grease, oil and dirt. Clean windings with suction cleaners or by wiping. Nozzles on suction type cleaners should be nonmetallic. Remove gummy deposits of dirt and grease by using a commercially available low volatile solvent. Do not use gasoline or other inflammable solvents.

   Never oil any part of the magnetic control.

2. Terminal connections, assembly screws, bolts, and nuts should be tight. They may loosen if the motor is not securely bolted and tends to vibrate.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

3. Check the insulation resistance of motors in service periodically (at approximately the same temperature and humidity conditions) to determine possible deterioration of the insulation. When measurements at regular intervals indicate a wide variation, determine the cause.

4. Grease lubricated motors are properly lubricated at the time of manufacture and it is not necessary to lubricate at installation. If the motor has been in storage for a period of six months or greater, lubricate before starting. A type of grease recommended and tested by the motor manufacturer should be used whenever possible. To lubricate, remove the filler plug and grease with clean lubricant (1/2 to 1 cubic inch of grease is sufficient). For the relubrication period, follow the instruction plate on the motor.

5. Periodically clean the enclosure by blowing out accumulated dust.

6. Check the surrounding area for new sources of dust, oil, or corrosive vapors not present at the time of installation. A general purpose enclosure may have been satisfactory when the control was installed but the proximity of new production equipment or processes might make it necessary to change enclosures or to shield the existing one from oil spray or excessive dust.

7. Inspect the insulation on wires. The conductors must be clear of all moving parts.

8. Examine the contact. Cleaning is not required because the contact material is a special pre-oxidized silver cadmium oxide alloy. Replacement is required when the contact material is almost worn down to the backing. Parts kits, including a complete set of stationary and movable contacts and contact springs, are available. Replace the silver and the contact spring on a given pole to assure proper contact mating for maximum life.

9. Check the magnet pole faces for oil deposits. If oil is present, carefully clean the pole faces with carbon tetrachloride. This prevents accumulation of dust and a potentially sticky magnet.

Changing Drier Cores

When it becomes necessary to replace the drier cores in the filter/drier, the following procedure is recommended (refer to Figure 6-1).

WARNING

All refrigeration service work should be provided by a qualified refrigeration technician or engineer. Filter/driers contain liquid refrigerant under high pressure. Failure to carefully follow these instructions could result in permanent injury or loss of life.

1. With the compressor operating, close the king valve (main valve on outlet of receiver) to allow pump down of the liquid into the receiver.

2. After the icemaker operation is terminated by the low pressure safety switch, isolate the filter/drier assembly by closing the valve downstream of the filter/drier assembly.

3. Attach a service gauge manifold set to the Schrader (charging port) fitting in the seal cap (flathead) of the filter/drier assembly.

4. Open the service valve to release any liquid remaining in the filter/drier housing and the liquid line piping. Opening the valve also reduces the pressure inside the housing to atmospheric pressure. Discharge refrigerant to a safe location. Never point the hose in the direction of personnel.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

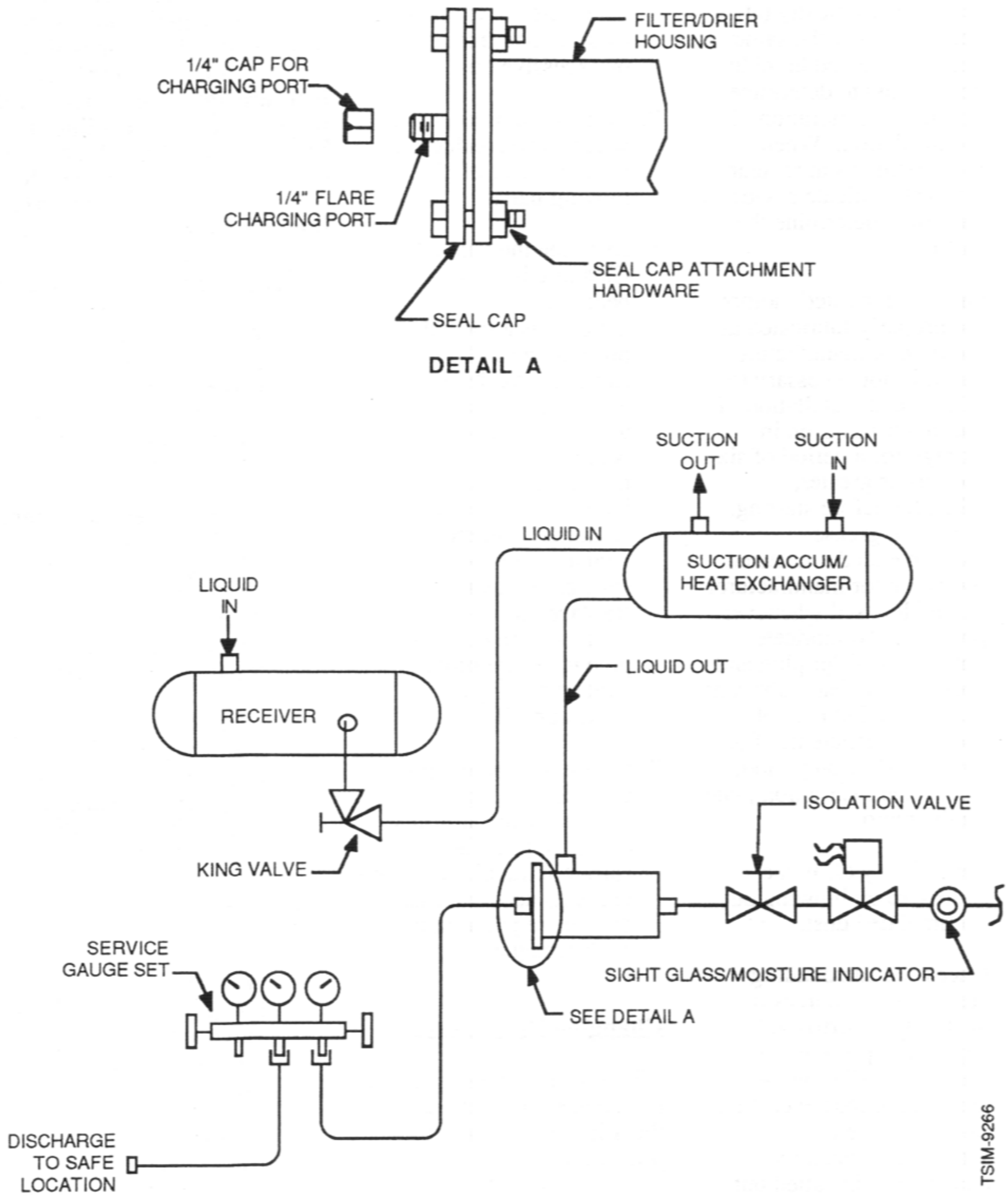

Figure 6-1 Typical Filter/Drier Installation

Note:
If the seal cap (flathead) on the filter/drier housing does not contain a charge port, the bolts on the cover should be loosened slowly and evenly. Tap the cover as the bolts are loosened to allow the refrigerant to slowly escape. Do not remove the bolts until the cover is loose enough to ensure that all of the refrigerant has escaped and the pressure inside the housing is at atmospheric pressure.

5. Once the refrigerant has been bled from the housing, slowly and evenly remove all of the bolts attaching the seal cap.

