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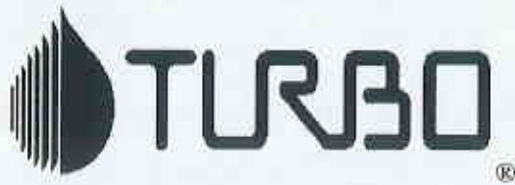
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TIGAR Icemaker

Installation, Operation and Maintenance Manual



TIGAR Series Ice Generators Installation, Operation & Maintenance Manual



**TIGAR Ice Generator
Operation & Maintenance Manual**

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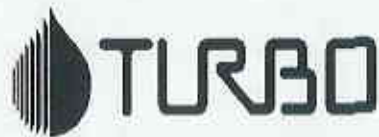


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TIGAR Ice Generator Operation & Maintenance Manual

INTRODUCTION

Turbo Refrigerating is a supplier of icemakers and storage systems for use in producing high quality nugget ice. TURBO does not engineer or design buildings, warehouses, mechanical rooms, or any structures that use icemaking equipment. TURBO can assist in all phases of selecting the proper equipment to meet customer needs.

Information on safety, installation, operation, maintenance, and troubleshooting is contained in this manual. If you have questions, contact TURBO or one of its distributors.

You must read all of the information carefully and make sure that all personnel involved in the installation and operation have 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.

Since 1960, Turbo Refrigerating has made the

highest quality industrial icemakers available on the market. 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.

TURBO offers this manual as a guide to owners and operators of TURBO® icemaking systems to assist in maintaining the equipment in a reliable and efficient manner.

Please read all information carefully and follow all instructions in order to avoid damage to equipment or injury to personnel. Review the installation instructions prior to the actual rigging operation to ensure that all of the necessary equipment will be available at the jobsite. This can also be used to acquaint all personnel with the proper procedures to be followed during installation.

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:

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Denton, Texas 76202-0396
Phone: 940-387-4301
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History

Turbo Refrigerating has been producing equipment for the ice industry since 1960. Since developing the plate icemaker, TURBO has been the leader in icemaking technology.

Single source packaged systems provide simple installation and fast start-up.

The ice generators described in this manual are part of a family of products designed specifically to meet the needs of the industrial ice users. The TIG/TIGAR series ice generators were introduced in 1985. Although they are the youngest member of the

TURBO family, they are built with the same high quality standards of engineering used to develop the icemakers of the 60's. Many of the latest developments in technology are used to design the TIG/TIGAR series ice generators. TIG/TIGAR ice generators have also been used in packaged ice applications by adding a TURBO ice sizer and improving the ice handling systems. In 2000 an upgraded version of the TIGAR with a new larger evaporator plate was introduced for both the industrial and packaged ice markets.

In applications where totally dry uniform ice is not required, the TIG/TIGAR series offers a low cost alternative. Applications requiring uniform ice can also be done at a lower cost per ton than other systems.

Icemakers versus Ice Generators

There are several basic differences between TURBO® icemakers (C-series) and TURBO® ice generators (TIG/TIGAR series).

TURBO® Icemakers

The traditional TURBO® icemaker was designed to meet the needs of the packaged ice industry where dry, sub-cooled, uniform

pieces of ice are essential. To meet these requirements, TURBO® icemakers make ice on only one side of the plate and warm water is used to harvest (some models are available with hot gas assist). The water to each section is cut-off and a drying cycle is used. Both of the above ensure a dry, sub-cooled ice. As the ice separates from the plates, it is metered into a breaker assembly to ensure uniform ice size. The sizing system consists of:

- A rotating breaker bar
- An adjustable sizer bar
- A fixed sizer grate

The unique sizing adjustment along with ice thickness controls allows the TURBO® icemaker to produce a wide variety of ice nugget sizes.

TURBO® Ice Generators – Industrial Applications

The TURBO® ice generators were designed to meet the needs of the industrial user requiring ice for its cooling effect rather than for consumption. TIG/TIGAR series units maintain the same operating technology, and sanitation requirements as the icemakers maintain, while eliminating the icemaker features not essential to their applications. In the TIG/TIGAR, the drying cycle and warm water harvest are replaced by a hot gas harvest, and the ice breaker/sizer mechanism is replaced by an auger to break the ice into irregular sizes. As a result, a random shaped piece of

fragmented ice is produced at a lower cost per ton.

TURBO® Ice Generators – Packaged Ice Applications

The standard TURBO® ice generators are modified to include a dry harvest and an external TURBO ice sizer is added to the system to obtain a uniform nugget size. In the TIGAR models the water flow is terminated during the harvest cycle and the control of the ammonia liquid and hot gas is modified to obtain reliable operation. As a result, a uniform shaped piece of fragmented ice is produced at a lower cost per ton. Dry harvest models produce slightly less capacity than the standard industrial version. This version is not offered in the TIG (R-22) version at this time.

Standard TIGAR Ice Generator (Ammonia)

Standard TURBO® icemakers use a water defrost and produce a dry, hard ice on one side of the evaporator plate. TIGAR ice generators use hot gas defrost and produce ice on both sides of the evaporator plate. TIGAR ice is wet when compared to the C-series icemaker ice. With proper handling, TIGAR 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.

TIGAR models do not have a built-in ice sizing mechanism

Read Safety Section before installing and using equipment

(standard on C-series). An external ice sizer must be used to obtain the uniform ice nugget sizing required.

All parts of the TIGAR 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 this model uses 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.

All TIGAR ice generators are provided with:

- Aluminum exterior panels (stainless steel optional)
- 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 NH₃ headers and cabinet interior piping in ice area
- Stainless steel ice slide
- Stainless steel evaporator plates
- All stainless steel and PVC water circulating system

- 230/3/60 or 460/3/60 motors with 115/1/60 controls; magnetic starter with overload protection for each motor
- Stainless steel water distribution pan

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

All TIGAR-FL (flooded) ice generators are provided with:

- Surge drum
- Two level switches
- Oil accumulator drum
- Hot gas strainer

These items are shipped loose for field installation. This equipment is intended for use on a central NH₃ system. For dedicated compressor systems, consult the factory.

Note:

Ammonia will be referred to as NH₃ in this manual.

Models

R (Remote Evaporator)

Low side evaporator including suction accumulator/heat exchanger for connection to remote high side equipment.

No refrigerant charge provided.

AR (Ammonia Remote)

Ammonia evaporator set up for connection to a remote ammonia recirculation and high side equipment.

Contains all controls for icemaking and electrical interface with remote refrigeration equipment.

Ammonia high side and recirculation packages can be furnished as options.

No refrigerant charge is provided (shipped with nitrogen holding charge only).

Capacities

The TIGAR series is available in 25, 50, 75, and 100 tons of ice per day models for TIGAR25, TIGAR 50, TIGAR75, and TIGAR100 models. All capacities are based on 60°F make-up water and 0°F evaporator temperatures.

Newer version TIGAR3620, TIGAR3636, TIGAR3656, and TIGAR3672 range in capacity from 51 to 184 tons per day for industrial application, and 45 to 163 tons per day for packaged ice applications. For complete capacity information reference Section 3 – Installation.

USDA Approved

All TURBO® TIGAR series ice generators have been successfully installed and operated in USDA inspected facilities and are built to meet rugged industrial standards which make them the most reliable in the industry. Each system is designed to provide the safest and simplest operation as well as to minimize maintenance.

Read Safety Section before installing and using equipment

Operation – Industrial Applications

The basic operating sequence of the TIGAR series unit is as follows:

1. Incoming water is fed into a tank located within the unit. A simple, easy to adjust float valve is used for this purpose. A distribution header is attached to the outlet of the float valve to distribute incoming water along the length of the tank.
2. Water is pumped from the tank through PVC pipe to a water distribution pan above the plates.
3. As the water leaves the stainless steel distribution pan, it is evenly distributed along the length of each plate.
4. Water leaving the bottom of the plate is collected in the ice discharge slide and returned to the tank for recirculation to the plate.
5. During this sequence, refrigeration is supplied to the plates and ice is built on both outside surfaces of the plates.
6. After a preset time, the refrigeration to a section of plates is removed and hot gas is introduced into

the plate. The water continues to run over the plates to assist in the harvest.

7. As the water and ice separate from the plates, they are collected by the ice slide and converge in a perforated trough.
8. The water drains through the perforated holes in the trough and back into the water tank. Ice is removed from the trough by the integral auger to the unit ice discharge.
9. A dry out section of trough as well as a special ice discharge are used to eliminate virtually all water from the ice.
10. After a preset time period, the harvest sequence for this group of plates ends and the section returns to the icemaking mode.
11. The next section of plates goes into harvest.
12. This sequence will repeat as long as the ice generator is operating.

Note:
The ice thickness can be varied from 3/16" to 1/2" by simple control changes. All sections are harvested one at time; i.e. a four section machine such as the TIGAR100 would have four harvests for each cycle.

Operation – Packaged Ice Applications (Dry Harvest)

The basic operating sequence of the dry harvest TIGAR series unit is as follows:

1. Incoming water is fed into a tank located within the unit. A simple, easy to adjust float valve is used for this purpose. A distribution header is attached to the outlet of the float valve to distribute incoming water along the length of the tank.
2. Water is pumped from the tank through PVC pipe to a water distribution pan above the plates.
3. As the water leaves the stainless steel distribution pan, it is evenly distributed along the length of each plate.
4. Water leaving the bottom of the plate is collected in the ice discharge slide and returned to the tank for recirculation to the plate.
5. During this sequence, refrigeration is supplied to the plates and ice is built on both outside surfaces of the plates.
6. After a preset time, the refrigeration to a section of plates is removed and hot gas is introduced into the plate. The water pump to the sections in harvest is turned off.

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NOTE: Dry harvest models have an ice discharge on both ends of the unit and the harvest is done for each half of the unit; i.e. a four section machine such as the tIGAR3672 has four sections. Two sections are harvested at the same time with half the machine discharging from one end during its harvest sequence and the other half discharging from the opposite end during its harvest sequence. This eliminates water flow over the ice during harvest.

7. As the ice separates from the plates, it is collected by the ice slide and converges into a perforated trough.
8. Water remaining on the ice drains through the perforated holes in the trough and back into the water tank. Ice is removed from the trough by the integral auger to the unit ice discharge.
9. A dry out section of trough as well as a special ice discharge are used to eliminate virtually all water from the ice.
10. After a preset time period, the harvest sequence for this group of plates (2 sections) ends and the section

returns to the icemaking mode.

11. The next group of sections goes into harvest.
12. This sequence will repeat as long as the ice generator is operating.

Note:

The ice thickness can be varied from 3/16" to 1/2" by simple control changes.

Sanitary Ice

TURBO makes every effort possible to minimize the potential for contamination of the ice produced on the ice generators (as well as all other products). All water and ice contact areas are either stainless steel, PVC, or hot-dipped galvanized. In addition, the stainless steel water distribution pan is open and easily accessible for cleaning.

The hole pattern in the water distribution pan acts as a secondary screening media for the water on the plates. A strainer is provided in the make-up water line. TURBO strongly urges each user to consult a local water treatment specialist to determine any water treatments that might be beneficial in obtaining the best ice possible.

Controls

TURBO® ice generators use the latest controls available for simple, reliable operation. All models are supplied with:

- Magnetic starters with overload protection (for all motors furnished with the ice generator – extra starters for remote equipment are optional)
- A programmable controller
- All selector switches required for automatic operation of the system

All components are mounted in a stainless steel electrical enclosure (UL Type 3R). Control panels are UL approved.

Ice Delivery

Ice produced by the ice generator is delivered to a common ice discharge opening outside the cabinet of all models. As noted previously dry harvest models have two ice discharge openings. Each discharge opening is a standard screw conveyor down spout. TURBO recommends that an inclined transfer screw conveyor or belt conveyor be used to transfer the ice from the ice discharge to its final delivery point. Such arrangements prevent any condensation or water from:

- Accidentally dumping into the system
- Draining or flowing into the final icing points

IMPORTANT

All conveyors, transitions, or belts connecting to the ice discharge should ensure that access into the screw conveyor (auger) is eliminated. Refer to section 2 – Safety.

Other TURBO Equipment

TURBO® Icemaker

Since 1960, TURBO has provided icemaking equipment for the packaged ice industry. TURBO® icemakers for this application produce a dry, sub-cooled, and uniform sized ice suitable for bagging and distribution to convenience and grocery stores. Stainless steel, PVC, or hot dip galvanizing is used on the icemaker everywhere the ice comes into contact to ensure a sanitary ice. These icemakers have been successfully installed and operated in USDA inspected facilities and are suitable for use in food processing applications.

TURBO® TIG Ice Generator (R-22)

Standard TURBO® icemakers (above) use 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. The TIG ice generator is provided in capacities from 4 to 85 tons per day.

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 get your money’s worth out of 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 TURBO® 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 is provided with a block bagger attachment which means:

- Less handling
- A better product
- Higher profits for the ice person

Rugged industrial construction and stainless steel or high density plastic 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 three 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 87 tons of ice while the larger automatic ice rakes range from 100 to 300 tons of ice storage.

All TURBO® ice storage systems have been successfully installed and operated in USDA inspected facilities. Each system is designed to make the loading and unloading of the ice in the storage system as safe and simple as possible. TURBO®

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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 TIGAR ice generator) into a uniform nugget suitable for packaging. A minimum of snow is produced. The addition of the ice sizer to the TIGAR 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.

Chillers can also be used with TIGAR ice generators to reduce the make-up temperature. As the make-up temperature is reduced, ice production is increased.

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 hold icing
- Truck icing
- Top icing in the field
- Concrete icing
- Chemical processes
- Bakery 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.

Ammonia (NH₃) High Side (Optional)

Complete skid mounted NH₃ high sides include 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

On CAR and TIGAR models, an NH₃ liquid recirculation unit is required in addition to the high side. On CAR-LR models, the addition of a high side only

is required. High sides can be provided for single icemakers (dedicated use) or for multiple icemakers.

Ammonia (NH₃) Liquid Recirculation Unit

Complete skid mounted recirculation packages include the:

- Surge drum
- Recirculation pump(s)
- Oil recovery system, controls, and regulators
- Isolation valves

This package is used only with CAR or TIGAR models to provide the recirculated liquid refrigerant to the evaporator.

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

Typical Industrial Applications

- Produce (broccoli, carrots, etc.) – Top icing in the field or processing area or 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 human consumption

Customer Service

The TURBO service department provides assistance for all customer needs. TURBO conducts training schools at the factory and at various locations throughout the world.

The model and serial number of your TURBO equipment is located on the data 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:

Think safely – act safely.

Understand operating procedures and dangers of the equipment.

Remember to think before you act.

Before you act, understand the consequences of your actions.

Observe equipment warnings and labels.

TERMS & CONDITIONS

Turbo Refrigerating, LLC (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.

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(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.

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(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

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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, insurrection 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

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(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.

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



TIGAR Ice Generator Operation & Maintenance Manual

SAFETY

Here are some safety points to keep in mind when creating an efficient yet 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

Indicates 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 as well as state and federal requirements.
- Have sufficient safety warnings on all equipment.
- Make sure all safety devices and guards are in place.

Note:

Warning labels attached to the control panel, screw trough extension, belt pulley guard, and on access panels should be followed. They are shown in Figures 2-1, 2-2, 2-3, and 2-4.

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



Figure 2-1 Warning Labels on Control Panel



Figure 2-2 Warning Label on Screw Trough Extension

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

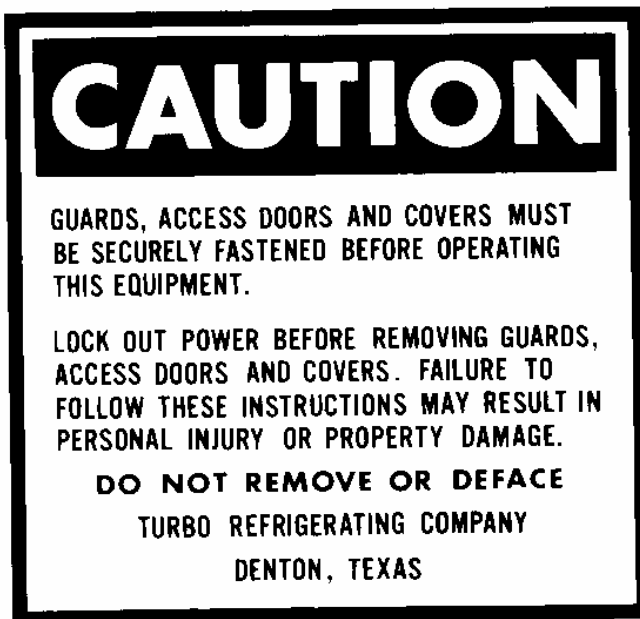


Figure 2-3 Warning Label on Access Panels



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.

If all labels are not attached and visible or labels start to become illegible, contact:

**Turbo Refrigerating
Service Department
P.O. Box 396
Denton, Texas 76202-0396
Phone:940-387-4301
Fax: 940-382-0364**

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 TIGAR.

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

WARNINGS

The TIGAR 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 TIGAR unless all electrical power is disconnected and locked out.

The ice discharge opening has a warning label (refer to 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.

Pull disconnect and lock out 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 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 proper 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 TIGAR TURBO recommends that at least two (2) people be present at all times.

Although TURBO 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.

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

All NH₃ field piping should be done in compliance with section 5 of Standard ANSI/IIAR 74-2-1984 (or the latest edition, if available). Field piping is not supplied by TURBO.

All NH₃ relief valve vent lines must be routed to a safe

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

discharge location having adequate ventilation to dissipate the NH₃. Consideration should be given to prevailing winds to ensure that refrigerant releases are not carried to or trapped in occupied areas.

Some states or local codes require a water system capable of absorbing the entire NH₃ charge to prevent the release of NH₃ to the atmosphere. The contractor should verify that the method used meets local, state, and federal codes.

Note:

Field piping is required by others from all safety relief devices supplied with the various components.

Adequate emergency equipment, including NH₃ masks with good canisters, should be located at all locations. Wash basins or shower heads for eye wash should be available for treatment of exposure to NH₃.

A written evacuation plan should be available to all employees and the local fire department should be provided with a copy. The written plan should be developed jointly between the fire department and operators or other designated personnel familiar with the NH₃ system. Fire department personnel should be familiarized with the NH₃ system, including the location of isolation valves and controls for terminating operation of

Safety

the system and/or isolating leaks. Emergency phone numbers should be posted in a visible manner near all areas in which the equipment is located.

IMPORTANT

A copy of the evacuation plan should be available in each area in which equipment is located. The location should be clearly marked, easily accessible, and away from piping or components from which escaping NH₃ would prevent access.

All leaks should be reported and repaired immediately.

Each pressure vessel is equipped with a safety relief valve to prevent operation over design limits. All safety relief valves are the dual safety relief type with a three-way manifold. If a safety relief valve discharges, the three-way valve position should be changed to the "good" relief valve and the "discharged" relief valve immediately replaced.

WARNING

Never install a second relief valve in the outlet of the original valve. All relief valves used in this system are atmospheric relief devices. Installation of any restriction in the valve outlet, including a second relief valve, will prevent proper operation of the safety relief valve. Failure to carefully follow

these instructions could result in permanent injury or loss of life.

Additional information on NH₃ system safety may be obtained through the International Institute of Ammonia Refrigeration (IIAR). To request bulletin #109 "IIAR Minimum Safety Criteria for A Safe Ammonia Refrigeration System," contact IIAR at:

International Institute of Ammonia Refrigeration
1110 North Glebe Road,
Suite 250
Arlington, Virginia
22201
Phone: 703/312-4200
Fax: 703/312-0065
E-mail: iiar@iiar.org

Notes:

1. Conveyor manufacturer's instructions and warnings are on pages 2-7 and 2-8.
2. Per the OSHA Hazard Communication Standard, material safety data sheets for refrigerant and refrigerant oils are on pages 2-9 through 2-16.
3. The safety lockout procedure is on pages 2-9 through 2-11.
4. 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

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

equipment, and properly installed.