6. Remove and replace the drier cores as outlined in the instructions supplied with the drier cores.

   – Do not open the drier core cans until you are ready to install the cores.

   – Place the "spent" cores in the can and properly dispose of the can and old drier cores. These cores may contain refrigerant oil or other combustible debris. Do not place in or near an open flame or incinerator.

7. Inspect the strainer screen for debris and clean as required.

8. After the drier cores have been replaced and the seal cap loosely attached with all of the bolts, slightly open the king valve to allow a very small amount of refrigerant to flow through the filter/drier housing and piping.

9. While the refrigerant is escaping, evenly tighten all of the seal cap bolts. This will ensure that air and moisture is purged from the assembly before it is sealed.

10. Check for leaks around the seal cap.

11. If no leaks are found and the system is ready to go back on-line, open the king valve and isolation valve.

WARNING

Liquid refrigerant can burn or cause severe irritation of the skin. Crack the king valve slowly open. Do not attempt to hold the seal cap while opening the king valve. After a small refrigerant flow is obtained, position and tighten the seal cap. Always wear rubber gloves and eye protection when changing the drier cores. Failure to carefully follow these instructions could result in permanent injury or loss of life.

12. After the system is restarted, observe the condition of the liquid line sight glass/moisture indicator.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

SPARE PARTS LIST

It is a good idea to keep spare parts on hand in case of emergencies. You will save operation time and money because you will not have to wait for parts to be ordered and delivered.

Part numbers may change without notice. When ordering or specifying parts, the serial number and model of the unit must be referenced.

Legend

SI = Items that should be stocked to maintain safe equipment operation, for normal maintenance, or frequent replacement items that can cause interruption of operation.

RI = Replacement items that are normally not subject to normal maintenance or replacement.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Water System

				B & C Series Tons Of Ice Per Day (Quantity)								
Part Number	SI	RI	Description	3	5	7	10	14/15	20	30	40	60
200-1001-01	x		Defrost Tube (Grey), Old Style									
200-1002-00	x		Water Supply Tube	2 (6)	4 (10)	4 (14)	6 (20)	6 (28)	8 (40)	8 (56)	10 (80)	12(120)
200-1001-00	x		Water Defrost Tube	1 (3)	1 (5)	2 (7)	3 (10)	3 (14)	4 (20)	5 (28)	6 (20)	8 (60)
009-0975-04	x		Snap-Tite Water Plug	5	8	10	15	20	30	40	50	60
009-0975-03	x		Snap-Tite Water Plug, Old Style Def. Tube									
002-1901-1201	x		O-Ring 3/4", Water & Defrost Tube	10	15	20	30	40	60	80	100	120
002-1901-12	x		O-Ring 3/8", Old Style Defrost Tube	5	8	10	15	20	30	40	50	60
CWAT001		x	Strainer*	1	1	1	1	1	1	1	1	1
CWAT002		x	Water Pump 1/3 HP	1								
028-0500-06		x	Water Pump 1/2 HP		1							
028-0500-0402		x	Water Pump 3/4 HP			1	1	2	2	4	4	6
CWAT003		x	Defrost Solenoid Valve**	1	1	1	2	2	2	4	4	6
220-1100-05	x		Stand-Pipe, Water Tank	1	1	1	1	1 (2)	1 (2)	1 (4)	1 (4)	1 (6)
200-1000-12	x		Water Supply Tube Clip	10	15	20	30	40	60	80	100	120
055-0001-01	x		Pliobond® Tube Adhesive	1 can	1 can	1 can	1 can	1 can	1 can	1 can	1 can	1 can
CWAT004		x	Defrost Water Header	1	1	1	1	2	2	4	4	6
CWAT005		x	Supply Water Header	1	1	1	1	2	2	4	4	6

* Specify size. ** Refer to Electrical Control Panel chart for coil.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Breaker Bar High Speed Drive (standard)

(208/3/60 available – special order)

				B & C Series Tons Of Ice Per Day (Quantity)								
Part Number	SI	RI	Description	3	5	7	10	14/15	20	30	40	60
034-1700-02	x		1 1/2 HP Drive Motor, 1800 RPM, ODP, 230/460/3/60	1								
034-1700-07	x		2 HP Drive Motor, 1800 RPM, ODP, 230/460/3/60		1							
034-1700-03	x		3 HP Drive Motor, 1800 RPM, ODP, 230/460/3/60			1	1	1	1	1 (2)	1 (2)	1 (2)
032-0200-02	x		3V-425 Belts (1 1/2 & 2 HP Drives)	3	3							
032-0200-04	x		3V-475 Belts (3 HP Drive)			3	3	3	3	6	6	9
015-0303-35		x	3 Groove 3V Sheave, 3.35" Pd (Drive)	1	1	1	1	1	1	1 (2)	1 (2)	2 (3)
015-0308-00		x	3 Groove 3V Sheave, 8" Pd (Breaker Bar)	1	1	1	1	1	1	1 (2)	1 (2)	2 (3)
015-1500-28		x	1 3/4" Sheave Bushing, Type SK	1	1	1	1	1	1	2	2	3
015-1200-14		x	7/8" Sheave Bushing, Type SH	1	1							
015-1200-18		x	1 1/8" Sheave Bushing, Type SH			1	1	1	1	2	2	2

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Breaker Bar Slow Speed Drive (optional)

(208/3/60 available – special order)

				B & C Series Tons Of Ice Per Day (Quantity)								
Part Number	SI	RI	Description	3	5	7	10	14/15	20	30	40	60
034-1800-02	x		2 HP Gear Motor, 150 RPM Output, 230/460/3/60	1	1	1	1	1	1	1 (2)	1 (2)	1 (3)
032-0500-04	x		50# Drive Chain	1	1	1	1	1	1	1	1	1
032-0502-04	x		50# Chain Master Link	3'	3'	3'	3'	3'	3'	6'	6'	9'
031-3050-25		x	25 Tooth Drive Sprocket (Drive)	2	2	2	2	2	2	4	4	6
015-1300-16		x	1" Sprocket Bushing, Type SDS	1	1	1	1	1	1	2	2	3
015-1300-28		x	1 3/4" Sprocket Bushing, Type SDS	1	1	1	1	1	1	2	2	3
200-1079-05		x	Motor Adjusting Base	1	1	1	1	1	1	2	2	3

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Breaker Bar Assembly

				B & C Series Tons Of Ice Per Day (Quantity)								
Part Number	SI	RI	Description	3	5	7	10	14/15	20	30	40	60
200-1012-03		x	Breaker Bar	1	1							
200-1012-03		x	Breaker Bar			1	1					
200-1012-1900/01		x	Breaker Bar					1	1	2	2	3
200-1018-03		x	Sizer Bar	1	1							
CBBA001		x	Sizer Bar			1	1					
200-1018-19		x	Sizer Bar					1	1	2	2	3
200-1033-0501		x	Fixed Crusher Grate	1	1							
CBBA002		x	Fixed Crusher Grate			1	1					
200-1033-1901		x	Fixed Crusher Grate					1	1	2	2	3
CBBA003		x	High Speed Sizer Bar Adjustment Handle	1	1	1	1	1	1	2	2	3
CBBA004		x	Heavy Duty Sizer Bar Adjustment Handle	1	1	1	1	1	1			
CBBA005		x	Heavy Duty Sizer Bar Adjustment Handle, Dual							1	1	2
CBBA006		x	T-Bar Spacer, Ice Discharge Opening	1	1	1	1	1	1	2	2	3
029-0001-28	x		Pillow Block Bearing With Grease Fitting	1 (2)	1 (2)	1 (2)	1 (2)	1 (2)	1 (2)	1 (4)	1 (4)	1 (6)

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Safety Switches

				B & C Series Tons Of Ice Per Day (Quantity)								
Part Number	SI	RI	Description	3	5	7	10	14/15	20	30	40	60
018-0000-12		x	Dual High/Low Pressure Switch	1	1	1	1	1	1	2	2	2
018-0000-11		x	Oil Failure Switch	1	1	1	1	1	1	2	2	2
CSAFSW001		x	Oil Temperature Switch (Open Compressor Only)					1	1	1	1	1
017-0709-02		x	Gauge, Suction Pressure, 30–200 PSIG	1	1	1	1	1	1	2	2	2
017-0709-03		x	Gauge, Oil Pressure, 0–200 PSIG	1	1	1	1	1	1	2	2	2
017-0709-04		x	Gauge, Discharge Pressure, 0–400 PSIG	1	1	1	1	1	1	2	2	2

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Condenser

Part Number	SI	RI	Description	B & C Series Tons Of Ice Per Day (Quantity)								
				3	5	7	10	14/15	20	30	40	60
			Water-Cooled (SC only):									
CCONW001		x	Water Regulating Valve	1	1	1	1	1	1	2	2	2
CCONW002		x	Condenser Head Gasket	2	2	2	2	2	2	4	4	4
CCONW003		x	Condenser	1	1	1	1	1	1	2	2	2
			Air-Cooled (SCA only):									
CCONA001		x	'L' Valve – Flood Back Controls*	Due to the number of variations, please specify icemaker serial number and condenser make and model number.								
CCONA002		x	'G' Valve – Flood Back Controls*									
CCONA003		x	Check Valve – Flood Back Controls*									
CCONA004	x		Belts – Fan Drive									
CCONA005		x	Motor – Fan Drive**									
			Evaporative-Cooled (SCE only):									
CCONE001		x	Water Pump	Due to the number of variations, please specify icemaker serial number and condenser make and model number.								
CCONE002		x	Fan Drive Motor									
CCONE003	x		Belts – Fan Drive									
CCONE004		x	Make-Up Water Float Valve									
CCONE005		x	Damper Controls									

* Specify size. ** Specify horsepower.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Refrigeration System

				B & C Series Tons Of Ice Per Day (Quantity)								
Part Number	SI	RI	Description	3	5	7	10	14/15	20	30	40	60
CREF001		x	Liquid Solenoid Valve, 115/1/60*	1	1	1	1	2	2	2	2	2
CREF002	x		Liquid Solenoid Valve Coil, 115/1/60	1	1	1	1	2	2	2	2	2
CREF003	x		Internal Parts Kit, Liquid Solenoid Valve	1	1	1	1	1	1	1	1	1
CREF004		x	Liquid Line Sight Glass*	1	1	1	1	1	1	2	2	2
012-0602-03	x		Relief Valve, 350 PSIG, 1/2" x 3/4"	1	1	1	1	1	1	1	1	1
CREF005	x		Thermal Expansion Valve, SVE6C	1								
013-0700-04	x		Thermal Expansion Valve, OVE10C		1		2					
013-0700-05	x		Thermal Expansion Valve, OVE15C			1		2		4		
013-0700-07	x		Thermal Expansion Valve, OVE20C						2		4	6
013-0001-36	x		Power Head, TXV, 83VC	1	1	1	2	1	2	2	4	6
CREF006	x		Power Head, TXV, 33VC		Consult factory – special applications only.							
CREF007	x		Internal Parts Kit, TXV, SVE6C	1								
013-0701-14	x		Internal Parts Kit, TXV, OVE10C		1		2					
013-0701-15	x		Internal Parts Kit, TXV, OVE15C			1		2		4		
013-0701-20	x		Internal Parts Kit, TXV, OVE20C						2		4	6
014-0100-02	x		Filter Drier Cores, RC-4864	1	1	2	2	4/3	3	6	6	8

* Specify size.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Refrigeration System (continued)

				B & C Series Tons Of Ice Per Day (Quantity)								
Part Number	SI	RI	Description	3	5	7	10	14/15	20	30	40	60
CREF008		x	Evaporator Plates	6	10	14	20	28	40	56	80	120
CREF009		x	Water Trough For Evaporator Plate Set	3	5	7	10	14	20	28	40	60
CREF010		x	Plate & Trough Assembly	3	5	7	10	14	20	28	40	60
012-0412-0601		x	Gas Powered Check Valve, 2 1/8"					2		4		
012-0412-0711		x	Gas Powered Check Valve, 2 5/8"						2		4	6
CREF013		x	Pilot Solenoid For Gas Powered Check Valve (Suction Solenoid Valve)					2	2	4	4	6
CREF014		x	Bypass Regulator					2	2	4	4	6
CREF015			Discharge Line Check Valve*	1	1	1	1**	2/1	1	2	2	2
CREF016		x	Semi-Hermetic Compressor	1	1	1	2	2				
CREF017		x	Open Drive Compressor				1	1	1	2	2	2
CREF018	x		Compressor Oil Cooler (Open Drive Only)				1	1	1	1	1	1
CREF019		x	Open Compressor Motor/Compressor Coupling***				1	1	1	1	1	1

* Specify size. ** 2 for CF88. *** Specify compressor & motor.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Electrical Control Panel (230/460/3/60)(115/1/60)

				B & C Series Tons Of Ice Per Day (Quantity)								
Part Number	SI	RI	Description	3	5	7	10	14/15	20	30	40	60
CELECT001	x		Coil, Control Relay*	1	1	1	1	1	1	2	2	2
CELECT002		x	Starter, Water Pump, 230V	1	1	1	1	2	2	4	4	6
CELECT003		x	Starter, Water Pump 460V	1	1	1	1	2	2	4	4	6
CELECT004		x	Starter, Breaker Bar High Drive, 230V	1	1	1	1	1	1	2	2	3
CELECT005		x	Starter, Breaker Bar High Drive, 460V	1	1	1	1	1	1	2	2	3
CELECT006		x	Starter, Breaker Bar Slow Drive, 230V	1	1	1	1	1	1	2	2	3
CELECT007		x	Starter, Breaker Bar Slow Drive, 460V	1	1	1	1	1	1	2	2	3
CELECT008	x		Coil For Starter, 115/1/60	1	1	1	1	1	1	2	2	2
CELECT009		x	Starter, Compressor Motor, 230/3/60**				1	1	1	2	2	2
CELECT010		x	Starter, Compressor Motor, 460/3/60**				1	1	1	2	2	2
CELECT011		x	Contactor, Semi-Hermetic Comp, 230/3/60	1	1	1	2					
CELECT012		x	Contactor, Semi-Hermetic Comp, 460/3/60	1	1	1	2					
CELECT013	x		Overload Heaters, Compressor***					3	3	6	6	6
CELECT014	x		Overload Heaters, Breaker Bar	3	3	3	3	3	3	6	6	9
CELECT015	x		Overload Heaters, Water Pump	3	3	3	3	6	6	4	4	6

* Specify number of poles. ** Open compressor only. *** Open drive only.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Electrical Control Panel (230/460/3/60)(115/1/60) (continued)