Checklist for Lock Out Of Controls

To lock out the TIGAR controls:

1. Pull disconnects and lock out all electrical service – single-phase and three-phase power. Refer to the “Safety Lockout Procedure” on page 2-9.
2. Turn the master control selector switch (provided) to the “off” position.

Emergency Stop Button

A red push/pull mushroom head emergency switch is on the control panel door for emergency cut-off of the control circuit power. This button is not to be used for service or lock out. This is an emergency button only.

If you have any questions, call Turbo Refrigerating Service Department at:

Telephone: 940-387-4301
Fax: 940-382-0364

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 does not install conveyors. 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 insists that disconnecting and **locking out** the power to the motor driving the unit provides the only real protection against injury. Other devices should be used as a

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

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 **lock out** power before removing covers or guards. This could result in a serious injury should the secondary device fail or malfunction.

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 to 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.

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

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

stored energy would create a hazard, the employee must turn off all power to the unit or 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 than 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 then 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

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

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.

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 Anhydrous Ammonia

I. Product Identification

Trade Name: Anhydrous Ammonia

Synonyms: Ammonia

Manufacturer's Name: USS Agri-Chemicals, Division, United States Steel Corporation

Regular Telephone: 404/572-4000

Emergency Telephone: 800/424-9300 (Chemtrec)

Address: P.O. Box 1685, Atlanta, GA 30301

Chemical Name: Ammonia

Formula: NH₃

CAS No.: 7664-41-7

Chemical Family: Nitrogen Hydride

EPA Reg. No.: Code A100-6259

II. Hazardous Ingredients

Material or Component: Ammonia

%: 100

Hazard Data (TLV): 50 PPM in air by volume, 8 hour time weighted average in any 8-hour work shift of a 40-hour work week (OSHA).

III. Physical Data

Boiling Point, 760 MM Hg: -33.3°C (-28.0°F)

Melting Point: @ 1 atm.: -77.8°C (-107.9°F)

Specific Gravity (H₂O=1): @ -33.3°C, 1 atm.: 0.682

Vapor Pressure: Sat. Liq. @ 32°F: 47.6 psig

Vapor Density (Air=1): @ 0.0°C (32°F), 1 atm.: 0.597

Solubility in H₂O % By Wt.: @ 32°F, 1 atm.: 47.3

% Volatiles by Vol.: 100

Evaporation Rate (Butyl Acetate=1): not applicable

Appearance And Odor: Colorless liquid or vapor with characteristic pungent odor.

IV. Fire and Explosion Data

Flash Point (Test Method): Not applicable.

Autoignition Temperature: 671°C (1204°F) (iron bomb)

Flammable Limits in Air, % by Volume: 16 – 25

Extinguishing Media: Water spray or fog, dry chemicals, carbon dioxide.

Special Fire Fighting Procedures: Stop flow of gas; move containers from fire zone if possible; stay clear of tank heads; use water to keep fire exposed containers cool and to protect personnel. Fire fighting personnel must be equipped with appropriate protective clothing and respiratory equipment.

Unusual Fire and Explosion Hazard: Presence of oil or other combustibles will increase fire hazard.

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

V. Health Hazard Information

Toxicity Data

Inhalation: Moderately toxic. LCLo: 1,000 PPM/3 hrs. (Humans)

Skin Contact: Corrosive: 1st and 2nd degree burns. Burns may be fatal if extensive.

Skin Absorption: Not listed as potentially contributing to overall exposure by the cutaneous route.

Eye Contact: Corrosive: Blindness may follow serious eye burns caused by liquid ammonia.

Ingestion: Highly Toxic: Five ml of ammonia solution (28% NH₃) has been recorded a fatal oral dose.

Effects of Exposure

Acute Overexposure: Concentrations of ammonia in air of 5,000 to 10,000 PPM are reportedly fatal.

Chronic Overexposure: Concentrations of ammonia in air of 2,500 to 6,000 PPM during 30 minute exposure are considered dangerous to life.

Emergency and First Aid Procedures

Eyes: Flood immediately with copious quantities of clean water. Irrigation must continue for at least 15 minutes. Patient must receive prompt attention from a physician.

Skin: Flood with water for 15 minutes and remove any contaminated clothing. Do not use salves or ointments during 24 hour period after injury. Subsequent treatment is as for thermal burns.

Inhalation: Remove to uncontaminated area and begin artificial respiration immediately if necessary. If available, administer oxygen when breathing restored. Call physician.

Ingestion: If patient is conscious and able, have him drink large quantities of water. If vomiting begins, place patient face down with head lower than hips.

Notes to Physician: If respiratory embarrassment is the result of pulmonary edema, provide appropriate supportive treatment and drug therapy.

VI. Reactivity Data

Conditions Contributing To Instability: Dissociation begins to occur at 429° – 498°C (804° – 930°F)

Incompatibility: Store separately from oxidizers, halogens and acids.

Hazardous Decomposition Products: Hydrogen and nitrogen.

Conditions Contributing To Hazardous Polymerization: Not applicable.

VII. Spill or Leak Procedures

Steps To Be Taken If Material Is Released Or Spilled:

Stop leak if no risk involved. Avoid breathing vapor or liquid. Evacuate personnel not equipped with protective clothing and equipment. Use copious amounts of water spray or fog to reduce concentration and lower vapor pressure. Do NOT put water on liquid ammonia spill unless more than 100 volumes of water are available for each volume of liquid ammonia.

Neutralizing Chemicals: Do NOT neutralize with chemicals. Use water only.

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

Waste Disposal Method:

Contain run-off of liquid ammonia or ammonia in water from getting into a stream, lake, sewer, or ditch by building a dam. Let ammonia evaporate or soak into the ground. Notify local, state, and federal authorities. Release of 100# or more of ammonia within 24 hours must be reported to the National Response Center, telephone: 800/424-8802.

VIII. Special Protection Information

Ventilation Requirements: Under normal operating conditions, sufficient ventilation is required to avoid vapor concentrations exceeding a threshold limit value of 50 PPM in air by volume based upon an 8-hour time weighted average. See 29 CFR 1910.1000.

Specific Personal Safety Equipment

Respiratory (Specify in Detail): Gas masks with canisters approved for ammonia by NIOSH/MSHA may be used in concentrations in air of up to 30,000 PPM. Over this limit or in unknown concentrations, approved air supplied respiratory equipment in pressure demand mode must be used.

Eye: Tight fitting chemical splash goggles with hooded ventilation. A full face shield may be worn over the goggles for additional protection, but not as a substitute for the goggles.

Gloves: Gauntlet type rubber or plastic impervious to ammonia.

Other Clothing and Equipment: For emergency and rescue purposes, protective slicker or protective pants and jacket; protective boots; hard hat; life line; safety shower and eye wash.

IX. Dot Information

Shipping Name: Anhydrous Ammonia, Nonflammable Gas, UN1005, RQ

Classification: Nonflammable Gas

Label: Nonflammable Gas

Placard: Nonflammable Gas

USSAC Hazard Class Code: C2

X. Special Precautions

Precautionary Statements:

WARNING! HAZARDOUS LIQUID AND VAPOR UNDER PRESSURE. LIQUID CAUSES BURNS. VAPOR EXTREMELY IRRITATING. Do not breathe vapor. Do not get in eyes, on skin, or clothing.

Other Handling and Storage Requirements:

Store and use with adequate ventilation, protect containers from excessive heat or physical damage. Zinc, copper, and copper base alloys such as brass are subject to rapid destruction by moist ammonia. Refer to ANSI K61.1.

The information and recommendations contained herein are based upon data believed to be correct. However, no guaranty or warranty of any kind expressed or implied is made by TURBO with respect to the information contained herein. This data is provided solely for your consideration and investigation.

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 3 GS & 4 GS

Product: Refrigeration Oil Suniso 3GS and 4GS

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, CO₂ 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 q

Strong Base q

Stable n

Unstable q

Viscosity SUS at 100° F: <100 q 100 or > n

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: n Dry Chemical n CO₂ n Water fog
q Water spray n Foam n Sand/Earth
q Other:

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

Section IV. Health Hazard Data

Permissible Concentrations (air): 5 mg/m³ mineral oil mist (OSHA).

Effects of Overexposure: 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

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. n

Regulated by D.O.T. q

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

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

Section IX. Comments

CAS #64742-52-5

Signature: _____

Title: _____

Telephone: _____

Date: _____

Revision Date: _____

Sent To: _____

Supersedes: _____

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 TURBO assumes 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.

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



TIGAR Ice Generator Operation & Maintenance Manual

INSTALLATION & PRE-START-UP REQUIREMENTS

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

This section includes step-by-step instructions on installing and connecting your TIGAR unit. Your TIGAR unit has been tested and inspected at the factory prior to packing and shipping.

Recirculated and Flooded Models Installation Sequence

1. Delivery Inspection
2. Hoisting or Moving
3. Site Preparation
4. Building Openings (Ice Chutes) To Storage
5. Optional High Side and/or Refrigerant Recirculation Unit
6. Electrical Connections
7. Water Connections
8. Refrigerant Piping
9. Testing Refrigeration System for Leaks – Field Piping
10. Evacuating the System
11. Charging the System with Refrigerant Oil
12. Refrigerant Charging
13. Pre-Start-Up Checklist

14. 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.

To Help You Get Started

Read the instructions completely before installation or operation of the equipment.

Gather all required tools.

The control panel is on the rear left when viewed from the rear.

Recirculated Models

Establish front and rear, and left and right of the TIGAR unit by facing the evaporator sections (refer to Figure 3-1).

Packaged ice version (dry harvest) – dual ice discharge:

- A screw conveyor discharge is located on both ends of the TIGAR unit for packaged ice models. Ice does not discharge from both ends at the same time; i.e. during a typical cycle ice will be discharged from the right end for the harvest

of sections 1 and 2, and from the right end for the harvest of sections 3 and 4.

- The water connections are on the left side of the TIGAR unit.
- All refrigerant connections can be made on the right or left side of the evaporator section.

Use this method when referring to parts that are left, right, front, or rear.

Industrial version – single ice discharge:

- The screw conveyor discharge is on the right as you face the front of the TIGAR unit for industrial models. Ice is discharged from the same end for all sections.
- The water connections are on the left side of the TIGAR unit.
- All refrigerant connections can be made on the right or left side of the evaporator section.

Use this method when referring to parts that are left, right, front, or rear.

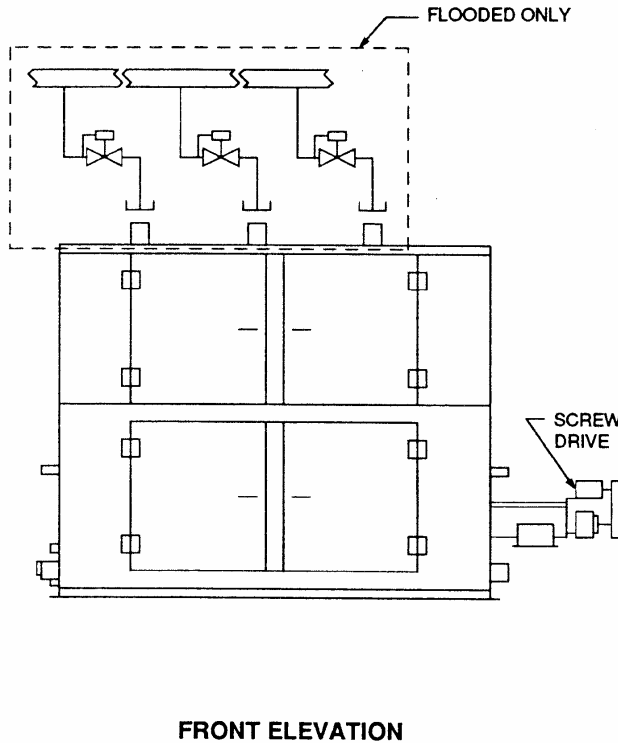
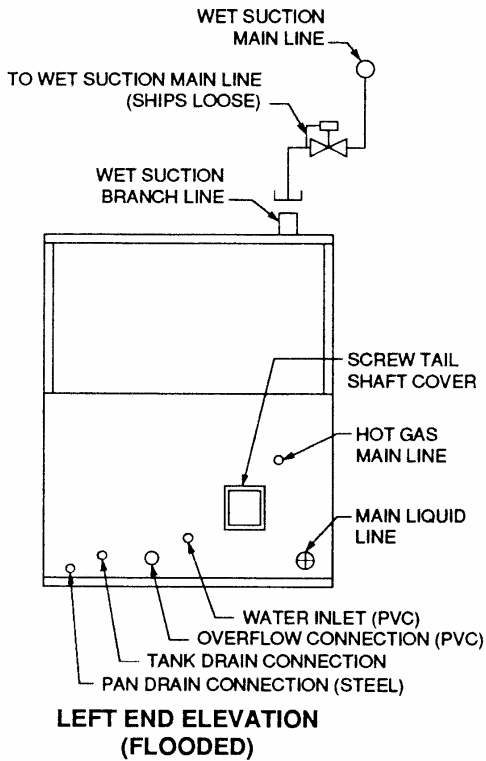
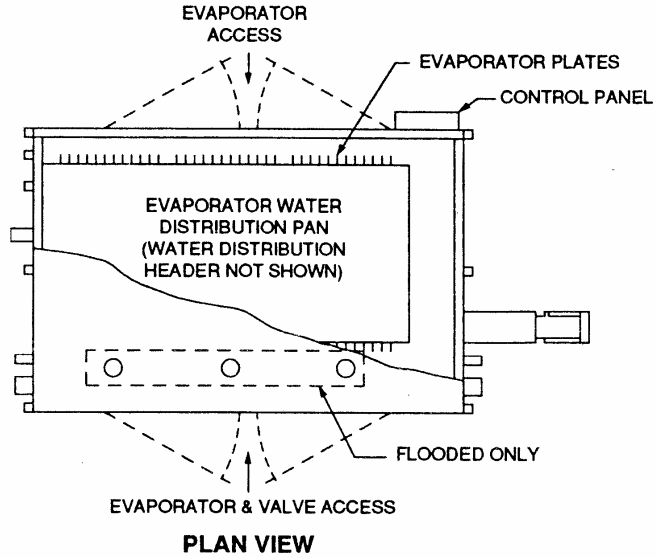
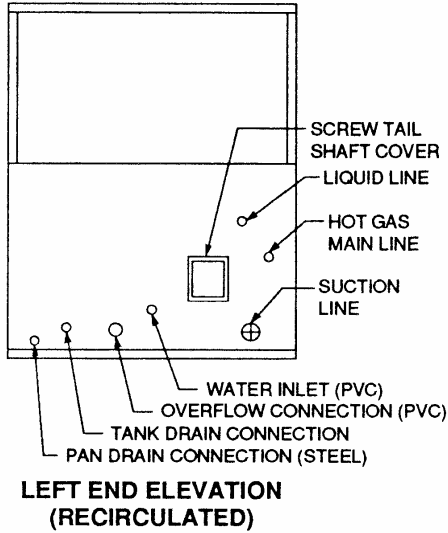
WARNING! Read safety section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Flooded Models

Establish the front and rear, and left and right of the evaporator. The ice discharge opening

should be on your right as you face the front of the evaporator (refer to Figure 3-1).

NOTE: REFRIGERANT CONNECTIONS CAN BE MADE FROM EITHER END.



NOTE: ALL WATER & REFRIGERANT PIPING LOCATIONS ARE APPROXIMATIONS.

TSTIGAR-9403

Figure 3-1 Typical TIGAR 25/50/75/100 Unit Orientation (Recirculated and Flooded)

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

Note:

On models furnished with optional condensing unit and/or recirculation unit, equipment is mounted on the left end of the unit or on a separate skid.

- The refrigerant liquid and hot gas piping and valves are located in the lower front section inside the evaporator compartment.
- The refrigerant wet suction valves and piping assembly are located external to the evaporator and the assembly is field installed. Piping stubs with flanges are located in the top of the evaporator along the front edge. The valve and piping assembly has the mating flanges. The refrigerant wet suction valves and piping assembly is set in place on top of the evaporator and each flange set is bolted together. A minimum of 48" is required above the evaporator for installation and service access to the valves and piping.
- All refrigerant connections can be made from either end of the evaporator or suction piping above the evaporator.
- All water connections are located on the left side as you face the front of the evaporator.

- The optional surge drum and liquid level controls are located above the evaporator.

Note:

The surge drum may be located remote from the evaporator. Consult TURBO for additional information.

- Access to all sides and the top must be provided to allow for service.

Minimum clearances:

- 48" on the rear for the control panel
- 48" on the ice discharge end (right end)
- 48" is recommended on the front and left sides
- 36" is recommended on the top

- Access doors are provided on the upper and lower sections of the front and rear.

Note:

A left hand version with the ice discharge on the left side as you face the front is available as an option.

Helpful Hints

Do not discharge ice directly from the TIGAR unit into the storage bin or delivery system. Use an inclined screw conveyor (auger) to transport the ice from both the single and dual discharge models to the ice

entry opening in the storage bin or delivery system

The external screw conveyor should be pitched to drain:

- Melting snow
- Ice fines (slivers of ice)
- Condensation
- Water accidentally dumped out of the TIGAR unit screw conveyor discharge
- Cleaning solutions used to clean the evaporator or upper frame

Always remember –SAFETY FIRST !!!

TOOLS

The following is a list of tools required for safe erection and assembly of the TIGAR unit:

- Wrenches and sockets (full set – up to 1 1/8")
- Phillips and standard screwdrivers
- Level (4' long)
- Tape measure (50' long)
- Pry bar
- Chain hoists (1 ton) or two "come along" (1000#)
- Allen wrenches (1/8" to 1/2")
- Chains (two 3/8", minimum – 10' long)
- Arc welder
- Amp probe
- Voltage tester
- Continuity tester
- Framing square
- Forklift or crane – reference data sheet for weight of TIGAR models.

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

1. DELIVERY INSPECTION

All TIGAR units are inspected and water/electrical circuits are tested at the factory to assure shipment of a mechanically sound piece of equipment.

TURBO® ice generators are shipped on “*air-ride*” trailers to ensure that the equipment arrives in the best possible condition.

Inspect the TIGAR 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 TIGAR unit and/or loose parts shipped with the unit
- Determine the extent of the damage
- Take the necessary steps to rectify the claim without costly delays

Since most equipment is shipped FOB Factory title to the equipment transfers to the owner when it is loaded on the truck and leaves the factory. Therefore any claims must be

filed by the owner. Notify TURBO of any claims made.

Delivery Inspection Checklist

1. Inspect panels.
2. Open and inspect loose equipment and crate(s).
3. Inspect evaporator plates.
4. Inspect valves and piping.
5. Damage must be noted on bill of lading.

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

2. HOISTING OR MOVING

Equipment Rigging Instructions

The TIGAR unit must be lifted by the lifting lugs provided by TURBO. Please note that these lifting lugs are not intended to be used for extended lifting

periods. Depending on the orientation of the lifting lugs, the use of a spreader bar and blocks may be required to protect the exterior panels. In some cases, remove certain exterior panels for the rigging operation.

Figure 3-2 shows the configuration with lifting lugs on the ends. This configuration is used on small TIGAR units. The use of blocks and spreader bars are required to avoid damage to the cabinetry.