Part Number	SI	RI	Description	B & C Series Tons Of Ice Per Day (Quantity) 3	5	7	10	14/15	20	30	40	60
			Programmable Controllers:									
CPC001		x	CPU									
CPC002	x		Magnetic Tape, Program Back-Up					Consult factory.				
CPC003		x	Input Module									
CPC004		x	Output Module									
CPC005	x		Back-Up Battery									
			Electro-Mechanical Controls:									
CEMC001		x	Timer (Complete)									
CEMC002	x		Timer Motor, 115/1/60									
CEMC003	x		20 Minute Gear Rack									
CEMC004	x		25 Minute Gear Rack					Consult factory.				
CEMC005	x		30 Minute Gear Rack									
CEMC006		x	Micro-Switch For Timer									
CEMC007		x	Spline Wrench (Cam Arm Adjustment)									
CEMC008		x	Shock Mount For Timer									
CEMC009		x	Relay Contact Kit									
CEMC010		x	Starter Contact Kit									

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Electrical Control Panel (230/460/3/60)(115/1/60) (continued)

				B & C Series Tons Of Ice Per Day (Quantity)								
Part Number	SI	RI	Description	3	5	7	10	14/15	20	30	40	60
			General Components:									
CELECT016		x	Wash Cycle Switch	1	1	1	1	2	2	4	4	6
CELECT017		x	Master Control Switch	1	1	1	1	1	1	1	1	
CELECT018	x		Rubber Starter Reset Cover Boot	2	2	2	2	4	4	6	6	11
CELECT019		x	10 Amp Circuit Breaker (Control Circuit)	2	2	2	2	2	2	2	2	2

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

OPTIONAL FEATURES & ACCESSORIES

You can maximize your system's operating potential by adding optional features and accessories. If you need to know more details about the options listed below, contact TURBO.

Option 1
Slow Speed Breaker Bar

The slow speed breaker bar consists of a drive chain rather than a belt drive.

The slow speed drive is required on icemakers making ice 3/4" thick or greater. The chain drive prevents drive slippage that would result with belt drives.

Factors to consider in selecting the slow speed drive are:

- Produces less snow due to less impact force on ice.
- Produces a more uniform ice with the sizer grate setting.
- Less likely to jam due to momentary surges or jams.
- Can handle all ice thickness (up to one inch (1") maximum).

Slow speed drives require:

- More maintenance.
- Frequent adjustment of the drive chain to prevent damage or breakage due to excessive chain slack.

Option 2
Slush Kit

The slush kit consists of a timer and thermostat to automatically turn off water pump(s) for a short time after defrost to prevent "slushing" on plates. Operation to eliminate slushing is automatic.

Option 3
Winterizing

When TURBO® icemakers are installed in an area where the ambient falls below freezing, it is necessary to provide precautionary measures to prevent equipment freeze-up.

Control Panel

Ambient temperatures can affect many of the electronic controls in the control panel. In general, the devices TURBO uses operate properly in temperatures between 32°F and 140°F.

In operating ambients under 40°F, TURBO recommends that a source of heat be available in the control panel to maintain a temperature above 40°F. This will ensure continuous, reliable operation of all components (even in severe applications*). An optional winterizing kit consisting of a heat source and control thermostat can be provided as a factory installation or as a retrofit to existing control panels.

* The control panel winterizing kit is designed for equipment operations in ranges from 0 to 40°F. Consult TURBO for equipment operations in conditions below 0°F.

Installation

All winterizing components are factory installed and prewired when ordered with the unit. Kits are also available for field installation.

Water Pump, Water Circulating Tank, And Condenser

Insulated lower panels and electric forced air heat can be furnished for areas where the ambient falls below 15°F. When the ambient is between 15°F and 40°F, only an electric forced air heater is furnished. The electric heaters are factory installed in the lower section of the icemaker and are thermostatically controlled.

Note:
A switch is not provided in the control wiring to the winterizing to prevent accidental interruption of the system or loss of protection during unexpected freezing conditions.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Option 4
Weatherizing

Weatherizing is an enclosure that protects equipment from rain, wind, snow, and access from unauthorized personnel.

A supporting structure and sheet metal enclosure can be provided to cover outboard equipment which includes the:

- Motor/compressor assembly
- Suction accumulator/heat exchanger
- Liquid line filter-drier
- Safety switch and gauge console.

The enclosure is not winterized for ambient temperatures below 40°F (refer to Option 3 – Winterizing on page 187).

On smaller units, access inside the enclosure is obtained by removing the fixed panel(s). On larger units, a hinged access door is provided.

Weatherizing is recommended on all outdoor installations to provide a suitable working environment for service during all types of weather conditions.

Option 5
Preheaters

Standard

Preheaters maintain the 70°F fresh defrost water entering the icemakers. Preheaters are available with a factory installed hot gas to water heat exchanger in the compressor hot gas discharge line within the TURBO® unit. For field installation, each kit includes:

- Hot water storage tank
- Recirculating water pump (tank to heat exchanger)
- Fresh water "in" strainer and check valve
- Recirculating hot water solenoid valve
- Hot water tank thermostat (bulb well provided inside hot water tank).

Built-In

These are the same as standard preheaters except that they are factory installed (SCE & SCA models only).

Option 6
Dump Valves

Dump valves are automatic solenoid valves on the drain line from the water pump tank.

The dump valve is opened during the drying cycle to drain the water and concentrated solids remaining in the tank at the end of the refrigeration cycle.

The connection is located in a PVC tee installed in the circulating pump suction line (between the water tank outlet and the pump suction inlet).

In areas with very poor water or high suspended solids, dump valves are used to ensure that a clean, quality ice is produced.

Option 7
Thermostatic Water Blending Valves

Domestic water blending valves are used to blend hot and cold water thermostatically to provide the required 70°F fresh defrost water to TURBO® icemakers. This arrangement can be used when sufficient hot water is available on the job site. Please specify both hot and cold water temperatures available. GPM is based on a maximum 5 PSI pressure drop across the blending valve.

Option 8
Cooling Tower (SC Model)

For water-cooled units, a separate cooling tower is required to reject the heat removed from the water circulated through the condenser. A cooling tower consists of a:

- Sump
- Circulating water pump (optional)

- Make-up water connection
- Spray water system
- Internal fiber fill

Water is pumped from the cooling tower sump to the condenser inlet. Return water from the condenser is routed to a spray header on top of the cooling tower. The water is distributed over a fiber fill inside the tower. The water is drained to the bottom of the sump after it works it's way through the fill material. Air is drawn through the fiber fill by a fan(s) to remove the heat from the water. The water evaporation and airflow through the tower fill material are used to remove the heat from the water in the same manner as an evaporative condenser.

Make-up water is fed to the tower automatically through a float valve, located in the cooling tower sump. This is required to make up for the water lost through evaporation during normal operation.

A blowdown line is also provided to prevent the concentration of solids and minerals (as a result of the evaporation process). This is required to prevent fouling the fill material in the cooling tower and in the tower sump.

The cooling tower pump runs continually during operation to prevent the concentration of solids and minerals, due to repeated wetting and drying of the fill material. Fan cycling is typically used to control the water temperature in the sump.

Standard design parameters for cooling towers are based on rejecting the total heat of rejection of the evaporator and heat of the compressor based on a 20°F saturated evaporative temperature (SET) at 105°F at 78°F wet bulb.

Other wet bulb design temperatures can be provided to reduce the cooling tower size in areas with lower wet bulbs. Geographic areas with higher wet bulbs can either run higher condensing pressures or select a larger cooling tower based on the actual design wet bulb in order to maintain the standard 105°F SCT. Larger cooling towers that allow lower saturated condensing temperatures can also be provided to provide lower operating costs and higher ice production.

Installation

Cooling towers can be mounted indoors or outdoors. Outdoor installations may require sump heaters and other protection from icing during operation below 40°F.

TURBO® cooling towers are provided with a water sump thermostat to cycle the fan and control the leaving water temperature.

Air Intake And Discharge Clearance

Clearance for air intake and discharge must be provided. When ordering a cooling tower, consult TURBO for guidelines on installing the cooling tower for optimum performance.

Magnetic starters for fan(s) are not included with the cooling tower.

Option 9 Cooling Tower Pump (SC Model)

To maintain the discharge pressure of the system, water must be supplied to the condenser. A separate cooling tower pump is available to pump water from the cooling tower sump to the condenser inlet. Pump selections are based on the maximum condenser water flow based on the THR (total heat of rejection) and the total pumping head of the system. Total pump head provided is normally fifty (50) feet to allow for:

- The pressure drop through the condenser.
- The water regulating valve pressure drop.
- Piping (including any elevation between the pump discharge and inlet to the condenser).

Note:
For typical installations, a vertical lift of twenty feet (20') is allowed between the pump (which could be installed at ground level) and the unit mounted on a platform or the roof of a building.

When ordering the pump, information on the location of the pump relative to the condenser should be stated so that the correct pump head can be specified.

Magnetic starters or controls are not included with the pump.

Option 10 Air-Cooled Condenser With Flood-Back Controls And Starters (SCAR Model)

SCAR models are shipped without the condenser which is then field piped and wired.

Optional air-cooled condensers can be provided by TURBO to meet the requirements of each model. Standard design conditions for air-cooled condensing units are 100°F ambient, 20°F TD across the condenser, and 120°F saturated condensing temperature (250 psig). Condensers can be selected at different dry bulb conditions for specific installations (consult TURBO).

Each condenser must be installed with adequate space for:

- Inlet airflow
- Discharge airflow
- Free drainage of liquid from the condenser outlet to the receiver inlet
- A means of varying the airflow over the condenser coil to maintain a constant discharge pressure as well as to prevent excessively low discharge pressure (below 170 psig).

Properly sized receiver(s), isolation valves for inlet and outlet, high pressure relief valve, and receiver mounting brackets can also be provided as options.

Optional winterizing of the receiver is recommended for installations operating in ambients below 20°F.

Magnetic starters for the condenser fan motor(s) are not included. Field piping from the condenser to the unit high side is not provided. SCAR's are shipped with a refrigerant holding charge only. All refrigerant and refrigerant charging is by others.

Option 11 Evaporative-Condenser With Damper Controls (SCER Model)

The evaporative-condenser is field installed on SCER models. All piping and wiring from the condenser to the refrigeration high side is provided by others.

Optional evaporative-condensers are sized to handle the THR (total heat of rejection) based on the design condenser of 78°F wet bulb, and 95°F SDT (saturated discharge temperature) (185 psig). For different wet bulb conditions, consult TURBO.

Condensers must be installed with adequate space for:

- Inlet airflow and discharge airflow.
- Free drainage of the liquid from the condenser outlet to the receiver inlet.
- A means of controlling the airflow over the condenser coil to maintain a constant discharge pressure as well as prevent excessively low discharge pressure (below 170 psig).

A pressure switch wired in series with the condenser control wiring is provided to energize the water pump and fan controls after a minimum system pressure (150 psig) is obtained during start-up. The water pump is not cycled to control discharge pressure due to scaling problems caused by repeated wetting and drying of the coil surface.

Optional winterizing of the receiver is recommended for installations operating in ambients below 20°F.

Magnetic starters for the condenser fan motor and water pump are not included. Field piping from the condenser to the unit high side is not provided. SCER's are shipped with a refrigerant holding charge only. All refrigerant and refrigerant charging is by others.

Installation

Evaporative-condensers can be installed indoors or outdoors. Outdoor installations may require a sump heater and other protection from icing. An indoor sump may also be used.

Air Intake & Discharge Clearances

Clearance for air intake and discharge must be provided. When ordering an evaporative condenser (if the condenser location is restricted), consult TURBO for guidelines on installing the evaporative-condenser for optimum performance.

Option 12 Programmable Controller

Replaces standard electro-mechanical controls for CF6–CF88. Programmable controllers are standard on CF28 and larger.

Programmable controllers can be ordered on all icemakers (factory installed). Programmable controllers may also be retrofitted to all sizes of existing TURBO® icemakers.

Each control panel consists of:

- Programmable controller with programmer, power supply, CPU, input/output models, and rack.
- Magnetic starters for the:
  - Compressor(s) (magnetic contactor for semi-hermetic compressor)
  - Water pump(s)
  - Breaker bar(s)
- Master control switch
- Overload and safety controls

The PLC replaces the control relays and cam sequence timers. The PLC controls the refrigeration times, defrost times, and other operating sequences.

Complete documentation of the controller ladder logic is provided. Refrigeration and defrost times are set as "presets", which can be changed with the programmer provided.

Note:
Controls necessary for accessory components (screw conveyors, augers, etc.) used to convey the ice to points of use are not furnished by TURBO.

Option 13 Outboarding Of Compressors

All TURBO® icemakers, except the CF120 (60 ton), are supplied with the compressor and condenser (SC model only) mounted under the icemaker ice slide. The compressor and condenser (SC model only) can be mounted on a frame extension outboard of the icemaker. Access for service and maintenance is improved. Components on outdoor installations or in operating ambients below 40°F need to be protected. Optional winterizing or weatherizing may be required.

Outboard compressor(s) are mounted to the right as you face the ice discharge. Left-hand versions are available if specified.

Refer to Figure 8-1.

Option 14 Mirror Image Units

Mirror image units have reversed ice discharge outlets and connections. Ice discharge openings on units discharging into a common screw conveyor will not line up unless mirror image is specified. Typical mirror image for ice discharge openings alignment is not required.

Mirror image is normally required to ensure that the water and refrigerant connections and the control panel are on same end of the unit mounted opposite each other, on end to end. Refer to Figure 8-2.