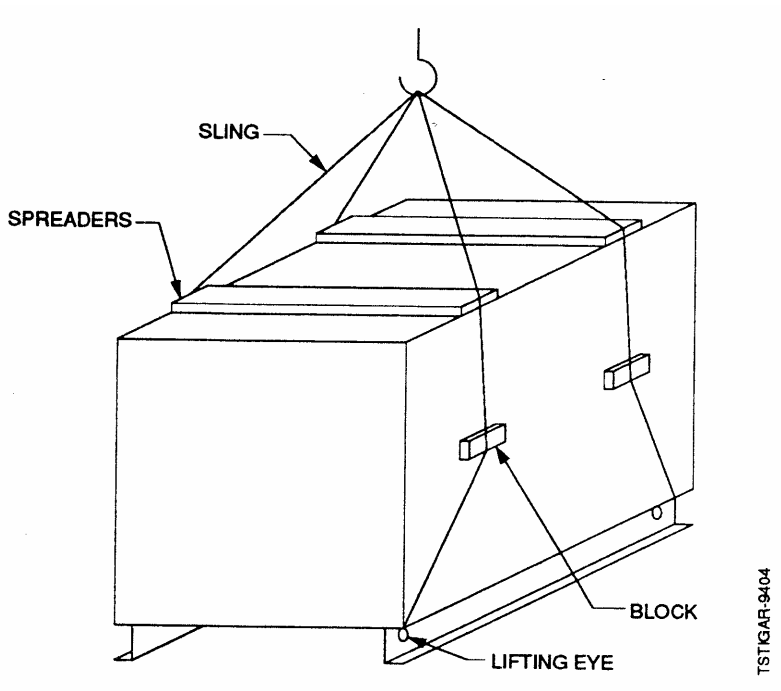


Figure 3-2 Small TIGAR Unit Lifting Configuration

Figure 3-3 shows the lifting lug operation used on large TIGAR

units. The lifting lugs can be used by running the sling

through the 3" pipes which run through the units.

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

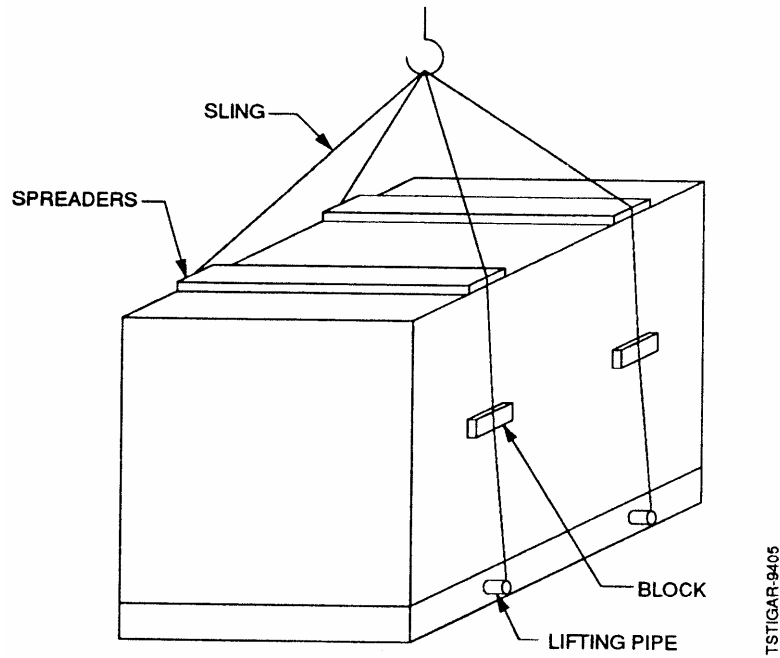


Figure 3-3 Large TIGAR Unit Lifting Configuration

Figure 3-4 shows a TIGAR unit with an optional condensing and/or liquid recirculation unit on a common skid. The lifting method is similar to that of Figure 3-3, with both spreader bars and blocks being required.

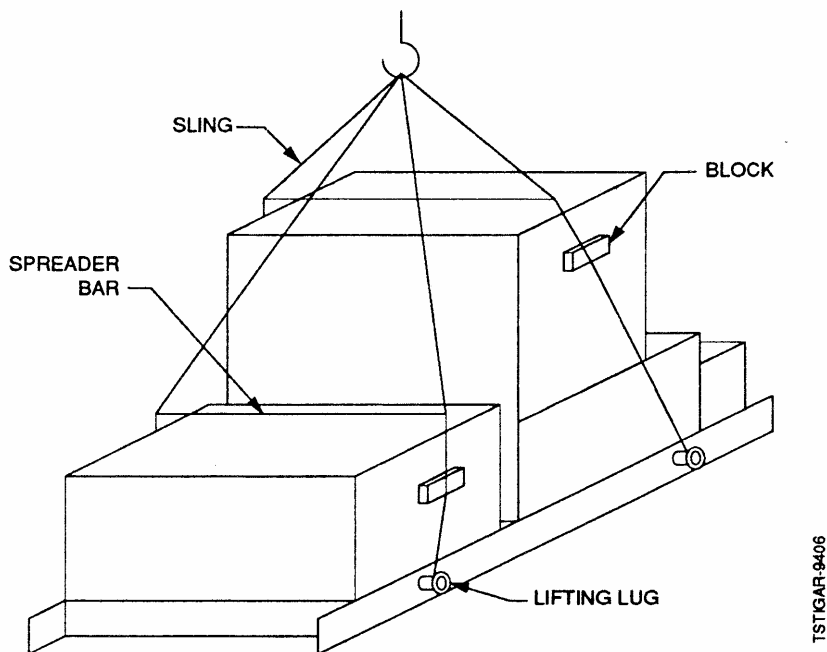


Figure 3-4 Common Skid Lifting Configuration

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

Figure 3-5 shows a large TIGAR unit requiring middle support during lifting. Additional lifting lug(s) will be provided as required for proper rigging.

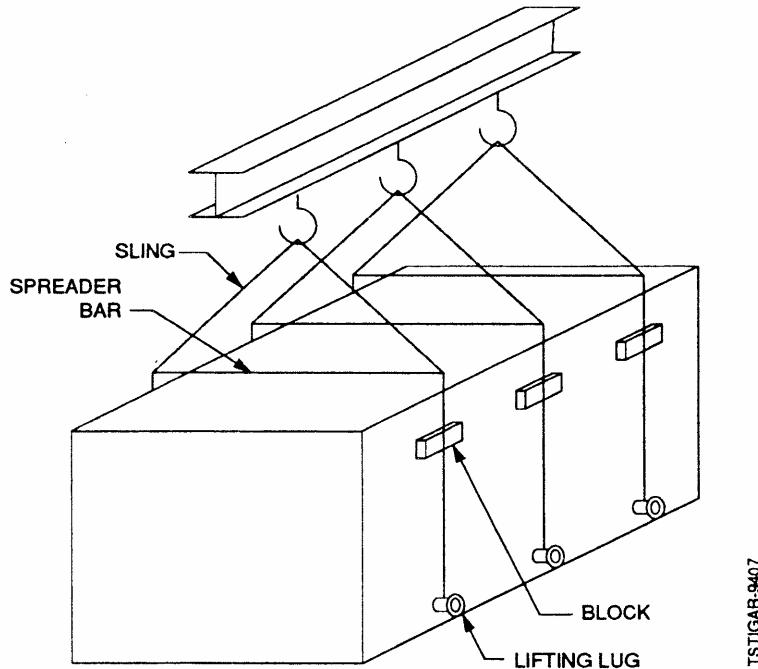


Figure 3-5 Large TIGAR Unit Lifting Configuration with Middle Support

Hoisting or Moving

If a TIGAR 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. 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 TIGAR unit.

If a TIGAR unit has to be moved along a floor, road, driveway, etc., use either pipes

as rollers or dollies (of sufficient capacity) under the unit or if available large forklift on both ends. The unit can also be moved by a large forklift from one end with heavy duty dollies under each corner of the other end.

IMPORTANT
Never lift or sling the TIGAR unit with devices fastened to the top frame structure. Lift the TIGAR unit only from the bottom.

Before hoisting, the rigger must ensure that the load is properly

balanced to prevent tilting or tipping of the TIGAR unit. Test the load before lifting it off the truck or ground.

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

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

3. SITE PREPARATION

Install the TIGAR unit in an area where the ambient temperature does not fall below 40°F or rise above 100°F. The upper freezing compartment of the unit is insulated against excessive heat infiltration. The lower machinery compartment of the unit is designed to provide ventilation for the machinery and motors.

Note:
Winterizing can be provided as an option to protect to 0°F.

Provide adequate working space on all sides and the top of the TIGAR unit for easy access to service and clean.

Concrete Slab

If the TIGAR unit is to be mounted on a concrete slab, the surface of the slab must be level or shimming must be provided under the unit to ensure that it is level to ensure proper water flow over the evaporator plates.

When shimming is required, use caution to prevent long

unsupported spans under the structural base frame.

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

When preparing the slab, 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 Figure 3-6.

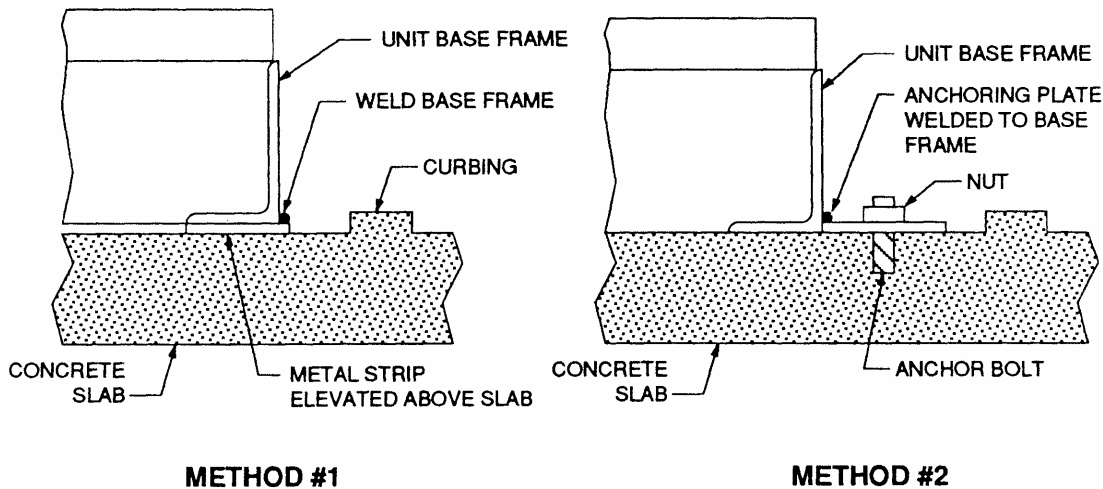


Figure 3-6 Typical Concrete Slab Detail

Base frame details for each model are available from TURBO to allow placement of metal inserts to match the structural base frame. No part of the unit base frame should be cantilevered or unsupported.

Raised Curbing

A raised curbing around the outside of the TIGAR unit is recommended to contain any condensate, leakage, or cleaning fluid during maintenance from the unit. To determine the maximum curbing height, check

the clearance between the bottom of the unit doors and the bottom of the structural base frame. A curbing height of two (2) to three (3) inches is sufficient. This height would clear the doors on all standard units. Refer to Figure 3-6.

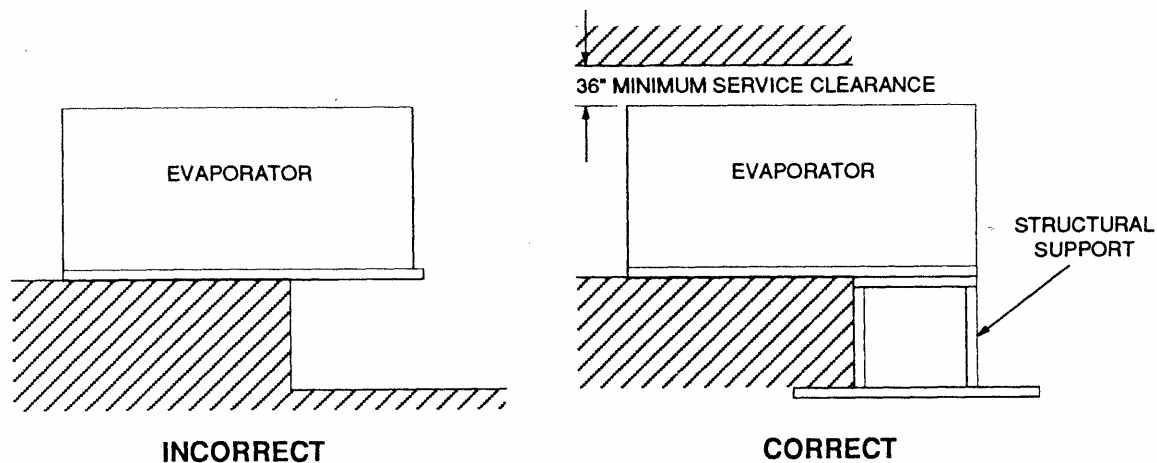
WARNING! Read safety section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Elevated Installation

Some installations require mounting the TIGAR unit at an elevation above grade. In these cases, a structural steel platform (capable of supporting the dynamic and static load) must be provided.

Due to variations in local and state codes, a local firm specializing in structural steel should be consulted to determine the requirements of the steel to be erected. Contact TURBO for information required by the firm that is providing the steel platform including weight, dimensions,

connection locations, and access requirements for service. The steel supporting the unit must be level or shimmed to obtain a satisfactory level. The same guidelines for supported and unsupported sections apply as for concrete slabs. Refer to Figure 3-7.



TSTIGAR-9409

Figure 3-7 Elevated Installation

Access, Service, Air Space

When laying out the unit installation, allow adequate space around the unit for access and service. Give particular attention to the location of the TIGAR, optional evaporator high side equipment, and optional refrigerant recirculation unit. Removal or service of larger, heavier components (condensers, compressors, etc.) may require access by a forklift or other lifting devices which require additional space.

On air cooled condensers, evaporative condensers, and

cooling towers (supplied as an option or by others), adequate space must be allowed for air intake and air discharges to prevent insufficient air supply or recirculation of discharge air.

Allow space for electrical disconnects and load centers near the equipment and for conduit runs from the load center to the equipment.

Water Pressure Lines

Properly size the water piping to the make-up water connection and cooling tower (if equipped) to deliver the specified flow and pressure.

Standard design parameters for TIGAR units use 40 PSIG city water pressure. If available water pressure is below 40 PSIG, consult TURBO to determine if a booster pump is required. The maximum water pressure is 100 PSIG. Systems with water pressures over 100 PSIG should be equipped with pressure reducing valves in the lines to the TIGAR unit. Expansion tanks may be required on some systems with high water pressure to prevent water hammer.

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

Floor Drain

The TIGAR water tank requires periodic cleaning. Make provisions for a floor drain to dispose of this water and for the unit overflow drain.

Water Treatment

TIGAR units are supplied with make-up strainers to remove solids and material large enough to plug openings in the water distribution system. Consult a local water treatment company

to determine if additional water treatment or filtration is required to produce the desired ice quality and reduce maintenance of the water distribution system.

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

4. BUILDING OPENINGS (ICE CHUTES) TO STORAGE

TIGAR units discharge ice through a standard twelve (12) inch screw conveyor downspout from the right end of the unit. If the unit is mounted directly above the ice storage, it

discharges into an inclined screw conveyor (not provided by TURBO) prior to delivery into the storage bin. Refer to Figure 3-8.

NOTE:

A nine (9) inch screw conveyor is used on the TIGAR25 and TIGAR3620. All others use the twelve (12) inch diameter screw conveyor.

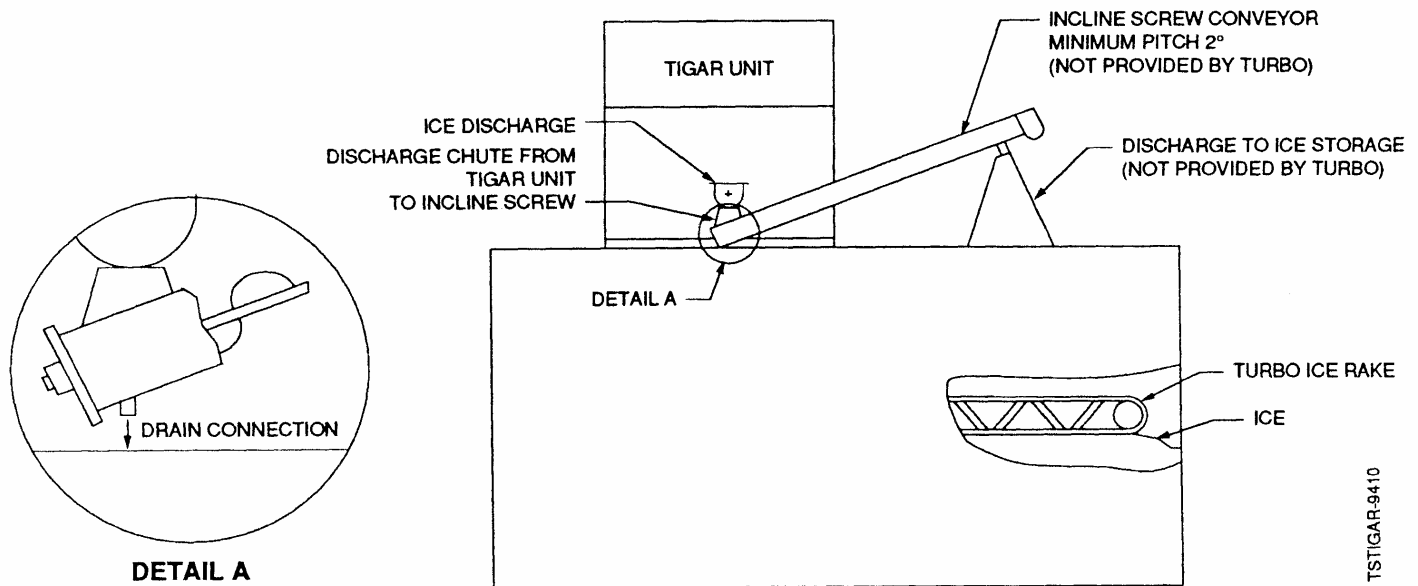


Figure 3-8 Typical Ice Delivery to Storage

Incline Screw Conveyor

An incline screw conveyor removes any condensate inside the auger and prevents:

- Water from melting snow (ice fines)
- Water overflow into storage through the discharge trough
- Overflow of cleaning fluids (used to clean the evaporator or water tank) into storage

- Any other source of water accidentally dumped into the discharge trough flowing into the storage area

Insulation

Insulate the discharge chutes from the TIGAR and the inclined screw(s) to reduce heat infiltration and condensation.

WARNING

Never operate the TIGAR unit without the discharge

chutes and screw conveyor in place. Access to the discharge downspout or incline screw could result in serious injury or loss of life. Never use a stick or probe to eliminate an obstruction. Never attempt to clean an obstruction in the discharge chute without locking out electrical power. Failure to carefully follow these instructions could result in permanent injury or loss of life.

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

5. OPTIONAL HIGH SIDE AND/OR REFRIGERANT RECIRCULATION UNIT

The TIGAR evaporator is low side only and must be connected to a dedicated condensing unit (compressor/condenser) or a central plant. A refrigerant recirculation unit is required to supply liquid refrigerant to the evaporator. With the possible exception of the central plant, all of the above require field installation that will include a

pad or structural support, refrigerant piping, water piping, and electrical service.

If the TIGAR is connected to an existing central refrigeration plant, the necessary tons of refrigeration (TR) and required NH₃ flow rates for each TIGAR model must be available for proper operation. Flow rates and TR are listed in Tables 3-1

and 3-2 for each model. The evaporator operating charge is listed in Table 3-3. Each of these requirements must be evaluated while planning the installation of the TIGAR evaporator to ensure the most efficient and cost effective installation as well as to avoid potential interface problems.