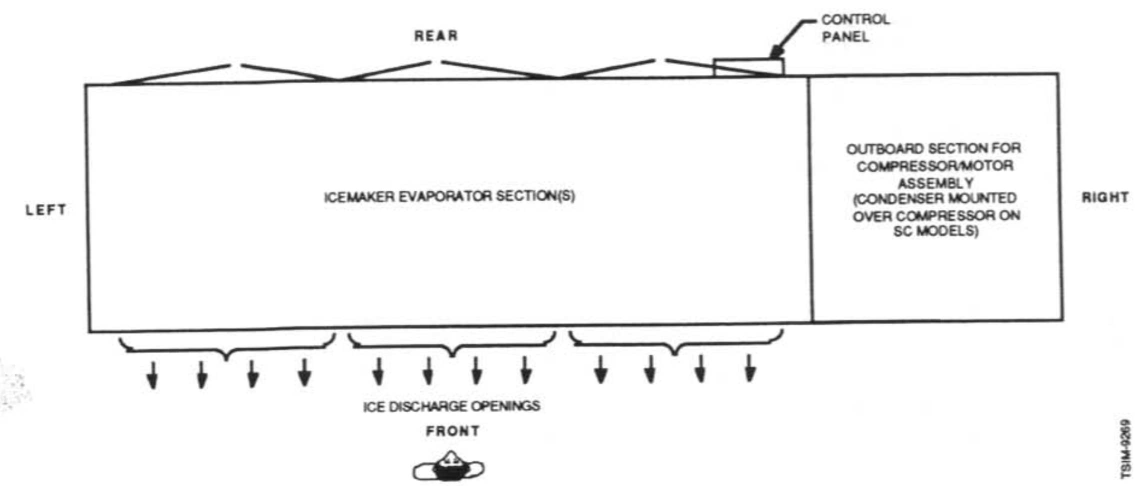

Figure 8-1 Typical Outboard Arrangement

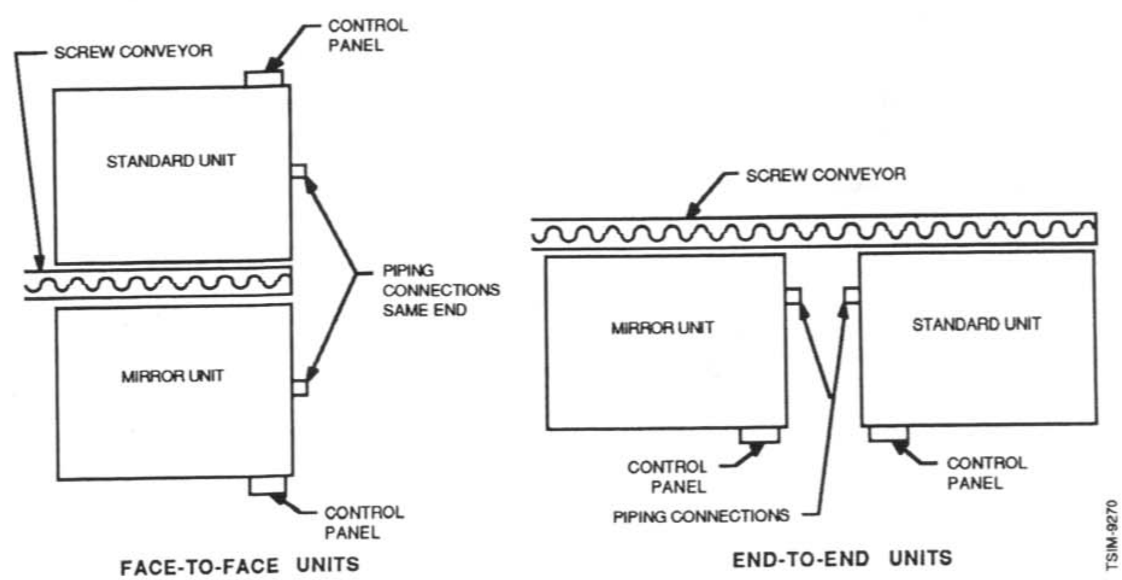

Figure 8-2 Typical Mirror Image Units

OPTIONS APPENDIX

Options Appendix contents are provided only when optional accessories are purchased.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

APPENDIX B:
WATER REGULATING VALVE (SC MODELS ONLY)
THREE-WAY VALVE

Figure 3-30 on page 95 (section 3 – Installation & Pre-Start-Up Requirements of this manual) illustrates a means of controlling the water regulating valves on multiple condenser installations. Operation where one or more condensers is inactive means that water flow to that circuit is no longer required. This requires that either a pump for each condenser must be installed or some means of bypassing the inactive circuit is provided.

Figure B-1 shows a typical single circuit machine with a three-way water regulating valve. In this arrangement, a constant water flow is maintained through the water-cooled condenser. The three-way valve modulates to return the water to the cooling tower or recirculates the flow to bypass the cooling tower. Water temperature entering the condenser varies and the flow remains the same.