TABLE 3-1 Tons of Refrigeration and Compressor Motor HP

Models with 31" Evaporator plates

	TIGAR 25	TIGAR 50	TIGAR 75	TIGAR 100
Tons of Refrigeration (required at 0°F SET)	37.5	75.0	112.5	150.0
Compressor Motor Nominal HP (based on 105°F SCT)	75	150	200	250

Models with 36" Evaporator plates

	TIGAR 3620	TIGAR3636	TIGAR3656	TIGAR3672
Tons of Refrigeration (required at 0°F SET)	64.0	115.0	180.0	230.5
Compressor Motor Nominal HP (based on 105°F SCT)	125	200	300*	400*

* Screw compressor recommended.

All capacities based on 60°F entering water temperature and 1/2" thick ice.

TABLE 3-2 NH₃ Flow rate

	TIGAR 25	TIGAR 50	TIGAR 75	TIGAR 100
NH ₃ Flow rate, GPM	10	19	29	38

	TIGAR3620	TIGAR3636	TIGAR3656	TIGAR3672
NH ₃ Flow rate, GPM	16	29	46	59

Based on oil free NH₃, 0°F liquid, 15 PSIG DP across evaporator.

All Turbo refrigerant recirculation units are sized for 4:1 recirculation rates.

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

TABLE 3-3 Evaporator Operating Charge

	TIGAR 25	TIGAR 50	TIGAR 75	TIGAR 100
Operating Charge, Lbs. of NH ₃	97	194	291	387

	TIGAR3620	TIGAR3636	TIGAR3656	TIGAR 3672
Operating Charge, Lbs. of NH ₃	139	250	388	499

If the condensing unit and/or refrigerant recirculation unit options are supplied by TURBO, additional information on site preparation, installation, operation, service, and maintenance are supplied with the equipment purchased. Some general guidelines are listed below to aid in the proper selection of the condensing unit and/or refrigerant recirculation unit.

Optional Condensing Unit

Condensing units supplied by TURBO consist of the following basic components:

Motor/Compressor Assembly

Open drive or screw compressor. When required, water cooled heads and/or water cooled oil coolers are provided. Water piping (if required) to the motor/compressor assembly is not included.

Condenser

Water cooled is standard. Evaporative cooled and air-cooled are available.

Condenser Head Pressure Controls

Water regulating valve is standard for water cooled.

High Pressure Receiver

For storage of refrigerant charge during pump down for service or extended off periods. Includes inlet isolation valve, outlet valve, and safety relief valves.

Controls

Magnetic starters for the compressor motor(s). Gauge and safety console for high, low, and oil pressure safety circuit. ON/OFF master control switch and terminal switch connections for interface with the TIGAR evaporator and/or refrigerant recirculation unit as well as for connection of the control circuit power and lugs for the three phase power connections. Main and branch circuit breakers and disconnects are not provided.

Refrigerant

The refrigerant operating charge required is provided by others. Unit is shipped with an ammonia holding charge only.

Structural Base Frame

Capable of supporting the basic components listed above during transportation and operation.

Field Piping

Field piping between the condensing unit and all other

components including the TIGAR evaporator and refrigerant recirculation unit is field installed by others.

Electrical Service

Electrical service to the condensing components and all other components is field installed by others.

Cooling Tower and Cooling Tower Pump(s)

Not included with the condensing unit. Available as options. Consult TURBO for additional information.

Optional Refrigerant Recirculation Unit

TIGAR evaporators are designed for refrigerant overfeed with an oil free refrigerant grade NH₃ supplied by a mechanical pumping system connected to a recirculation vessel. Optional recirculation units supplied by TURBO consist of:

Recirculation Vessel

Sized for the refrigeration duty listed above. This vessel serves as the source of liquid refrigerant for the refrigerant pump as well as a surge vessel to separate the liquid and gas returning from the evaporator.

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

Connections are provided for the wet suction return, dry suction to the compressor, relief valve(s), oil drain, high pressure liquid make-up, liquid level column, and pump vent.

Refrigerant Recirculation Pump

Typically either a Viking or Cornell pump is used. Pumping capacities for the recirculation rates and conditions stated are listed in Table 3-2.

High Pressure Refrigerant Make-Up Line Assembly

Consists of a liquid solenoid valve, hand expansion valve, and isolation valves on the inlet and outlet of the assembly. A second hand expansion valve is connected in parallel to the solenoid valve and main hand expansion valve. The manual bypass permits operation while the solenoid valve and/or hand expansion are being serviced.

Dual Safety Relief Valves

Provided with all vessels supplied. Field piping by others is required from the discharge of the relief valves to a safe discharge location. Refer to section 2 – Safety.

Oil Recovery Vessel

Consists of an oil pot, relief valve, vent line, and isolation valves for the removal of oil from the system. Oil is removed manually from the oil pot connected to the drop leg of the recirculation vessel.

Structural Base Frame

Capable of supporting the components listed above during transportation and operation.

Recirculation Vessel Insulation

Required for proper operation. Due to variations in requirements, insulation of the vessel and piping is field installed and provided by others. Vessel is insulated with rubber but is not jacketed. Additional insulation or jacketing may be required (by others). Insulation and jacketing can be supplied as an option.

Refrigerant

The refrigerant operating charge required is provided by others. Reference Table 3-3 for evaporator operating charge for each model.

Field Piping

Field piping between the recirculation unit and all other components including the TIGAR evaporator and condensing unit is field installed by others.

Electrical Service

Electrical service to the recirculation unit and all other components is also field installed by others.

Optional Flooded Unit

TIGAR evaporators designed for flooded operation with an oil free refrigerant grade NH₃ are connected to an optional surge drum. The surge drum

package supplied by TURBO consists of:

Surge Drum

Sized for the refrigeration duty listed above. This vessel serves as the source of liquid refrigerant for the evaporator plates as well as a surge vessel to separate the liquid and gas returning from the evaporator. Connections are provided for the wet suction return, dry suction to the compressor, relief valve, oil drain, high pressure liquid make-up, liquid level column, and pump vent.

High Pressure Refrigerant Make-Up Line Assembly

Consists of a liquid solenoid valve, hand expansion valve, and isolation valves on the inlet and outlet of the assembly. A second hand expansion valve is connected in parallel to the solenoid valve and main hand expansion valve. The manual bypass permits operation while the solenoid valve and/or hand expansion are being serviced.

Dual Safety Relief Valves

Provided. Field piping by others is required from the discharge of the relief valves to a safe discharge location. Refer to section 2 – Safety.

Oil Recovery Vessel

Consists of an oil pot, relief valve, vent line, and isolation valves for the removal of oil from the system. Oil is removed manually from the oil pot connected to the drop leg of the surge drum.

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

Structural Base Frame

Capable of supporting the components listed above during transportation and operation.

Surge Drum Insulation

Required for proper operation. Due to variations in requirements, insulation of the vessel and piping is field installed and provided by

others. Insulation and jacketing can be supplied as an option.

Refrigerant

The refrigerant operating charge required is provided by others. Reference Table 3-3 for evaporator operating charge for each model.

Field Piping

Field piping between the surge drum and all other components including the TIGAR evaporator and condensing unit is field installed by others.

Electrical Service

Electrical service to the recirculation unit and all other components is also field installed by others.

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

6. ELECTRICAL CONNECTIONS

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. Consult these diagrams before making electrical service connections.

Electrical Service Connections

TIGAR units are furnished completely pre-wired internally but require electrical service connections to the:

- L1, L2, L3 motor starter connectors (three phase)
- L1, L2 control circuit connections (single phase)

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

on the TIGAR. Field wiring is required from the electrical source to the disconnects and/or circuit breakers, and from the disconnects/circuit breakers to the terminal blocks in the ice generator. All field wiring is provided by others.

Refer to Table 3-4 for conduit connections and Table 3-5 for total connection amps

TABLE 3-4 Conduit Connections for All TIGAR Models

Conduit Connection	
Control Circuit 120/1/60	1/2" MPT
Three Phase 230/460/3/60	3/4" MPT*

* A TIGAR 100, TIGAR3656, and TIGAR3672 with optional motor starters may require a 1" MPT.

TABLE 3-5 Total Connection Amps @ 230/3/60

Model	Amps
TIGAR 25	10.4
TIGAR 50	14.0
TIGAR 75	17.6
TIGAR 100	21.2
TIGAR3620	10.4
TIGAR3636	14.0
TIGAR3656	17.6
TIGAR3672	21.2

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

Note: Refer to the electrical data plate on the control panel door for actual full load amps (FLA) for the control circuit and three-phase devices supplied.

Checking Rotation

WARNING

Make sure the conveyor screw is clear of all obstacles and

warn all personnel to stay clear of the conveyor screw at all times. Failure to carefully follow these instructions could result in permanent injury or loss of life.

The conveyor screw should rotate in a clockwise direction when viewed from the end with the ice discharge facing you. As long as the conveyor screw 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 (i.e., the same phasing is used to all motor starters).

Note:

When checking rotation, only the power to the screw conveyor should be on. Turn the three phase power to the compressor and water pump off.

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

7. WATER CONNECTIONS

Make-Up Water

The source of make-up water and the make-up water temperature are important. The make-up water is the supply water from which the ice is made. The quality of the ice will depend on the type of water supplied. Ice production is affected by water temperature and water quality. As the supply water temperature decreases the ice production will increase.

Water Type

Ice can be no better than the water from which it is made. Extremely hard water will tend

to make cloudy, soft ice and will leave deposits within the machine, necessitating frequent cleaning. Hard water will not harm the TIGAR unit, but it will increase the maintenance necessary to keep the machine clean and maintain ice capacity. Good water quality will also reduce the amount of water blow down required to produce clear ice.

Water Temperature

Water temperature is an important factor in determining the icemaking capacity of the TIGAR unit. All icemaking

capacities are based on a design make-up water temperature of 60°F and no blowdown. As the water temperature increases, the icemaking capacity will decrease due to the additional cooling load on the refrigeration system. Conversely, as the make-up water temperature decreases, the icemaking capacity will increase since less refrigeration is required to remove the heat from the water before it is converted to ice. Correction factors for different water temperatures are shown in Table 3-6.

Table 3-6 Correction Factor for Feed Water Temperature

Water Temperature (°F)	35	40	50	60	70	80	90
Ice Capacity Multiplier	1.17	1.13	1.06	1.00	0.94	0.89	0.85

Example: TIGAR 50 with 40°F make-up water:

Nominal capacity with 60°F water	=	50 tons/day
Correction factor for 40°F water	=	1.13
Corrected ice capacity	=	50 x 1.13
	=	56.5 tons/day

Make-Up Water Connection

Standard TIGAR units use a 1-1/2" make-up water connection. Actual make-up water flows are shown in Table 3-7.

Table 3-7 TIGAR Models Make-Up Water Flow

TIGAR Model	25	50	75	100	3620	3636	3656	3672
Make-Up Water Flow, GPM (0% Blowdown)	4	8	13	17	9	16	25	33
Maximum Flow, GPM (25% Blowdown)	5	10	17	21	12	20	31	41

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

Note: Use maximum flow rates for design purposes. Maximum water flow for 36XX models is based on industrial ratings.

Make-Up Water Pressure and Temperature

The float valves used in the make-up water line are typically rated for a maximum water pressure of 100 PSIG and 125°F

fluid temperature (125°F is for cleaning purposes). The temperature should not exceed 90°F during normal operation. Consult the factory for operation with water temperature above 90°F.

The minimum water pressure should be approximately 5 PSIG to ensure continuous water feed to fully wet the evaporator plates at all times.

IMPORTANT

Never undersize a make-up water line. Ice capacity cannot be reached without the proper make-up water line size.

Drains

There are three drain connections on TIGAR units. Refer to Table 3-8 for connection sizes.

Table 3-8 Water Connections for All TIGAR Models - 31” and 36” Evaporator Plates

	Connection
Pan Drain	1-1/4” FPT
Tank Drain	1-1/2” FPT
Auxiliary Water Spray System	1-1/2” FPT *
Overflow Drain (hose connection)	3” PVC

*The auxiliary spray system is connected (tee) to the main make-up water connection.

Note: Provisions should be made to drain water from all vessels during winter shut-down. Drain cocks are provided in the return head of the water cooled condenser for draining. Removal of the condenser heads is recommended after draining to ensure that all of the water has been removed. If this cannot be done, the condenser can be either partially or totally filled with glycol. Indoor installations with an ambient temperature above 40°F should

require draining of the condenser only.

Auxiliary Water Spray System

A water spray system is mounted above the lower (outlet) manifold of each group of plates. A water solenoid periodically opens to spray make-up water over the manifold to prevent ice build up during extended operation. Each section has a spray manifold and solenoid valve with flow control to balance the water flow. Reference the operating section for additional information.

Two Pan Drains

A watertight pan is provided under each TIGAR to collect condensate, etc. Connect a drain line of the proper size to the pan drain. This line will normally be dry or contain only a small amount of water. There are two pan drain connections on a TIGAR unit, one in the center bottom of the pan (plugged) and one in the end of the pan. The plugged drain in the bottom of the pan is used only when the unit is located on an elevated platform or steel structure

One Overflow Drain

Blowdown or overflow of water in the tank can be adjusted from 0 to 25% to reduce collection of residual solids. The icemaking process tends to concentrate

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

(freeze-out) minerals and suspended solids in the water. Depending on the water quality (hardness, etc.), this can cause enough concentrations in the water tank to produce white or cloudy ice. A float valve on the make-up water line is provided to allow adjustment of the overflow or blowdown rate on a continuous basis.

Lowering the float arm reduces the overflow rate. Raising the float arm allows more water to overflow since the water level in the tank has to rise to a higher level before the float valve shuts off.

At start-up, adjustments can be made to obtain the desired blowdown rate. Make periodic checks to ensure that deposits are not building up in the tank.

Have a local water treatment consultant determine if additional water treatment (chemical, filtration, etc.) is required to obtain the desired ice quality.

IMPORTANT
Normal freeze-up precautions should be taken when drain lines must be exposed to freezing temperatures.

Water Cooled Condensers (Optional)

Water condensers supplied on TIGAR units 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.

Water Requirements (Optional Condensing Unit)

Condenser water requirements are based on 85°F water to the condenser, 95°F water off the condenser, and 105°F condensing. The condenser's design water flow rate is based on 3 GPM/ton of refrigeration.* The actual flow rate is wholly contingent on the water temperature and evaporator load but will not exceed the design flow.

* Tons of refrigeration = Total Heat Rejection @ 10°F SET/105°F SDT ÷ 15,000 BTU/ton

Optional Water Regulating Valve (SC Models Only)

A water regulating valve can be furnished in the TIGAR unit and must be field installed external of the unit in the outlet water line. A 1/4" SAE flare type valve is provided on the water cooled condenser for the water regulator high pressure gas connection. The regulator modulates in response to increases and decreases in the discharge pressure to maintain a

constant pressure under all operating conditions.

Water Temperatures

When cooling towers (optional) are used and no other positive means of regulating head pressure are provided (i.e., fan and pump pressure switches), a water regulating valve will be required. Adequate head pressure is important to provide proper refrigerant flow to refrigerant control valves such as hand expansion valves or other devices used to feed liquid to the recirculation vessel or surge drum. During harvest, an adequate supply of hot gas must also be available to obtain a proper harvest.

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 TIGAR units are installed in an area where the ambient falls below freezing, refer to section 8 – Optional Features & Accessories for Winterizing.

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

8. REFRIGERANT PIPING

Piping in a refrigerant system has two functions:

1. To carry the refrigerant through the system as a liquid, a gas, or a liquid/gas mixture with a minimum pressure drop.
2. To return any oil entrained in the refrigerant to the compressor.

Avoid trapping the lines except for specific purposes. If traps are used, the horizontal dimension should be as short as possible to avoid excessive

trapping of oil. Suction mains should be pitched toward the compressor.

Steel Pipe Joints

Clean threads on the pipe and fittings to remove all traces of grease or oil.

Wipe the threads dry with a lintless wiping cloth.

Threaded Joints

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.

Refer to Table 3-9 for refrigerant connections to the evaporator.

Table 3-9 Refrigerant Connections to Evaporator and Recirculator

Evaporator Connections Required (Recirculated and Flooded Models):

Recirculated Units with 31" Evaporator Plates:

	TIGAR 25	TIGAR 50	TIGAR 75	TIGAR 100
Pumped Liquid Line	1-1/2"	2"	2"	2-1/2"
Wet Suction	3"	4"	5"	6"
Hot Gas	1-1/2"	2-1/2"	2-1/2"	2-1/2"

Flooded Units with 31" Evaporator Plates:

	TIGAR 25	TIGAR 50	TIGAR 75	TIGAR 100
Liquid Line (low pressure)	1-1/2"	2"	2"	2-1/2"
Wet Suction	4"	5"	8"	8"
Hot Gas	1-1/2"	2-1/2"	2-1/2"	2-1/2"

Recirculated Units with 36" Evaporator Plates:

	TIGAR3620	TIGAR3636	TIGAR3656	TIGAR3672
Pumped Liquid Line	1-1/2"	2"	2"	2-1/2"
Wet Suction	3"	4"	5"	6"
Hot Gas	1-1/2"	2-1/2"	2-1/2"	2-1/2"

Flooded Units with 36" Evaporator Plates:

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

	TIGAR3620	TIGAR3636	TIGAR3656	TIGAR3672
Liquid Line (low pressure)	1-1/2"	2"	2"	2-1/2"
Wet Suction	4"	5"	8"	8"
Hot Gas	1-1/2"	2-1/2"	2-1/2"	2-1/2"

Optional Recirculation Vessels, Surge Drums & Condensing Units Suggested Line Sizes
 Recirculated & Flooded Units (based on tons of refrigeration in Table 3-1)

	TIGAR 25	TIGAR 50	TIGAR 75	TIGAR 100
Liquid Line (high pressure*)	3/4"	1"	1-1/4"	1-1/4"
Dry Suction	2-1/2"	3"	3"	4"
Discharge (compressor)	1-1/2"	2"	2-1/2"	3"

	TIGAR3620	TIGAR3636	TIGAR3656	3672
Liquid Line (high pressure*)	3/4"	1"	1-1/4"	1-1/4"
Dry Suction	2-1/2"	3"	3"	4"
Discharge (compressor)	1-1/2"	2"	2-1/2"	3"

* High pressure refrigerant line to recirculation vessel (recirculated unit) or surge drum (flooded unit).

Notes:

- The evaporator is shipped with connections on both ends of the evaporator. All connections are welded closed with a flat cap. During installation, cut off the flat cap on the end the connections are to be made to and grind a weld bevel on the end of the pipe for connection to the field piping.**
- All piping connections in the table above are carbon steel: Schedule 40 pipe for 2" and above. Schedule 80 pipe for 1-1/2" and below.**

Steel Pipe

Carbon steel or stainless steel pipe can be used for refrigerant lines but must be either sandblasted 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.

Storage / Inactive Systems

If the equipment is not installed upon receipt or is installed but not put in service, the interior must be maintained in a clean dry environment. All units are evacuated and charged with nitrogen or an ammonia holding charge to protect the system.

During installation the dry holding charge will be lost. If the system is not started after installation, the system should be properly evacuated and an ammonia holding charge established. All external surfaced should also be thoroughly washed with clean water and air dried or wiped off with clean dry cloth. The integrity of the system should be checked on a regular basis to avoid damage during the extended off period.

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

9. TESTING REFRIGERATION SYSTEM FOR LEAKS – FIELD PIPING

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

In order to test field piping for leaks, the system pressure must be built up. Test pressures for the system's low side and high side are defined in the following standards:

- ANSI/ASHRAE 15 Safety Code For Mechanical Refrigeration
- ANSI B9.1 Safety Code for Mechanical Refrigeration
- ASME/ANSI B31.5 Refrigeration Piping

These standards should be referenced for field test pressures and procedures. 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

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 bypass arrangements.

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

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 and threaded or welded joints with a one inch round brush. A small amount of glycerin 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 welded joints while the system is under pressure. Welded joints should be ground and rewelded. Do not simply add more weld to a leaking joint.

4. After all the joints have been repaired and the system is considered "tight", test the TIGAR 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 sulfur stick or electronic leak detector. Check all flanged, welded, screwed, and gasket joints, all valve stem packings, and all parting lines on castings. If any leaks are found, they must be repaired and rechecked before the system can be considered tight.

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

10. 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 TIGAR unit before charging it with refrigerant. If air, water vapor, or non-condensables are left in the system, various operating difficulties can be encountered, including:

1. Water will decrease the capacity of the evaporator and cause formation of ice in orifice openings causing restriction or complete shut-off of refrigerant flow.
2. Air and non-condensables will lodge in the condenser; decrease the space for condensing liquid and cause the head pressures to rise, thus reducing capacity.

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 the 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 manufacturer's 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.

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.

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

4. Allow it to stand at this vacuum for another five (5) to six (6) hours.
5. Break the vacuum.
6. Raise the system pressure up to zero (0) with oil free dry nitrogen.
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 the oil pumped dry nitrogen.
5. Raise the pressure in the system to zero (0).
3. Stop the system and allow it to stand for approximately twelve (12) hours at the low pressure.
4. Break the vacuum with the 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.

Third Evacuation

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.

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).
6. Evacuate the system below the 500 micron figure and charge with the refrigerant being used for the system.

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

11. CHARGING THE SYSTEM WITH REFRIGERANT OIL

After the complete system consisting of the TIGAR (evaporator), high side, and refrigerant recirculation unit is started, it may be necessary to add oil to maintain the proper level in the compressor (by others).

Note:

Production capacity of the TIGAR is based on an oil free NH₃ refrigerant supply. Optional equipment supplied for the refrigeration system must provide for proper oil management. Consult the high side and/or refrigerant recirculation package supplier for additional information on oil management.

When properly charged, the oil level in the compressor should be visible in the compressor sight glass. An oil reservoir may also be used on these units.

Other equipment such as the oil filter or oil coolers (when used)

also require an oil charge. Therefore, the oil level in the compressor and oil reservoir should be rechecked after the compressor has been operated. If additional oil is required, add only the oil specified by the compressor manufacturer. Use only dehydrated, wax-free, refrigerant grade oil of suitable viscosity.

Periodic Checks & Records

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

Refrigerant Oil

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

- Sun Oil Suniso 3GS

- DuPont synthetic oil, 150 SSU only
- Texaco Capella B1

Consult the equipment supplier specifications.

IMPORTANT

Do not mix different types or grades of oil. Do not overfill with oil; this is especially true on the hermetic type compressors. Make sure the oil is fresh and not contaminated.

Oil Quality

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

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

12. REFRIGERANT CHARGING

Possible Leaks

TIGAR units are furnished with a nitrogen holding charge to keep the system dry during shipping. A leak in the refrigerant circuit might occur during shipping or handling. If a leak is detected, immediate corrective action should be taken before refrigerant gas is added to the system. Refer to step 9 – Testing Refrigeration System for Leaks.

Adding Refrigerant

IMPORTANT

Before adding refrigerant or placing the unit in operation, evacuate the entire system to ensure a completely dry system. Refer to step 10 – Evacuating the System.

Whenever refrigerant is added to any TIGAR system, extreme care should be taken in admitting the refrigerant to the system.

The TIGAR unit should be placed in operation and the liquid level observed during the first five minutes of the freezing cycle.

With the head pressure between 180 PSIG and 213 PSIG, additional refrigerant, if required, 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.

When the liquid level in the refrigerant recirculation drum is stable during both refrigeration and harvest, the unit is fully charged. The unit data nameplate lists the unit model, refrigerant type, and refrigerant charge of the evaporator. Always monitor and record how much refrigerant is added. Never exceed the data nameplate charge listed. The charge listed is for the evaporator only. Additional refrigerant will be required for field piping and/or other components added to the systems by others.

IMPORTANT

Do not overcharge the refrigerant circuit because this induces high discharge pressures. Be sure the correct type of refrigerant is being added to the systems (refrigerant grade NH3). Do not use agricultural grade NH3.

TIGAR Units

TIGAR units are furnished without refrigerant charge. The entire refrigerant system must be evacuated (refer to step 10 – Evacuating the System) 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.

Remote Air or Evaporative Cooled Units (Optional)

Optional condensing 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.

Refrigerant Recirculation Systems (Optional)

Optional refrigerant recirculation vessels are shipped without a refrigerant charge.

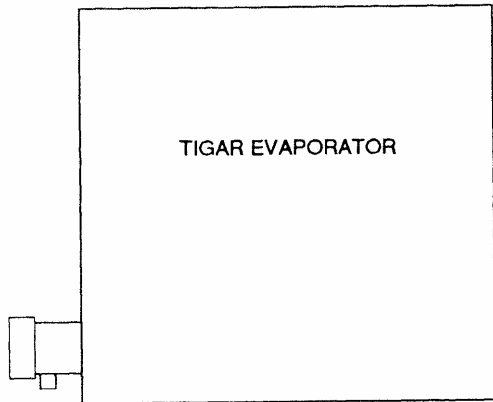
Relief Devices

Relief valves should be installed on all 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 will be required to vent the valve outside for indoor installations or to a location away from exposure to personnel for indoor or outdoor

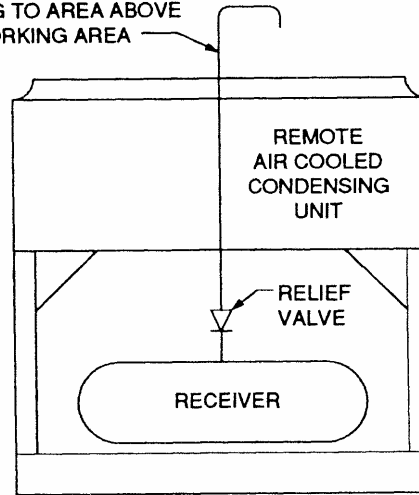
WARNING! Read safety section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

installations. Refer to Figure 3-9, Figure 3-10, and Figure 3-11.

NOTE: REFRIGERANT RECIRCULATION UNIT NOT SHOWN. RELIEF VALVE PIPING SHOWN IS TYPICAL FOR ALL VESSELS.



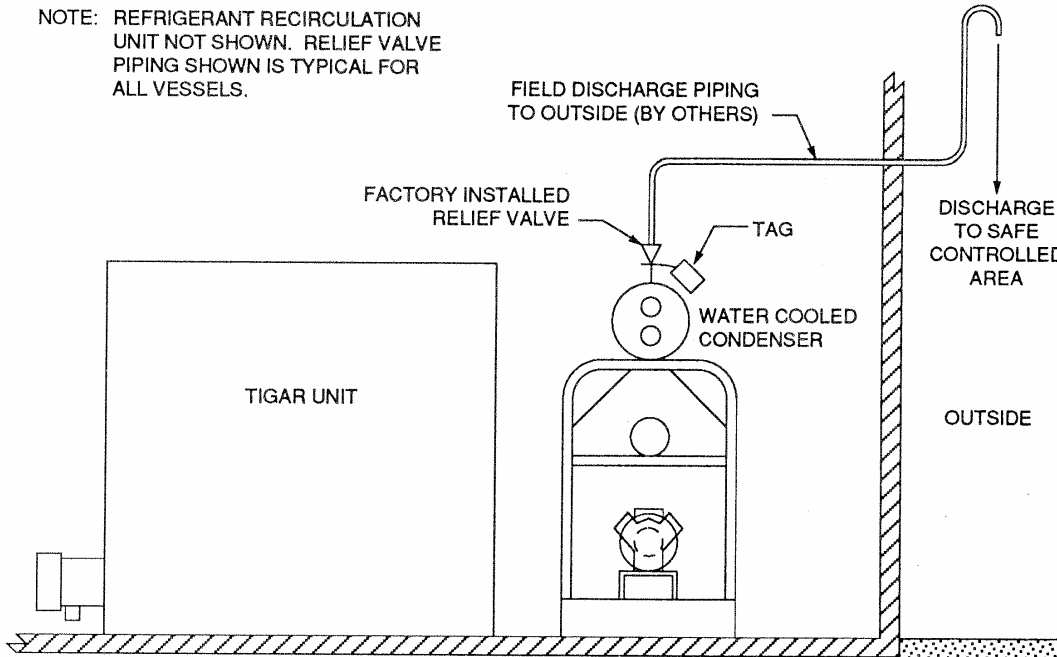
RELIEF VALVE DISCHARGE LINE FIELD PIPING TO AREA ABOVE NORMAL WORKING AREA



TSTIGAR-9411

Figure 3-9 Typical Optional Air Cooled Condenser Relief Valve Field Piping

NOTE: REFRIGERANT RECIRCULATION UNIT NOT SHOWN. RELIEF VALVE PIPING SHOWN IS TYPICAL FOR ALL VESSELS.



TSTIGAR-9412

Figure 3-10 Typical Indoor Installation Relief Valve Piping of Optional Condensing Unit

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

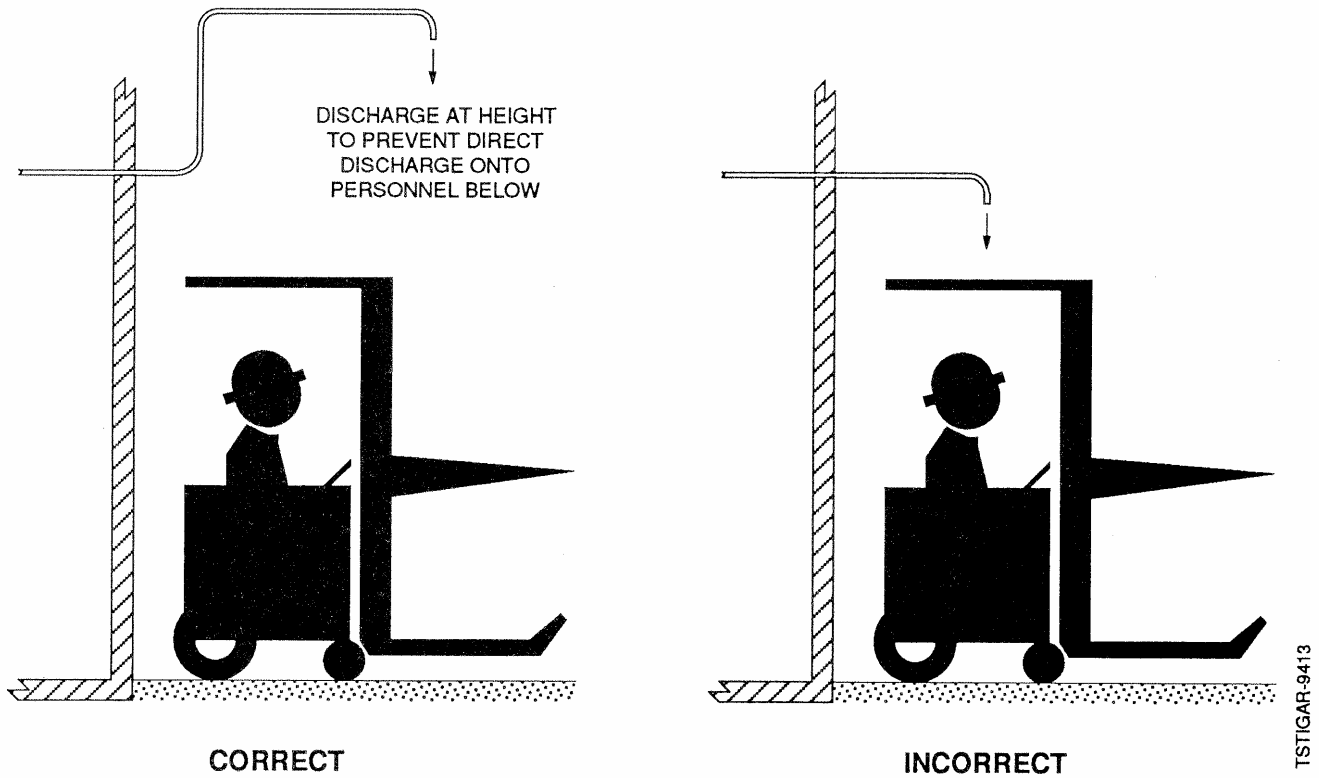


Figure 3-11 Correct and Incorrect Relief Valve Discharge Piping

TURBO provides a relief valve on all vessels supplied with the unit.

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 warning or a similar warning.

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

ANSI/ASHRAE 15-1987 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:

$$L = [0.2146(d^5)(P_o^2 - P_2^2)/fCr^2] - [(d)Ln P_o / P_2] / 6f$$

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where:

- L = maximum length of relief valve discharge piping (ft)
- P₂ = Absolute pressure at relief valve outlet (PSIA)
- P_o = Absolute back pressure at relief valve outlet (PSIA)
- d = Internal diameter of discharge piping (inches)

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

- Cr = Rated capacity of relief valve (lbs. of air per minute)
- f = Moody friction factor in full turbulent flow (see list below for factors)
- Ln = Natural logarithm

- P_o = 0.15 P + 14.7 for conventional relief valves
- Where P = Set pressure of the relief valve used

Friction factors for typical pipe sizes are:

Table 3-10 Relief Valve Piping Friction Factors

Pipe size	Internal Diameter, inches	Friction factor, f
1/2"	0.622	0.0259
3/4"	0.824	0.0240
1"	1.049	0.0225
1-1/4"	1.038	0.0209
1-1/2"	1.610	0.0202
2"	2.067	0.0190
2-1/2"	2.469	0.0173

For larger sizes consult ASHRAE, the relief valve or TURBO

For selection of relief valve, the calculated discharge rate is:

$$C = fDL_1$$

where:

- C = minimum required discharge capacity of relief valve (lbs. of air per minute)
- f = 0.5 for NH₃
- D = outside diameter of vessel (ft)
- L₁ = length of vessel (ft)

Example:

TIGAR 25 with a water cooled condensing unit using a 12-3/4" diameter x 48" receiver.

Design relief pressure is 300 PSIG.

Refrigerant is NH₃ (ammonia) – refrigerant grade.

Minimum required discharge capacity of the relief valve:

$$C = fDL_1 = (0.5) * (12-3/4/12) * (48/12) = 2.1 \text{ pounds of air per minute required}$$

And maximum discharge piping length:

$$L = [0.2146(d^5)(P_o^2 - P_2^2)/fCr^2] - [(d)Ln P_o / P_2] / 6f]$$

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

Where:

$$P_2 = 14.7 \text{ PSIA}$$

$$\text{Therefore } P_2^2 = 216.09$$

$$P_o = (0.15 * 300) + 14.7 = 59.7 \text{ PSIA}$$

$$\text{Therefore } P_o^2 = 3,564.09$$

$$d = 1.049" \text{ (1-1/4" SCH40 pipe)}$$

$$d^5 = 1.2702$$

$$Cr = 20.5 \text{ pounds of air per minute}$$

Hansen H5600R pressure relief valve 1/2" x 3/4" (inlet x outlet) or equivalent

$$Cr^2 = 420.25$$

$$\ln P_o / P_2 = \ln(59.7/14.7) = 1.401$$

Then:

$$L = [(0.2146 * 1.2702 * (3,564.09 - 216.09)) / (0.0225 * 420.25)] - [1.049 * 1.401 / (6 * 0.0225)] = 85.6 \text{ feet}$$

Therefore, a 1" SCH40 pipe is adequate for installations with relief valve discharge piping less than 86 feet long. If longer piping is required, a larger pipe size may be required. In the example above a 1-1/4" line could be used for relief discharge lines up to 394 feet.

For other applications the tables and formulas above should be used to calculate the relief valve size and the maximum piping distance. For convenience Table 3-11 below shows typical valve selections and piping distances for the relief valves used on standard TURBO models.

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

Table 3-11 Maximum Equivalent Relief Valve discharge Piping

Relief Pressure, PSIG	Relief Valve Size, inches	Capacity, lbs/min of air	Maximum Equivalent Length of Outlet Piping Schedule 40 Pipe Size					
			3/4"	1"	1-1/4"	1-1/2"	2"	2-1/2"
			150	1/2" x 3/4"	10.6	30	119	524
	1/2" x 3/4"	31.3		7	51	125	456	
	1/2" x 1"	35.8		4	37	92	344	
250	1/2" x 3/4"	17.2	22	93	422			
	1/2" x 3/4"	50.5		25	70	298		
	1/2" x 1"	57.7			25	70	298	
	3/4" x 1"	17.2		93	422			
	3/4" x 1"	57.7			25	70	298	
	1" x 1-1/4"	85.4			4	23	124	344
300	1/2" x 3/4"	20.5	19	86	394			
	1/2" x 3/4"	60.1			32	88	370	
	1/2" x 1"	68.6			21	63	278	
	3/4" x 1"	20.5		86	394			
	3/4" x 1"	68.6			21	63	278	
	1" x 1-1/4"	101.6				19	113	319
350	1/2" x 3/4"	24.1	27	113	510			
	1/2" x 3/4"	70.1			46	118	480	
	1/2" x 1"	80.0			32	86	364	
	3/4" x 1"	24.1	27	113	510			
	3/4" x 1"	80.0			32	86	364	
	1" x 1-1/4"	118.5				29	152	419

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

13. PRE-START-UP CHECKLIST

Customer _____

Date _____

Serial No _____

Model _____

Check off the following items prior to start-up of the unit (recirculated or flooded):

1. Verify that all loose components shipped for field installation are at the jobsite and have been installed per the manufacturer's instructions.

Note: The TIGAR is a low side evaporator only. Field connection to a condensing unit and refrigerant recirculation unit or surge vessel are required to complete the system. Field connections may include water piping, refrigerant piping, electrical controls and power, and insulation of vessels and piping. Refer to the wiring and piping diagrams provided with the unit for field connection requirements.

2. Familiarize yourself with the installation site: the location of safety equipment, eye wash and showers for exposure to NH₃, and evacuation plans in the event of an NH₃ release.
3. Review the operating and maintenance manual provided with the equipment. Read the safety section before starting the installation of the equipment.
4. Complete the checklist provided with the condensing unit (if applicable).
5. Complete the checklist provided with the refrigerant recirculation unit or surge drum (if applicable).
6. Verify that all field electrical connections to the evaporator have been completed per the wiring diagram provided with the equipment and per the instructions in the operating and maintenance manual. Circuit breakers and/or electrical disconnects are not supplied by TURBO but are required by code in most locations. Supply and proper installation of the circuit breakers and/or disconnects to meet all applicable codes is the responsibility of others.
7. Verify that all field refrigerant piping connections to the evaporator have been completed per the piping diagram provided with the equipment and per the instructions in the operating and maintenance manual. Supply and proper installation of field refrigerant piping to meet all applicable codes is the responsibility of others.
8. If the unit is to be connected to an existing central system, verify the interface requirements for the evaporator to the central system.
9. Verify that all relief valves have been piped to a safe discharge location (refer to the operating and maintenance manual for guidelines).

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

- 10. Verify that all field water piping connections to the evaporator have been completed per the piping diagram provided with the equipment and per the instructions in the operating and maintenance manual. Supply and proper installation of field water piping to meet all applicable codes is the responsibility of others. Flush and drain all water piping and water tanks.

Note: Water piping may include the make-up water to condensers, oil coolers, or components supplied by others with the condensing unit and/or refrigerant recirculation unit, and the make-up water connection to the evaporator. Water drain and overflow piping is required from the evaporator to the proper disposal points (provided by others).