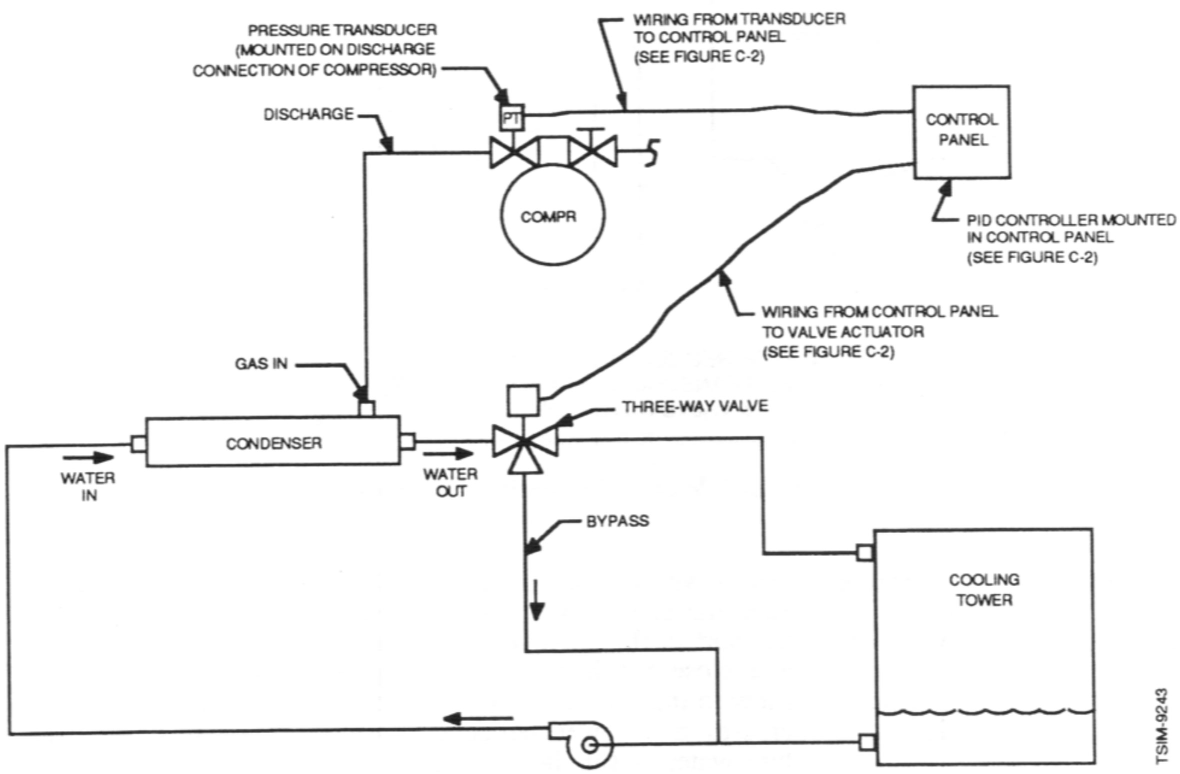

Figure B-1 Condenser With Three-Way Water Regulating Valve

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

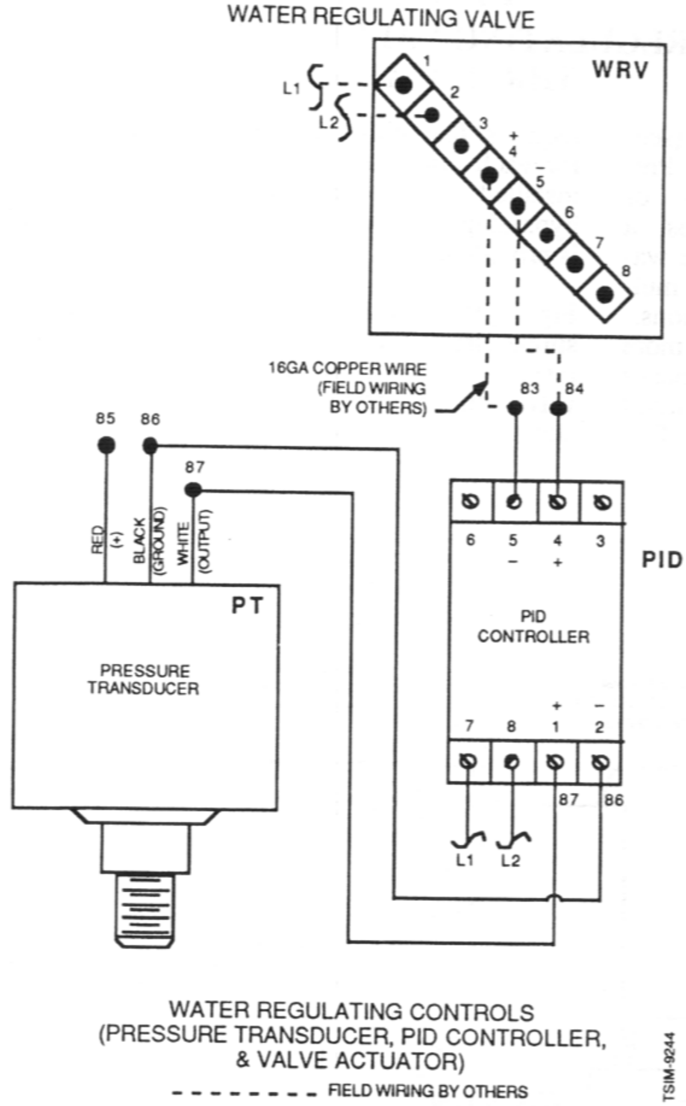

Figure B-2 Water Regulating Controls

A signal from a pressure transducer mounted on the discharge service valve is transmitted to a PID controller located in the control panel (refer to Figure B-2).

The controller drives a valve actuator to open or close the valve as required. For example, if the pressure transducer senses an increase in pressure, the controller will open the port to the cooling tower and close the bypass port. Flow to the cooling tower increases and lower temperature water is supplied to the condenser inlet to lower the discharge pressure. On the other hand, if the discharge pressure starts to decrease, flow to the cooling tower is restricted and the bypass flow is increased to raise the temperature of the water. Continuous modulation of the valves maintains the discharge pressure at the controller setpoint.

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Multiple condenser installations can be set up the same (refer to Figure B-3). Operation of each circuit is the same as described above. If a circuit (compressor) is inactive, the pressure transducer will sense the decrease in pressure as the compressor cools and equalizes. After the valve actuator reduces the flow from the inactive condenser, the active condensers continue to modulate to control the entering water temperature to the active condensers.

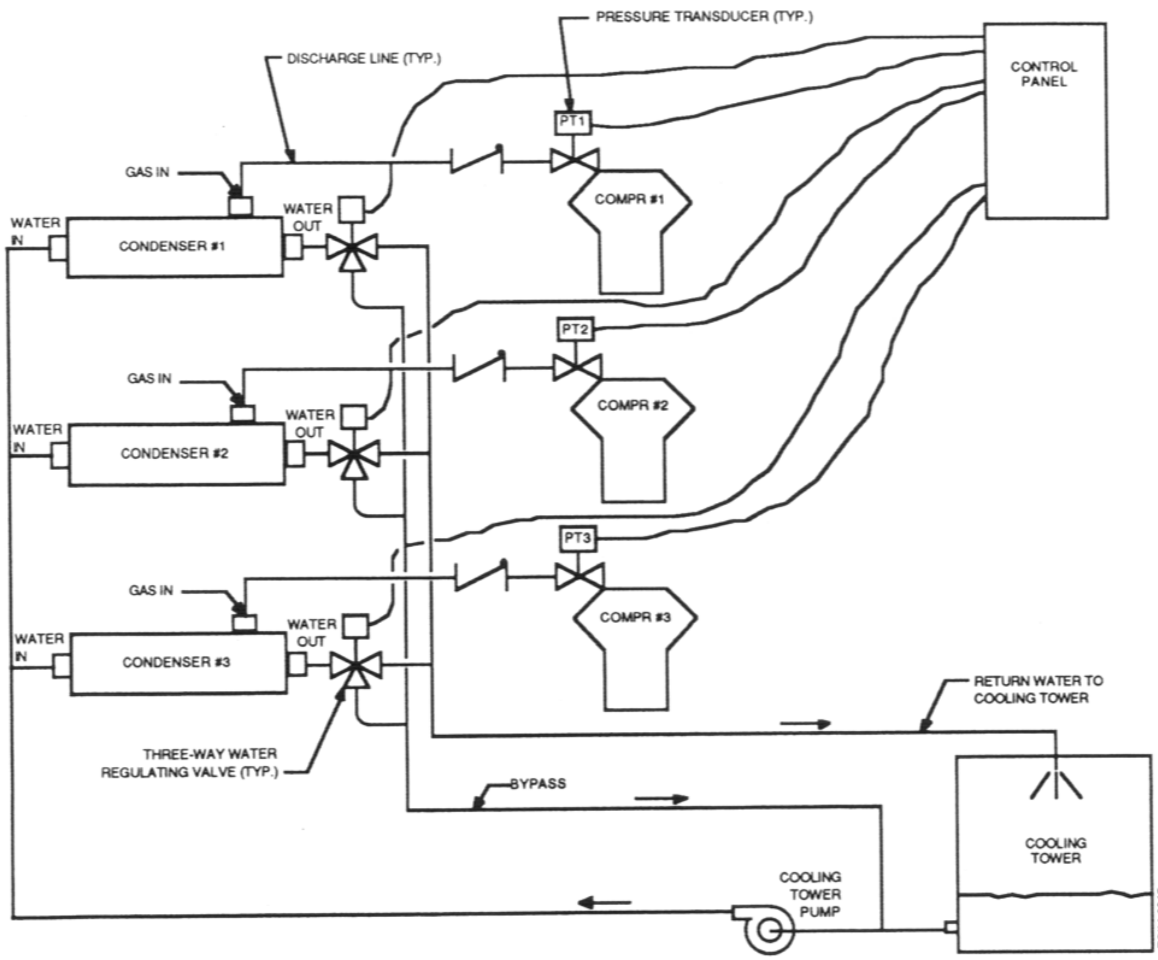

Figure B-3 Multiple Condenser Installation With Three-Way Water Regulating Valves