- 11. Verify that the complete system has been properly evacuated, leak checked, and charged with the proper refrigerant (refrigerant grade NH₃).

Note: Each of the above functions is the responsibility of others. Refrigerant is not supplied with the equipment.

- 12. Note all leaks found and repaired during step number 11.

Checklist Completed By _____

Date _____

If you have any questions concerning the above checklist or any other aspect of equipment installation in preparation for start-up, contact:

Turbo Refrigerating, LLC
Service Department
P.O. Box 396
Denton, Texas 76202-0396
Phone: 940-387-4301
Fax: 940-382-0364

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

14. START-UP CHECKLIST

Page 1 of 2



TIGAR START-UP CHECKLIST

The following items must be checked off prior to and during start-up of the unit.

Customer _____ Date _____ Model _____ Unit Serial # _____

Before start-up of the unit(s), verify that all screw conveyors, covers, guards, and safety panels are properly installed.
Notify all personnel that the equipment is being started and that power to the equipment has been connected.

EVAPORATOR					
Check Item	Data	Checked By	Date	Comments	
Refrigeration time, seconds					
Defrost time, seconds					
Evaporator pressure during icemaking (PSIG – design is 15 PSIG)					
Evaporator pressure during defrost (PSIG – design is 68-80 PSIG)					
Hand TXV settings (# of turns open) Note position of all valves.					
Verify DPS switch operation (note setting)					
WATER CIRCUIT					
Check Item	Data	Checked By	Date	Comments	
Water pressure @ TIGAR water inlet (PSIG)					
Water temperature @ pump discharge/water pans (°F)					
Blowdown (overflow) YES/NO					
Water distribution pans secure					
Water flow over plates checked					
Water distribution pan filter pad in place					
Water pan float switch level adjusted					
Water level in water distribution pans (inches – minimum level is 1-1/2")					
EVAPORATOR MOTOR PERFORMANCE DATA					
Motor	Voltage (230 or 460/3/60)	Amp Draw	HP	FLA	Nameplate Data
Harvest screw conveyor					
Water pump #1					
Water pump #2					
Water pump #3					
Water pump #4 (TIGAR 100 only)					
RECIRCULATION MOTOR DATA (by others)					
Check Item	Data	Checked By	Date	Comments	
Refrig. recirc. pump(s)					
Oil pot heater (if so equipped)					

Turbo Refrigerating • 1815 Shady Oaks Dr. • P.O. Box 396 • Denton, TX 76202 • Phone: 944-387-4301 • Fax: 944-382-0364

F-9423

The checklist below is a reduction of the actual checklist. Contact TURBO for a full sized checklist.

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

TIGAR START-UP CHECKLIST

Page 2 of 2

CONDENSING UNIT MOTOR DATA (by others)

Check Item	Date	Checked By	Date	Comments
Compressor #1				
Compressor #2				
Water cooled models cooling tower pump(s)				
Water cooled models cooling tower fan(s)				
Water cooled models sump heater (if so equipped)				
Evaporative cooled models fan motor(s)				
Evaporative cooled models circulating pump(s)				
Evaporative cooled models sump heater (if so equipped)				
Air cooled models fan motor(s)				
Verify rotation of all motors				

MISCELLANEOUS

Check Item	Date	Checked By	Date	Comments
Refrigerant charge (lbs) (system – evap., recirc. unit, condensing unit)				
Safety circuit switch settings (by others, refer to the manufacturer's checklist)				

NOTES:

- The screw conveyors from the ice generator to the TURBO® ice rake or other delivery point should be interlocked with the TIGAR controls to prevent operation if they are off or "tripped" on overload.
- Before starting equipment, verify that the wiring diagram, piping diagram, and ladder logic are available for quick reference. If these documents are not available, contact TURBO before proceeding.

Upon completion of the start-up, please mail or fax a copy of the start-up checklist to:

Henry Vogt Machine Company
Refrigeration Division – Turbo Refrigerating
Service Department
P.O. Box 396
Denton, Texas 76202
Phone: 817-387-4301
Fax: 817-382-0364

ACCEPTED BY

Name _____ Date _____ Company _____

print

signature

START-UP BY

Name _____ Date _____ Company _____

print

Turbo Refrigerating • 1815 Shady Oaks Dr. • P.O. Box 396 • Denton, TX 76202 • Phone: 944-387-4301 • Fax: 944-382-0364

E-9423

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



TIGAR Ice Generator Operation & Maintenance Manual

INSTALLATION & PRE-START-UP REQUIREMENTS

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

This section includes step-by-step instructions on installing and connecting your TIGAR unit. Your TIGAR unit has been tested and inspected at the factory prior to packing and shipping.

Recirculated and Flooded Models Installation Sequence

1. Delivery Inspection
2. Hoisting or Moving
3. Site Preparation
4. Building Openings (Ice Chutes) To Storage
5. Optional High Side and/or Refrigerant Recirculation Unit
6. Electrical Connections
7. Water Connections
8. Refrigerant Piping
9. Testing Refrigeration System for Leaks – Field Piping
10. Evacuating the System
11. Charging the System with Refrigerant Oil
12. Refrigerant Charging
13. Pre-Start-Up Checklist

14. 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.

To Help You Get Started

Read the instructions completely before installation or operation of the equipment.

Gather all required tools.

The control panel is on the rear left when viewed from the rear.

Recirculated Models

Establish front and rear, and left and right of the TIGAR unit by facing the evaporator sections (refer to Figure 3-1).

Packaged ice version (dry harvest) – dual ice discharge:

- A screw conveyor discharge is located on both ends of the TIGAR unit for packaged ice models. Ice does not discharge from both ends at the same time; i.e. during a typical cycle ice will be discharged from the right end for the harvest

of sections 1 and 2, and from the right end for the harvest of sections 3 and 4.

- The water connections are on the left side of the TIGAR unit.
- All refrigerant connections can be made on the right or left side of the evaporator section.

Use this method when referring to parts that are left, right, front, or rear.

Industrial version – single ice discharge:

- The screw conveyor discharge is on the right as you face the front of the TIGAR unit for industrial models. Ice is discharged from the same end for all sections.
- The water connections are on the left side of the TIGAR unit.
- All refrigerant connections can be made on the right or left side of the evaporator section.

Use this method when referring to parts that are left, right, front, or rear.

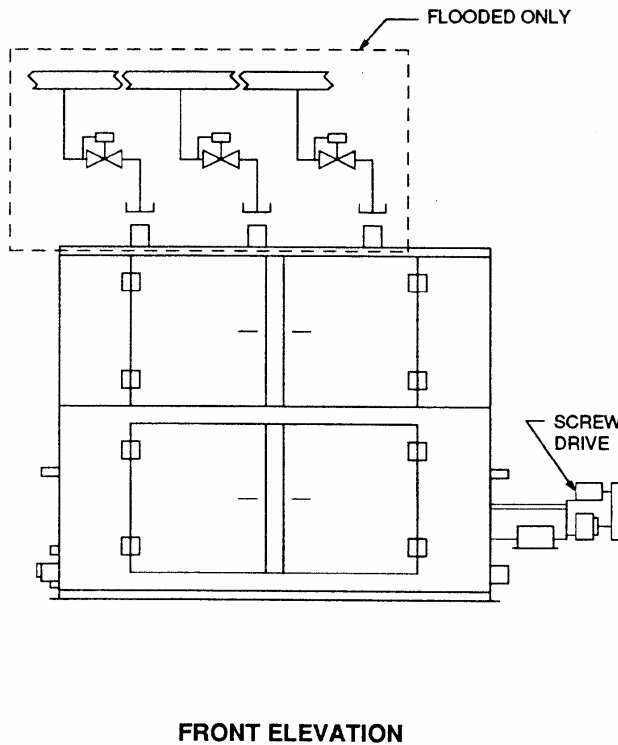
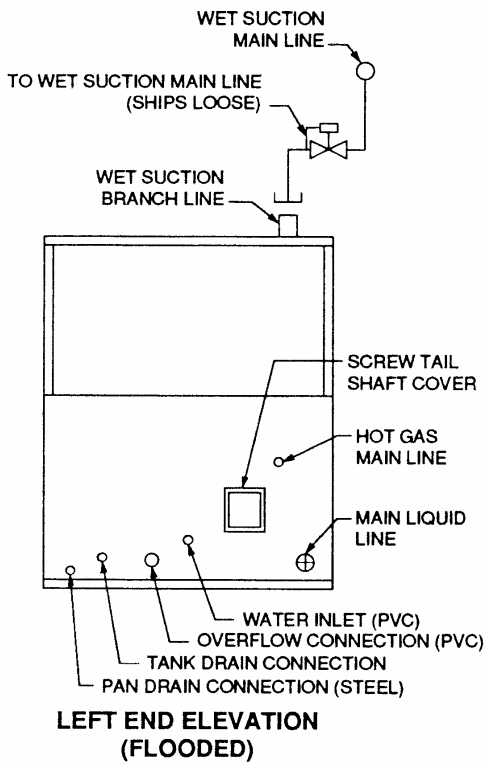
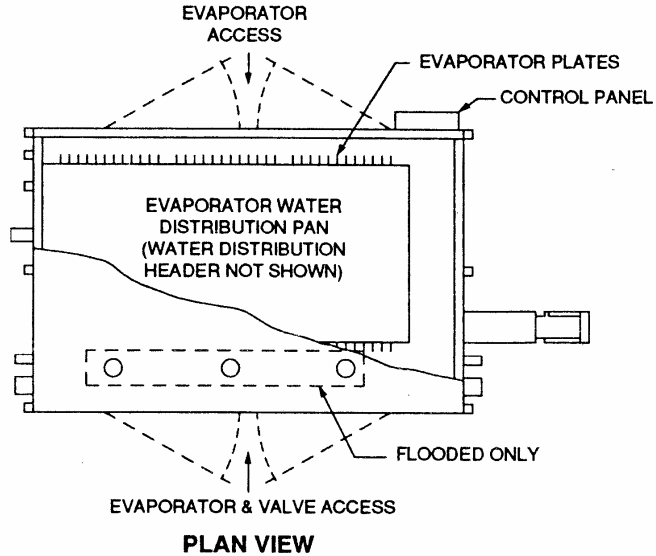
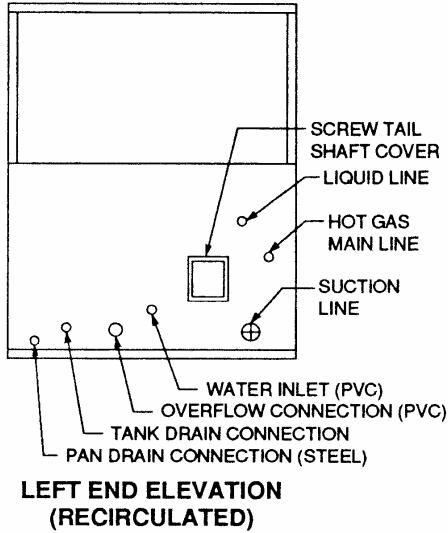
WARNING! Read safety section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Flooded Models

Establish the front and rear, and left and right of the evaporator. The ice discharge opening

should be on your right as you face the front of the evaporator (refer to Figure 3-1).

NOTE: REFRIGERANT CONNECTIONS CAN BE MADE FROM EITHER END.



NOTE: ALL WATER & REFRIGERANT PIPING LOCATIONS ARE APPROXIMATIONS.

TSTIGAR-9403

Figure 3-1 Typical TIGAR 25/50/75/100 Unit Orientation (Recirculated and Flooded)

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

Note:

On models furnished with optional condensing unit and/or recirculation unit, equipment is mounted on the left end of the unit or on a separate skid.

- The refrigerant liquid and hot gas piping and valves are located in the lower front section inside the evaporator compartment.
- The refrigerant wet suction valves and piping assembly are located external to the evaporator and the assembly is field installed. Piping stubs with flanges are located in the top of the evaporator along the front edge. The valve and piping assembly has the mating flanges. The refrigerant wet suction valves and piping assembly is set in place on top of the evaporator and each flange set is bolted together. A minimum of 48" is required above the evaporator for installation and service access to the valves and piping.
- All refrigerant connections can be made from either end of the evaporator or suction piping above the evaporator.
- All water connections are located on the left side as you face the front of the evaporator.

- The optional surge drum and liquid level controls are located above the evaporator.

Note:

The surge drum may be located remote from the evaporator. Consult TURBO for additional information.

- Access to all sides and the top must be provided to allow for service.

Minimum clearances:

- 48" on the rear for the control panel
- 48" on the ice discharge end (right end)
- 48" is recommended on the front and left sides
- 36" is recommended on the top

- Access doors are provided on the upper and lower sections of the front and rear.

Note:

A left hand version with the ice discharge on the left side as you face the front is available as an option.

Helpful Hints

Do not discharge ice directly from the TIGAR unit into the storage bin or delivery system. Use an inclined screw conveyor (auger) to transport the ice from both the single and dual discharge models to the ice

entry opening in the storage bin or delivery system

The external screw conveyor should be pitched to drain:

- Melting snow
- Ice fines (slivers of ice)
- Condensation
- Water accidentally dumped out of the TIGAR unit screw conveyor discharge
- Cleaning solutions used to clean the evaporator or upper frame

Always remember –SAFETY FIRST !!!

TOOLS

The following is a list of tools required for safe erection and assembly of the TIGAR unit:

- Wrenches and sockets (full set – up to 1 1/8")
- Phillips and standard screwdrivers
- Level (4' long)
- Tape measure (50' long)
- Pry bar
- Chain hoists (1 ton) or two "come along" (1000#)
- Allen wrenches (1/8" to 1/2")
- Chains (two 3/8", minimum – 10' long)
- Arc welder
- Amp probe
- Voltage tester
- Continuity tester
- Framing square
- Forklift or crane – reference data sheet for weight of TIGAR models.

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

1. DELIVERY INSPECTION

All TIGAR units are inspected and water/electrical circuits are tested at the factory to assure shipment of a mechanically sound piece of equipment.

TURBO® ice generators are shipped on “*air-ride*” trailers to ensure that the equipment arrives in the best possible condition.

Inspect the TIGAR 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 TIGAR unit and/or loose parts shipped with the unit
- Determine the extent of the damage
- Take the necessary steps to rectify the claim without costly delays

Since most equipment is shipped FOB Factory title to the equipment transfers to the owner when it is loaded on the truck and leaves the factory. Therefore any claims must be

filed by the owner. Notify TURBO of any claims made.

Delivery Inspection Checklist

1. Inspect panels.
2. Open and inspect loose equipment and crate(s).
3. Inspect evaporator plates.
4. Inspect valves and piping.
5. Damage must be noted on bill of lading.

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

2. HOISTING OR MOVING

Equipment Rigging Instructions

The TIGAR unit must be lifted by the lifting lugs provided by TURBO. Please note that these lifting lugs are not intended to be used for extended lifting

periods. Depending on the orientation of the lifting lugs, the use of a spreader bar and blocks may be required to protect the exterior panels. In some cases, remove certain exterior panels for the rigging operation.

Figure 3-2 shows the configuration with lifting lugs on the ends. This configuration is used on small TIGAR units. The use of blocks and spreader bars are required to avoid damage to the cabinetry.

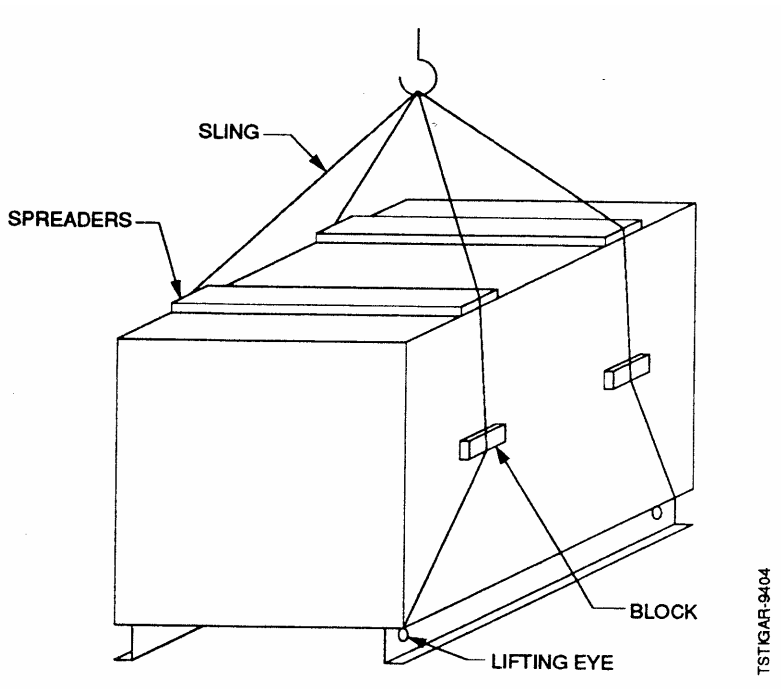


Figure 3-2 Small TIGAR Unit Lifting Configuration

Figure 3-3 shows the lifting lug operation used on large TIGAR

units. The lifting lugs can be used by running the sling

through the 3" pipes which run through the units.

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

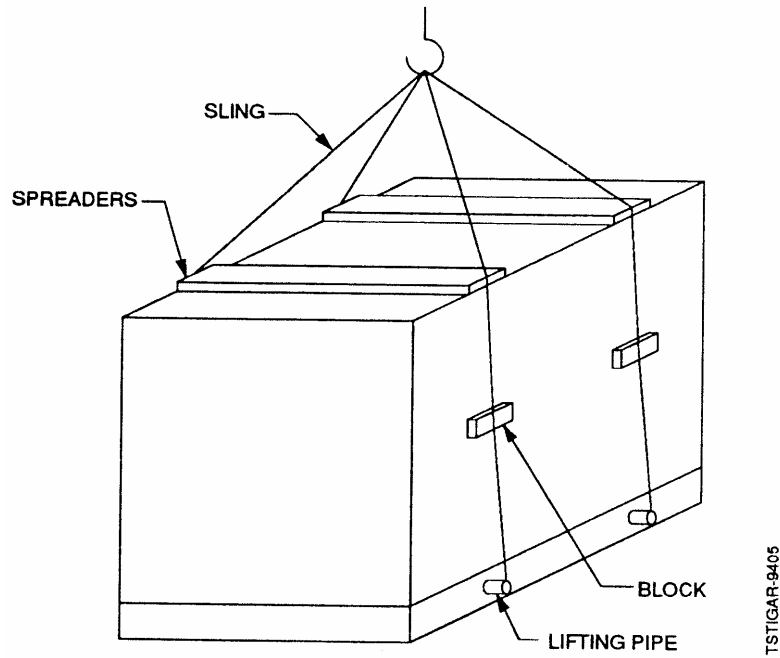


Figure 3-3 Large TIGAR Unit Lifting Configuration

Figure 3-4 shows a TIGAR unit with an optional condensing and/or liquid recirculation unit on a common skid. The lifting method is similar to that of Figure 3-3, with both spreader bars and blocks being required.