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

APPENDIXES & NOTES

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

APPENDIX A: INDUSTRIAL MODEL SPECIFICATIONS

Table A-1 Thick Ice – Remote Icemakers For Applications With R-22 High Side

Nominal Ice Capacity U.S. Tons (24 hrs.)	Model Number	Overall Dimensions L x W x H (inches)	Net Weight (lbs.)	Ship Weight (lbs.)	Recommended Comp. Cap. TR @ 0°F Suction	Breaker Bar (hp)	Water Pump (hp)	Defrost Water Flow (gpm)	Feed Water Conn. (inches)
1	CF2R	76 x 24 x 72	895	1007	1.86	1	1/3	3	1
2	CF4R	76 x 24 x 72	940	1052	3.72	1	1/3	6	1
3	CF6R	78 x 44 x 88	2220	2410	5.58	1 1/2	1/3	9	1 1/4
5	CF8R	78 x 44 x 88	2930	3120	9.30	1 1/2	1/2	15	1 1/4
7	CF14R	78 x 72 x 94	4762	5020	13.02	1 1/2	3/4	22	1 1/2
10	CF16R	78 x 72 x 94	5029	5284	18.60	3	3/4	30	1 1/2
14	CF28R	99 x 94 x 110	7769	8120	26.04	3	(2) 3/4	22	2
20	CF40R	128 x 94 x 110	8500	8958	37.20	3	(2) 3/4	30	2
28	CF56R	198 x 94 x 110	14772	15300	52.08	(2) 3	(4) 3/4	22	2
40	CF80R	256 x 94 x 110	15800	16440	74.40	(2) 3	(4) 3/4	30	2
60	CF120R	480 x 94 x 121	23185	23865	111.60	(3) 3	(6) 3/4	30	2

Specifications subject to change without notice.

TSIM-9268

Read Safety Section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Table A-2 Thick Ice – Self-Contained R-22 Icemakers

Nominal Ice Capacity U.S. Tons (24 hrs.)	Model Number	Overall Dimensions L x W x H (inches)	Net Weight (lbs.)	Ship Weight (lbs.)	Comp. (hp)	Water Pump (hp)	Breaker Bar (hp)	Defrost Water Flow (gpm)	Feed Water Conn. (in.–ips.)
1	CF2SC	76 x 24 x 72	1173	1285	3	1/3	1	3	1
1	CF2SCA	76 x 82 x 78	1793	2016	5	1/3	1	3	1
1	CF2SCAR	76 x 24 x 72	1331	1443	5	1/3	1	3	1
2	CF4SC	76 x 24 x 72	1402	1514	7 1/2	1/3	1	6	1
2	CF4SCA	76 x 86 x 78	2474	2698	10	1/3	1	6	1
2	CF4SCAR	76 x 24 x 72	1331	1443	10	1/3	1	6	1
3	CF6SC	78 x 44 x 88	3420	3610	15	1/3	1 1/2	9	1 1/4
3	CF6SCA	120 x 88 x 94	4070	4450	20	1/3	1 1/2	9	1 1/4
3	CF6SCAR	78 x 44 x 88	3170	3360	20	1/3	1 1/2	9	1 1/4
5	CF8SC	78 x 44 x 88	3730	3920	25	1/2	1 1/2	15	1 1/4
5	CF8SCA	134 x 88 x 94	4967	5347	30	1/2	1 1/2	15	1 1/4
5	CF8SCAR	78 x 44 x 88	3420	3610	30	1/2	1 1/2	15	1 1/4
5	CF8SCE	144 x 88 x 94	4967	5347	25	1/2	1 1/2	15	1 1/4
5	CF8SCER	78 x 44 x 88	3420	3610	25	1/2	1 1/2	15	1 1/4
7	CF14SC	78 x 72 x 94	5596	5854	35	3/4	1 1/2	22	1 1/2
7	CF14SCA	191 x 88 x 102	7204	7462	35	3/4	1 1/2	22	1 1/2
7	CF14SCAR	78 x 72 x 94	5466	5766	35	3/4	1 1/2	22	1 1/2
7	CF14SCE	88 x 150 x 102	7204	7462	35	3/4	1 1/2	22	1 1/2
7	CF14SCER	78 x 72 x 94	5466	5724	35	3/4	1 1/2	22	1 1/2
10	CF88SC	78 x 72 x 94	6626	6884	(2) 25	3/4	3	30	1 1/2
10	CF88SCA	213 x 88 x 102	8554	8964	(2) 30	3/4	3	30	1 1/2
10	CF88SCAR	78 x 72 x 94	6425	6680	(2) 30	3/4	3	30	1 1/2
10	CF88SCE	176 x 88 x 102	8554	8964	(2) 25	3/4	3	30	1 1/2
10	CF88SCER	78 x 72 x 94	6425	6680	(2) 25	3/4	3	30	1 1/2
10	CF16SC	78 x 72 x 94	6626	6884	(1) 40	3/4	3	30	1 1/2
10	CF16SCE	176 x 88 x 102	8554	8964	(1) 40	3/4	3	30	1 1/2
10	CF16SCER	78 x 72 x 94	6425	6680	(1) 40	3/4	3	30	1 1/2
14	CF28SC	99 x 94 x 110	9039	9390	(2) 35	(2) 3/4	3	22	2
14	CF28SCA	312 x 96 x 118	11500	11800	(2) 35	(2) 3/4	3	22	2
14	CF28SCAR	96 x 94 x 110	8519	8870	(2) 35	(2) 3/4	3	22	2
14	CF28SCE	240 x 94 x 118	11500	11800	(2) 35	(2) 3/4	3	22	2
14	CF28SCER	99 x 94 x 110	8519	8870	(2) 35	(2) 3/4	3	22	2
15	CF28SC	99 x 94 x 110	9039	9390	(1) 60	(2) 3/4	3	22	2
15	CF28SCA	312 x 96 x 118	11500	11800	(1) 60	(2) 3/4	3	22	2
15	CF28SCAR	99 x 94 x 110	8519	8870	(1) 60	(2) 3/4	3	22	2
15	CF28SCE	240 x 94 x 118	11500	11800	(1) 60	(2) 3/4	3	22	2
15	CF28SCER	99 x 94 x 110	8519	8870	(1) 60	(2) 3/4	3	22	2
20	CF40SC	128 x 94 x 110	11702	12160	(1) 75	(2) 3/4	3	30	2
20	CF40SCAR	128 x 94 x 110	9206	9664	(1) 75	(2) 3/4	3	30	2
20	CF40SCER	128 x 94 x 110	9206	9664	(1) 75	(2) 3/4	3	30	2
30	CF56SC	198 x 94 x 110	21012	21540	(2) 60	(4) 3/4	(2) 3	22	2
30	CF56SCAR	198 x 94 x 110	19972	20500	(2) 60	(4) 3/4	(2) 3	22	2
30	CF56SCER	198 x 94 x 110	19972	23600	(2) 60	(4) 3/4	(2) 3	22	2
40	CF80SC	256 x 94 x 110	22580	23220	(2) 75	(4) 3/4	(2) 3	30	2
40	CF80SCAR	256 x 94 x 110	21760	22400	(2) 75	(4) 3/4	(2) 3	30	2
40	CF80SCER	256 x 94 x 110	21760	22400	(2) 75	(4) 3/4	(2) 3	30	2
60	CF120SC	480 x 94 x 121	40075	40755	(2) 100	(6) 3/4	(3) 3	30	2
60	CF120SCER	480 x 94 x 121	38475	39175	(2) 100	(6) 3/4	(3) 3	30	2

Specifications subject to change without notice.

TSIM-9267