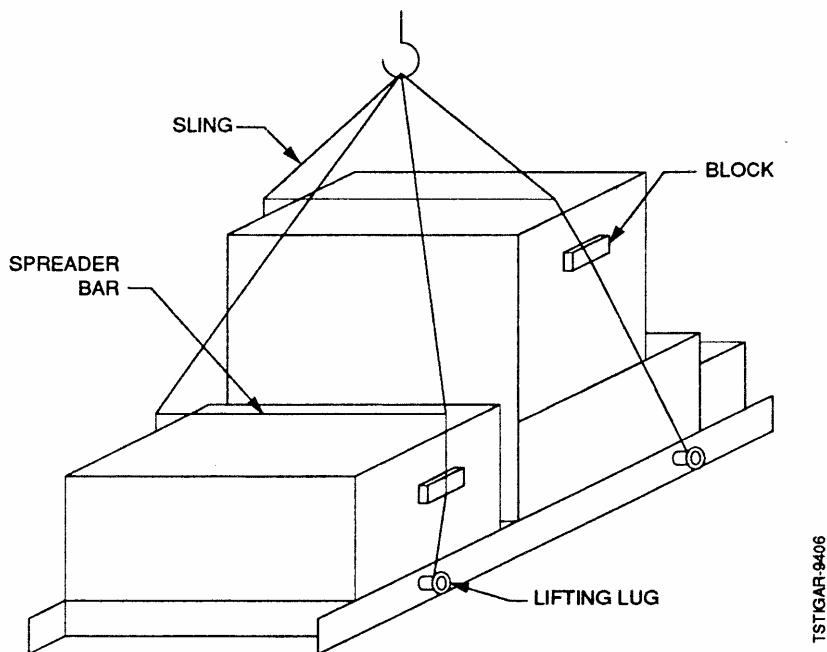


Figure 3-4 Common Skid Lifting Configuration

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

Figure 3-5 shows a large TIGAR unit requiring middle support during lifting. Additional lifting lug(s) will be provided as required for proper rigging.

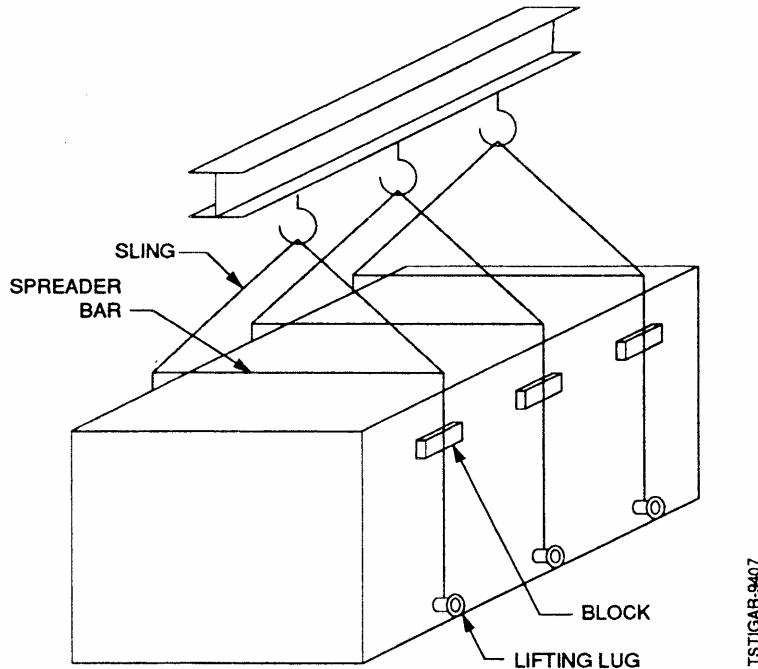


Figure 3-5 Large TIGAR Unit Lifting Configuration with Middle Support

Hoisting or Moving

If a TIGAR 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. 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 TIGAR unit.

If a TIGAR unit has to be moved along a floor, road, driveway, etc., use either pipes

as rollers or dollies (of sufficient capacity) under the unit or if available large forklift on both ends. The unit can also be moved by a large forklift from one end with heavy duty dollies under each corner of the other end.

IMPORTANT
Never lift or sling the TIGAR unit with devices fastened to the top frame structure. Lift the TIGAR unit only from the bottom.

Before hoisting, the rigger must ensure that the load is properly

balanced to prevent tilting or tipping of the TIGAR unit. Test the load before lifting it off the truck or ground.

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

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

3. SITE PREPARATION

Install the TIGAR unit in an area where the ambient temperature does not fall below 40°F or rise above 100°F. The upper freezing compartment of the unit is insulated against excessive heat infiltration. The lower machinery compartment of the unit is designed to provide ventilation for the machinery and motors.

Note:
Winterizing can be provided as an option to protect to 0°F.

Provide adequate working space on all sides and the top of the TIGAR unit for easy access to service and clean.

Concrete Slab

If the TIGAR unit is to be mounted on a concrete slab, the surface of the slab must be level or shimming must be provided under the unit to ensure that it is level to ensure proper water flow over the evaporator plates.

When shimming is required, use caution to prevent long

unsupported spans under the structural base frame.

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

When preparing the slab, 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 Figure 3-6.

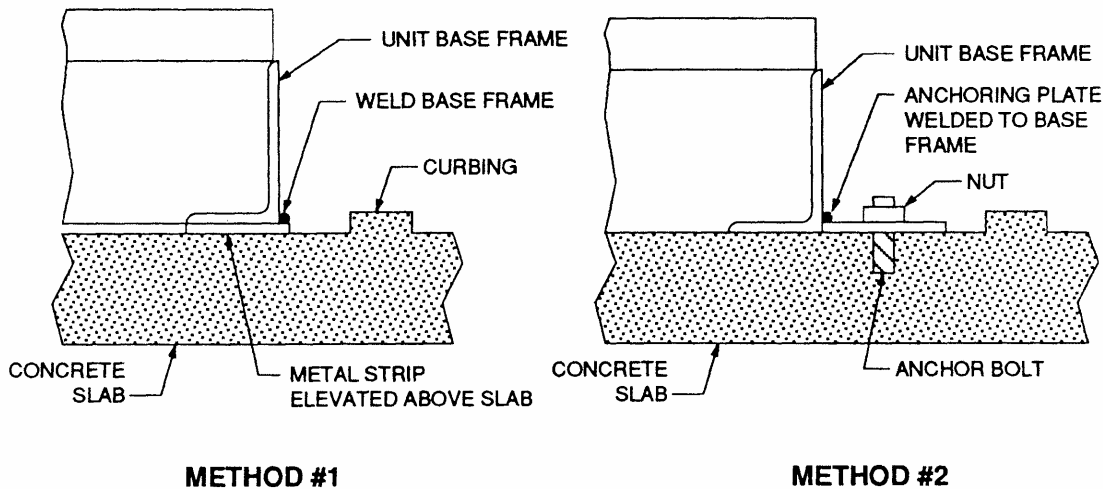


Figure 3-6 Typical Concrete Slab Detail

Base frame details for each model are available from TURBO to allow placement of metal inserts to match the structural base frame. No part of the unit base frame should be cantilevered or unsupported.

Raised Curbing

A raised curbing around the outside of the TIGAR unit is recommended to contain any condensate, leakage, or cleaning fluid during maintenance from the unit. To determine the maximum curbing height, check

the clearance between the bottom of the unit doors and the bottom of the structural base frame. A curbing height of two (2) to three (3) inches is sufficient. This height would clear the doors on all standard units. Refer to Figure 3-6.

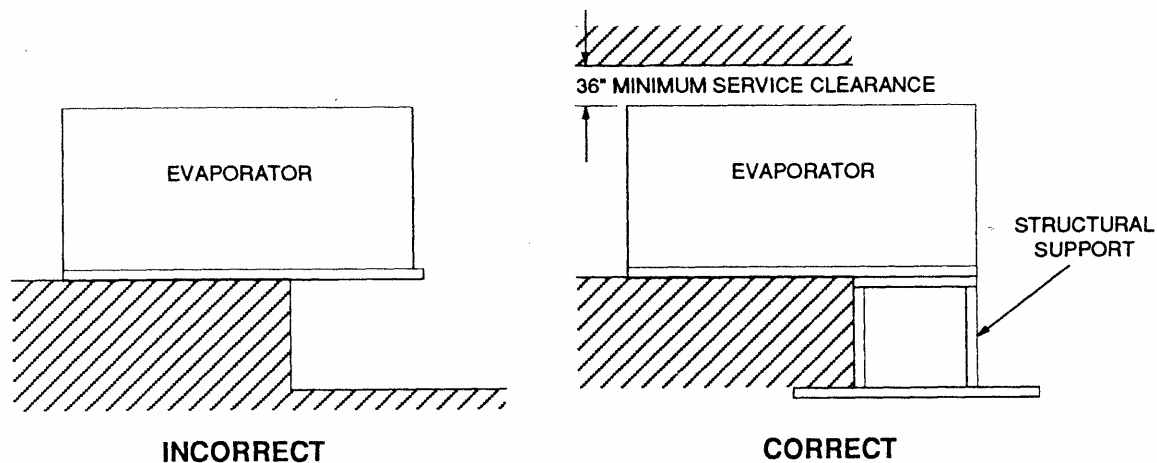
WARNING! Read safety section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Elevated Installation

Some installations require mounting the TIGAR unit at an elevation above grade. In these cases, a structural steel platform (capable of supporting the dynamic and static load) must be provided.

Due to variations in local and state codes, a local firm specializing in structural steel should be consulted to determine the requirements of the steel to be erected. Contact TURBO for information required by the firm that is providing the steel platform including weight, dimensions,

connection locations, and access requirements for service. The steel supporting the unit must be level or shimmed to obtain a satisfactory level. The same guidelines for supported and unsupported sections apply as for concrete slabs. Refer to Figure 3-7.



TSTIGAR-9409

Figure 3-7 Elevated Installation

Access, Service, Air Space

When laying out the unit installation, allow adequate space around the unit for access and service. Give particular attention to the location of the TIGAR, optional evaporator high side equipment, and optional refrigerant recirculation unit. Removal or service of larger, heavier components (condensers, compressors, etc.) may require access by a forklift or other lifting devices which require additional space.

On air cooled condensers, evaporative condensers, and

cooling towers (supplied as an option or by others), adequate space must be allowed for air intake and air discharges to prevent insufficient air supply or recirculation of discharge air.

Allow space for electrical disconnects and load centers near the equipment and for conduit runs from the load center to the equipment.

Water Pressure Lines

Properly size the water piping to the make-up water connection and cooling tower (if equipped) to deliver the specified flow and pressure.

Standard design parameters for TIGAR units use 40 PSIG city water pressure. If available water pressure is below 40 PSIG, consult TURBO to determine if a booster pump is required. The maximum water pressure is 100 PSIG. Systems with water pressures over 100 PSIG should be equipped with pressure reducing valves in the lines to the TIGAR unit. Expansion tanks may be required on some systems with high water pressure to prevent water hammer.

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

Floor Drain

The TIGAR water tank requires periodic cleaning. Make provisions for a floor drain to dispose of this water and for the unit overflow drain.

Water Treatment

TIGAR units are supplied with make-up strainers to remove solids and material large enough to plug openings in the water distribution system. Consult a local water treatment company

to determine if additional water treatment or filtration is required to produce the desired ice quality and reduce maintenance of the water distribution system.

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

4. BUILDING OPENINGS (ICE CHUTES) TO STORAGE

TIGAR units discharge ice through a standard twelve (12) inch screw conveyor downspout from the right end of the unit. If the unit is mounted directly above the ice storage, it

discharges into an inclined screw conveyor (not provided by TURBO) prior to delivery into the storage bin. Refer to Figure 3-8.

NOTE:

A nine (9) inch screw conveyor is used on the TIGAR25 and TIGAR3620. All others use the twelve (12) inch diameter screw conveyor.

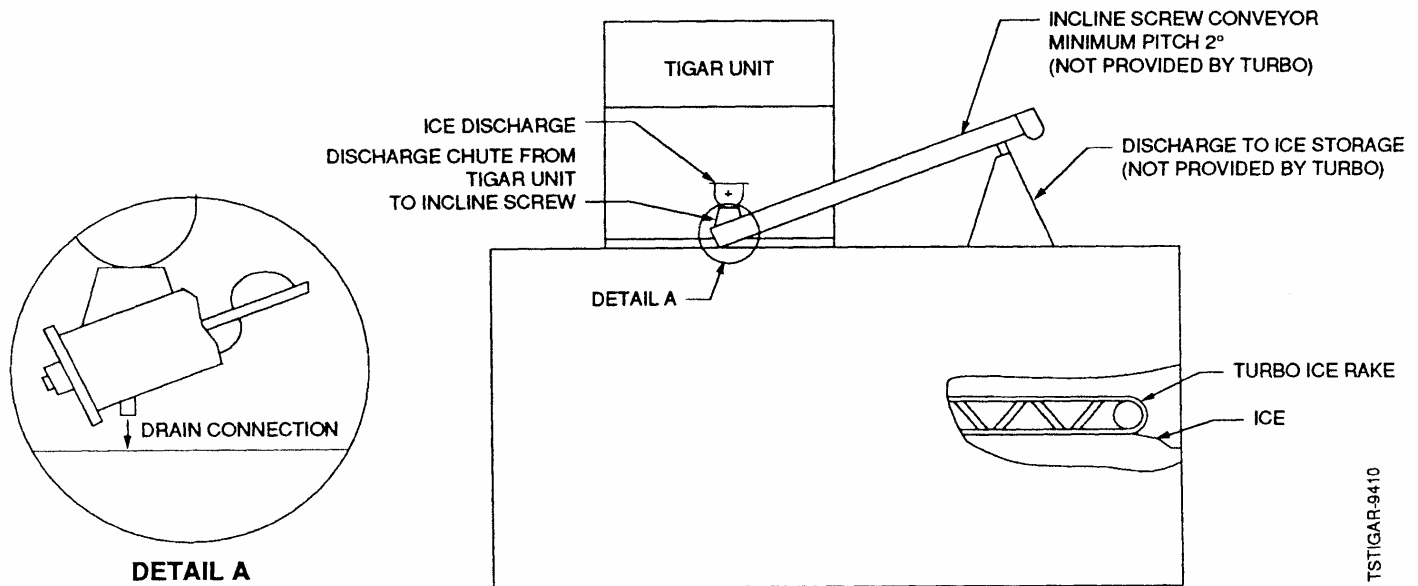


Figure 3-8 Typical Ice Delivery to Storage

Incline Screw Conveyor

An incline screw conveyor removes any condensate inside the auger and prevents:

- Water from melting snow (ice fines)
- Water overflow into storage through the discharge trough
- Overflow of cleaning fluids (used to clean the evaporator or water tank) into storage

- Any other source of water accidentally dumped into the discharge trough flowing into the storage area

Insulation

Insulate the discharge chutes from the TIGAR and the inclined screw(s) to reduce heat infiltration and condensation.

WARNING

Never operate the TIGAR unit without the discharge

chutes and screw conveyor in place. Access to the discharge downspout or incline screw could result in serious injury or loss of life. Never use a stick or probe to eliminate an obstruction. Never attempt to clean an obstruction in the discharge chute without locking out electrical power. Failure to carefully follow these instructions could result in permanent injury or loss of life.

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

5. OPTIONAL HIGH SIDE AND/OR REFRIGERANT RECIRCULATION UNIT

The TIGAR evaporator is low side only and must be connected to a dedicated condensing unit (compressor/condenser) or a central plant. A refrigerant recirculation unit is required to supply liquid refrigerant to the evaporator. With the possible exception of the central plant, all of the above require field installation that will include a

pad or structural support, refrigerant piping, water piping, and electrical service.

If the TIGAR is connected to an existing central refrigeration plant, the necessary tons of refrigeration (TR) and required NH₃ flow rates for each TIGAR model must be available for proper operation. Flow rates and TR are listed in Tables 3-1

and 3-2 for each model. The evaporator operating charge is listed in Table 3-3. Each of these requirements must be evaluated while planning the installation of the TIGAR evaporator to ensure the most efficient and cost effective installation as well as to avoid potential interface problems.

TABLE 3-1 Tons of Refrigeration and Compressor Motor HP

Models with 31" Evaporator plates

	TIGAR 25	TIGAR 50	TIGAR 75	TIGAR 100
Tons of Refrigeration (required at 0°F SET)	37.5	75.0	112.5	150.0
Compressor Motor Nominal HP (based on 105°F SCT)	75	150	200	250

Models with 36" Evaporator plates

	TIGAR 3620	TIGAR3636	TIGAR3656	TIGAR3672
Tons of Refrigeration (required at 0°F SET)	64.0	115.0	180.0	230.5
Compressor Motor Nominal HP (based on 105°F SCT)	125	200	300*	400*

* Screw compressor recommended.

All capacities based on 60°F entering water temperature and ½" thick ice.

TABLE 3-2 NH₃ Flow rate

	TIGAR 25	TIGAR 50	TIGAR 75	TIGAR 100
NH ₃ Flow rate, GPM	10	19	29	38

	TIGAR3620	TIGAR3636	TIGAR3656	TIGAR3672
NH ₃ Flow rate, GPM	16	29	46	59

Based on oil free NH₃, 0°F liquid, 15 PSIG DP across evaporator.

All Turbo refrigerant recirculation units are sized for 4:1 recirculation rates.

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

TABLE 3-3 Evaporator Operating Charge

	TIGAR 25	TIGAR 50	TIGAR 75	TIGAR 100
Operating Charge, Lbs. of NH ₃	97	194	291	387

	TIGAR3620	TIGAR3636	TIGAR3656	TIGAR 3672
Operating Charge, Lbs. of NH ₃	139	250	388	499

If the condensing unit and/or refrigerant recirculation unit options are supplied by TURBO, additional information on site preparation, installation, operation, service, and maintenance are supplied with the equipment purchased. Some general guidelines are listed below to aid in the proper selection of the condensing unit and/or refrigerant recirculation unit.

Optional Condensing Unit

Condensing units supplied by TURBO consist of the following basic components:

Motor/Compressor Assembly

Open drive or screw compressor. When required, water cooled heads and/or water cooled oil coolers are provided. Water piping (if required) to the motor/compressor assembly is not included.

Condenser

Water cooled is standard. Evaporative cooled and air-cooled are available.

Condenser Head Pressure Controls

Water regulating valve is standard for water cooled.

High Pressure Receiver

For storage of refrigerant charge during pump down for service or extended off periods. Includes inlet isolation valve, outlet valve, and safety relief valves.

Controls

Magnetic starters for the compressor motor(s). Gauge and safety console for high, low, and oil pressure safety circuit. ON/OFF master control switch and terminal switch connections for interface with the TIGAR evaporator and/or refrigerant recirculation unit as well as for connection of the control circuit power and lugs for the three phase power connections. Main and branch circuit breakers and disconnects are not provided.

Refrigerant

The refrigerant operating charge required is provided by others. Unit is shipped with an ammonia holding charge only.

Structural Base Frame

Capable of supporting the basic components listed above during transportation and operation.

Field Piping

Field piping between the condensing unit and all other

components including the TIGAR evaporator and refrigerant recirculation unit is field installed by others.

Electrical Service

Electrical service to the condensing components and all other components is field installed by others.

Cooling Tower and Cooling Tower Pump(s)

Not included with the condensing unit. Available as options. Consult TURBO for additional information.

Optional Refrigerant Recirculation Unit

TIGAR evaporators are designed for refrigerant overfeed with an oil free refrigerant grade NH₃ supplied by a mechanical pumping system connected to a recirculation vessel. Optional recirculation units supplied by TURBO consist of:

Recirculation Vessel

Sized for the refrigeration duty listed above. This vessel serves as the source of liquid refrigerant for the refrigerant pump as well as a surge vessel to separate the liquid and gas returning from the evaporator.

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

Connections are provided for the wet suction return, dry suction to the compressor, relief valve(s), oil drain, high pressure liquid make-up, liquid level column, and pump vent.

Refrigerant Recirculation Pump

Typically either a Viking or Cornell pump is used. Pumping capacities for the recirculation rates and conditions stated are listed in Table 3-2.

High Pressure Refrigerant Make-Up Line Assembly

Consists of a liquid solenoid valve, hand expansion valve, and isolation valves on the inlet and outlet of the assembly. A second hand expansion valve is connected in parallel to the solenoid valve and main hand expansion valve. The manual bypass permits operation while the solenoid valve and/or hand expansion are being serviced.

Dual Safety Relief Valves

Provided with all vessels supplied. Field piping by others is required from the discharge of the relief valves to a safe discharge location. Refer to section 2 – Safety.

Oil Recovery Vessel

Consists of an oil pot, relief valve, vent line, and isolation valves for the removal of oil from the system. Oil is removed manually from the oil pot connected to the drop leg of the recirculation vessel.

Structural Base Frame

Capable of supporting the components listed above during transportation and operation.

Recirculation Vessel Insulation

Required for proper operation. Due to variations in requirements, insulation of the vessel and piping is field installed and provided by others. Vessel is insulated with rubber but is not jacketed. Additional insulation or jacketing may be required (by others). Insulation and jacketing can be supplied as an option.

Refrigerant

The refrigerant operating charge required is provided by others. Reference Table 3-3 for evaporator operating charge for each model.

Field Piping

Field piping between the recirculation unit and all other components including the TIGAR evaporator and condensing unit is field installed by others.

Electrical Service

Electrical service to the recirculation unit and all other components is also field installed by others.

Optional Flooded Unit

TIGAR evaporators designed for flooded operation with an oil free refrigerant grade NH₃ are connected to an optional surge drum. The surge drum

package supplied by TURBO consists of:

Surge Drum

Sized for the refrigeration duty listed above. This vessel serves as the source of liquid refrigerant for the evaporator plates as well as a surge vessel to separate the liquid and gas returning from the evaporator. Connections are provided for the wet suction return, dry suction to the compressor, relief valve, oil drain, high pressure liquid make-up, liquid level column, and pump vent.

High Pressure Refrigerant Make-Up Line Assembly

Consists of a liquid solenoid valve, hand expansion valve, and isolation valves on the inlet and outlet of the assembly. A second hand expansion valve is connected in parallel to the solenoid valve and main hand expansion valve. The manual bypass permits operation while the solenoid valve and/or hand expansion are being serviced.

Dual Safety Relief Valves

Provided. Field piping by others is required from the discharge of the relief valves to a safe discharge location. Refer to section 2 – Safety.

Oil Recovery Vessel

Consists of an oil pot, relief valve, vent line, and isolation valves for the removal of oil from the system. Oil is removed manually from the oil pot connected to the drop leg of the surge drum.

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

Structural Base Frame

Capable of supporting the components listed above during transportation and operation.

Surge Drum Insulation

Required for proper operation. Due to variations in requirements, insulation of the vessel and piping is field installed and provided by

others. Insulation and jacketing can be supplied as an option.

Refrigerant

The refrigerant operating charge required is provided by others. Reference Table 3-3 for evaporator operating charge for each model.

Field Piping

Field piping between the surge drum and all other components including the TIGAR evaporator and condensing unit is field installed by others.

Electrical Service

Electrical service to the recirculation unit and all other components is also field installed by others.

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

6. ELECTRICAL CONNECTIONS

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. Consult these diagrams before making electrical service connections.

Electrical Service Connections

TIGAR units are furnished completely pre-wired internally but require electrical service connections to the:

- L1, L2, L3 motor starter connectors (three phase)
- L1, L2 control circuit connections (single phase)

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

on the TIGAR. Field wiring is required from the electrical source to the disconnects and/or circuit breakers, and from the disconnects/circuit breakers to the terminal blocks in the ice generator. All field wiring is provided by others.

Refer to Table 3-4 for conduit connections and Table 3-5 for total connection amps

TABLE 3-4 Conduit Connections for All TIGAR Models

Conduit Connection	
Control Circuit 120/1/60	1/2" MPT
Three Phase 230/460/3/60	3/4" MPT*

* A TIGAR 100, TIGAR3656, and TIGAR3672 with optional motor starters may require a 1" MPT.

TABLE 3-5 Total Connection Amps @ 230/3/60

Model	Amps
TIGAR 25	10.4
TIGAR 50	14.0
TIGAR 75	17.6
TIGAR 100	21.2
TIGAR3620	10.4
TIGAR3636	14.0
TIGAR3656	17.6
TIGAR3672	21.2

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

Note: Refer to the electrical data plate on the control panel door for actual full load amps (FLA) for the control circuit and three-phase devices supplied.

Checking Rotation

WARNING

Make sure the conveyor screw is clear of all obstacles and

warn all personnel to stay clear of the conveyor screw at all times. Failure to carefully follow these instructions could result in permanent injury or loss of life.

The conveyor screw should rotate in a clockwise direction when viewed from the end with the ice discharge facing you. As long as the conveyor screw 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 (i.e., the same phasing is used to all motor starters).

Note:

When checking rotation, only the power to the screw conveyor should be on. Turn the three phase power to the compressor and water pump off.

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

7. WATER CONNECTIONS

Make-Up Water

The source of make-up water and the make-up water temperature are important. The make-up water is the supply water from which the ice is made. The quality of the ice will depend on the type of water supplied. Ice production is affected by water temperature and water quality. As the supply water temperature decreases the ice production will increase.

Water Type

Ice can be no better than the water from which it is made. Extremely hard water will tend

to make cloudy, soft ice and will leave deposits within the machine, necessitating frequent cleaning. Hard water will not harm the TIGAR unit, but it will increase the maintenance necessary to keep the machine clean and maintain ice capacity. Good water quality will also reduce the amount of water blow down required to produce clear ice.

Water Temperature

Water temperature is an important factor in determining the icemaking capacity of the TIGAR unit. All icemaking

capacities are based on a design make-up water temperature of 60°F and no blowdown. As the water temperature increases, the icemaking capacity will decrease due to the additional cooling load on the refrigeration system. Conversely, as the make-up water temperature decreases, the icemaking capacity will increase since less refrigeration is required to remove the heat from the water before it is converted to ice. Correction factors for different water temperatures are shown in Table 3-6.

Table 3-6 Correction Factor for Feed Water Temperature

Water Temperature (°F)	35	40	50	60	70	80	90
Ice Capacity Multiplier	1.17	1.13	1.06	1.00	0.94	0.89	0.85

Example: TIGAR 50 with 40°F make-up water:

Nominal capacity with 60°F water	=	50 tons/day
Correction factor for 40°F water	=	1.13
Corrected ice capacity	=	50 x 1.13
	=	56.5 tons/day

Make-Up Water Connection

Standard TIGAR units use a 1-1/2" make-up water connection. Actual make-up water flows are shown in Table 3-7.

Table 3-7 TIGAR Models Make-Up Water Flow

TIGAR Model	25	50	75	100	3620	3636	3656	3672
Make-Up Water Flow, GPM (0% Blowdown)	4	8	13	17	9	16	25	33
Maximum Flow, GPM (25% Blowdown)	5	10	17	21	12	20	31	41

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

Note: Use maximum flow rates for design purposes. Maximum water flow for 36XX models is based on industrial ratings.

Make-Up Water Pressure and Temperature

The float valves used in the make-up water line are typically rated for a maximum water pressure of 100 PSIG and 125°F

fluid temperature (125°F is for cleaning purposes). The temperature should not exceed 90°F during normal operation. Consult the factory for operation with water temperature above 90°F.

The minimum water pressure should be approximately 5 PSIG to ensure continuous water feed to fully wet the evaporator plates at all times.

IMPORTANT

Never undersize a make-up water line. Ice capacity cannot be reached without the proper make-up water line size.

Drains

There are three drain connections on TIGAR units. Refer to Table 3-8 for connection sizes.

Table 3-8 Water Connections for All TIGAR Models - 31” and 36” Evaporator Plates

	Connection
Pan Drain	1-1/4” FPT
Tank Drain	1-1/2” FPT
Auxiliary Water Spray System	1-1/2” FPT *
Overflow Drain (hose connection)	3” PVC

*The auxiliary spray system is connected (tee) to the main make-up water connection.

Note: Provisions should be made to drain water from all vessels during winter shut-down. Drain cocks are provided in the return head of the water cooled condenser for draining. Removal of the condenser heads is recommended after draining to ensure that all of the water has been removed. If this cannot be done, the condenser can be either partially or totally filled with glycol. Indoor installations with an ambient temperature above 40°F should

require draining of the condenser only.

Auxiliary Water Spray System

A water spray system is mounted above the lower (outlet) manifold of each group of plates. A water solenoid periodically opens to spray make-up water over the manifold to prevent ice build up during extended operation. Each section has a spray manifold and solenoid valve with flow control to balance the water flow. Reference the operating section for additional information.

Two Pan Drains

A watertight pan is provided under each TIGAR to collect condensate, etc. Connect a drain line of the proper size to the pan drain. This line will normally be dry or contain only a small amount of water. There are two pan drain connections on a TIGAR unit, one in the center bottom of the pan (plugged) and one in the end of the pan. The plugged drain in the bottom of the pan is used only when the unit is located on an elevated platform or steel structure

One Overflow Drain

Blowdown or overflow of water in the tank can be adjusted from 0 to 25% to reduce collection of residual solids. The icemaking process tends to concentrate

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

(freeze-out) minerals and suspended solids in the water. Depending on the water quality (hardness, etc.), this can cause enough concentrations in the water tank to produce white or cloudy ice. A float valve on the make-up water line is provided to allow adjustment of the overflow or blowdown rate on a continuous basis.

Lowering the float arm reduces the overflow rate. Raising the float arm allows more water to overflow since the water level in the tank has to rise to a higher level before the float valve shuts off.

At start-up, adjustments can be made to obtain the desired blowdown rate. Make periodic checks to ensure that deposits are not building up in the tank.

Have a local water treatment consultant determine if additional water treatment (chemical, filtration, etc.) is required to obtain the desired ice quality.

IMPORTANT
Normal freeze-up precautions should be taken when drain lines must be exposed to freezing temperatures.

Water Cooled Condensers (Optional)

Water condensers supplied on TIGAR units 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.

Water Requirements (Optional Condensing Unit)

Condenser water requirements are based on 85°F water to the condenser, 95°F water off the condenser, and 105°F condensing. The condenser's design water flow rate is based on 3 GPM/ton of refrigeration.* The actual flow rate is wholly contingent on the water temperature and evaporator load but will not exceed the design flow.

* Tons of refrigeration = Total Heat Rejection @ 10°F SET/105°F SDT ÷ 15,000 BTU/ton

Optional Water Regulating Valve (SC Models Only)

A water regulating valve can be furnished in the TIGAR unit and must be field installed external of the unit in the outlet water line. A 1/4" SAE flare type valve is provided on the water cooled condenser for the water regulator high pressure gas connection. The regulator modulates in response to increases and decreases in the discharge pressure to maintain a

constant pressure under all operating conditions.

Water Temperatures

When cooling towers (optional) are used and no other positive means of regulating head pressure are provided (i.e., fan and pump pressure switches), a water regulating valve will be required. Adequate head pressure is important to provide proper refrigerant flow to refrigerant control valves such as hand expansion valves or other devices used to feed liquid to the recirculation vessel or surge drum. During harvest, an adequate supply of hot gas must also be available to obtain a proper harvest.

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 TIGAR units are installed in an area where the ambient falls below freezing, refer to section 8 – Optional Features & Accessories for Winterizing.

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

8. REFRIGERANT PIPING

Piping in a refrigerant system has two functions:

1. To carry the refrigerant through the system as a liquid, a gas, or a liquid/gas mixture with a minimum pressure drop.
2. To return any oil entrained in the refrigerant to the compressor.

Avoid trapping the lines except for specific purposes. If traps are used, the horizontal dimension should be as short as possible to avoid excessive

trapping of oil. Suction mains should be pitched toward the compressor.

Steel Pipe Joints

Clean threads on the pipe and fittings to remove all traces of grease or oil.

Wipe the threads dry with a lintless wiping cloth.

Threaded Joints

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.

Refer to Table 3-9 for refrigerant connections to the evaporator.

Table 3-9 Refrigerant Connections to Evaporator and Recirculator

Evaporator Connections Required (Recirculated and Flooded Models):

Recirculated Units with 31" Evaporator Plates:

	TIGAR 25	TIGAR 50	TIGAR 75	TIGAR 100
Pumped Liquid Line	1-1/2"	2"	2"	2-1/2"
Wet Suction	3"	4"	5"	6"
Hot Gas	1-1/2"	2-1/2"	2-1/2"	2-1/2"

Flooded Units with 31" Evaporator Plates:

	TIGAR 25	TIGAR 50	TIGAR 75	TIGAR 100
Liquid Line (low pressure)	1-1/2"	2"	2"	2-1/2"
Wet Suction	4"	5"	8"	8"
Hot Gas	1-1/2"	2-1/2"	2-1/2"	2-1/2"

Recirculated Units with 36" Evaporator Plates:

	TIGAR3620	TIGAR3636	TIGAR3656	TIGAR3672
Pumped Liquid Line	1-1/2"	2"	2"	2-1/2"
Wet Suction	3"	4"	5"	6"
Hot Gas	1-1/2"	2-1/2"	2-1/2"	2-1/2"

Flooded Units with 36" Evaporator Plates:

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

	TIGAR3620	TIGAR3636	TIGAR3656	TIGAR3672
Liquid Line (low pressure)	1-1/2"	2"	2"	2-1/2"
Wet Suction	4"	5"	8"	8"
Hot Gas	1-1/2"	2-1/2"	2-1/2"	2-1/2"

Optional Recirculation Vessels, Surge Drums & Condensing Units Suggested Line Sizes
 Recirculated & Flooded Units (based on tons of refrigeration in Table 3-1)

	TIGAR 25	TIGAR 50	TIGAR 75	TIGAR 100
Liquid Line (high pressure*)	3/4"	1"	1-1/4"	1-1/4"
Dry Suction	2-1/2"	3"	3"	4"
Discharge (compressor)	1-1/2"	2"	2-1/2"	3"

	TIGAR3620	TIGAR3636	TIGAR3656	3672
Liquid Line (high pressure*)	3/4"	1"	1-1/4"	1-1/4"
Dry Suction	2-1/2"	3"	3"	4"
Discharge (compressor)	1-1/2"	2"	2-1/2"	3"

* High pressure refrigerant line to recirculation vessel (recirculated unit) or surge drum (flooded unit).

Notes:

- The evaporator is shipped with connections on both ends of the evaporator. All connections are welded closed with a flat cap. During installation, cut off the flat cap on the end the connections are to be made to and grind a weld bevel on the end of the pipe for connection to the field piping.**
- All piping connections in the table above are carbon steel: Schedule 40 pipe for 2" and above. Schedule 80 pipe for 1-1/2" and below.**

Steel Pipe

Carbon steel or stainless steel pipe can be used for refrigerant lines but must be either sandblasted 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.

Storage / Inactive Systems

If the equipment is not installed upon receipt or is installed but not put in service, the interior must be maintained in a clean dry environment. All units are evacuated and charged with nitrogen or an ammonia holding charge to protect the system.

During installation the dry holding charge will be lost. If the system is not started after installation, the system should be properly evacuated and an ammonia holding charge established. All external surfaced should also be thoroughly washed with clean water and air dried or wiped off with clean dry cloth. The integrity of the system should be checked on a regular basis to avoid damage during the extended off period.

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

9. TESTING REFRIGERATION SYSTEM FOR LEAKS – FIELD PIPING

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

In order to test field piping for leaks, the system pressure must be built up. Test pressures for the system's low side and high side are defined in the following standards:

- ANSI/ASHRAE 15 Safety Code For Mechanical Refrigeration
- ANSI B9.1 Safety Code for Mechanical Refrigeration
- ASME/ANSI B31.5 Refrigeration Piping

These standards should be referenced for field test pressures and procedures. 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

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 bypass arrangements.

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

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 and threaded or welded joints with a one inch round brush. A small amount of glycerin 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 welded joints while the system is under pressure. Welded joints should be ground and rewelded. Do not simply add more weld to a leaking joint.

4. After all the joints have been repaired and the system is considered "tight", test the TIGAR 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 sulfur stick or electronic leak detector. Check all flanged, welded, screwed, and gasket joints, all valve stem packings, and all parting lines on castings. If any leaks are found, they must be repaired and rechecked before the system can be considered tight.

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

10. 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 TIGAR unit before charging it with refrigerant. If air, water vapor, or non-condensables are left in the system, various operating difficulties can be encountered, including:

1. Water will decrease the capacity of the evaporator and cause formation of ice in orifice openings causing restriction or complete shut-off of refrigerant flow.
2. Air and non-condensables will lodge in the condenser; decrease the space for condensing liquid and cause the head pressures to rise, thus reducing capacity.

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 the 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 manufacturer's 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.

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.

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

4. Allow it to stand at this vacuum for another five (5) to six (6) hours.
5. Break the vacuum.
6. Raise the system pressure up to zero (0) with oil free dry nitrogen.
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 the oil pumped dry nitrogen.
5. Raise the pressure in the system to zero (0).
3. Stop the system and allow it to stand for approximately twelve (12) hours at the low pressure.
4. Break the vacuum with the 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.

Third Evacuation

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.

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).
6. Evacuate the system below the 500 micron figure and charge with the refrigerant being used for the system.

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

11. CHARGING THE SYSTEM WITH REFRIGERANT OIL

After the complete system consisting of the TIGAR (evaporator), high side, and refrigerant recirculation unit is started, it may be necessary to add oil to maintain the proper level in the compressor (by others).

Note:

Production capacity of the TIGAR is based on an oil free NH₃ refrigerant supply. Optional equipment supplied for the refrigeration system must provide for proper oil management. Consult the high side and/or refrigerant recirculation package supplier for additional information on oil management.

When properly charged, the oil level in the compressor should be visible in the compressor sight glass. An oil reservoir may also be used on these units.

Other equipment such as the oil filter or oil coolers (when used)

also require an oil charge. Therefore, the oil level in the compressor and oil reservoir should be rechecked after the compressor has been operated. If additional oil is required, add only the oil specified by the compressor manufacturer. Use only dehydrated, wax-free, refrigerant grade oil of suitable viscosity.

Periodic Checks & Records

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

Refrigerant Oil

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

- Sun Oil Suniso 3GS

- DuPont synthetic oil, 150 SSU only
- Texaco Capella B1

Consult the equipment supplier specifications.

IMPORTANT

Do not mix different types or grades of oil. Do not overfill with oil; this is especially true on the hermetic type compressors. Make sure the oil is fresh and not contaminated.

Oil Quality

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

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

12. REFRIGERANT CHARGING

Possible Leaks

TIGAR units are furnished with a nitrogen holding charge to keep the system dry during shipping. A leak in the refrigerant circuit might occur during shipping or handling. If a leak is detected, immediate corrective action should be taken before refrigerant gas is added to the system. Refer to step 9 – Testing Refrigeration System for Leaks.

Adding Refrigerant

IMPORTANT

Before adding refrigerant or placing the unit in operation, evacuate the entire system to ensure a completely dry system. Refer to step 10 – Evacuating the System.

Whenever refrigerant is added to any TIGAR system, extreme care should be taken in admitting the refrigerant to the system.

The TIGAR unit should be placed in operation and the liquid level observed during the first five minutes of the freezing cycle.

With the head pressure between 180 PSIG and 213 PSIG, additional refrigerant, if required, 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.

When the liquid level in the refrigerant recirculation drum is stable during both refrigeration and harvest, the unit is fully charged. The unit data nameplate lists the unit model, refrigerant type, and refrigerant charge of the evaporator. Always monitor and record how much refrigerant is added. Never exceed the data nameplate charge listed. The charge listed is for the evaporator only. Additional refrigerant will be required for field piping and/or other components added to the systems by others.

IMPORTANT

Do not overcharge the refrigerant circuit because this induces high discharge pressures. Be sure the correct type of refrigerant is being added to the systems (refrigerant grade NH3). Do not use agricultural grade NH3.

TIGAR Units

TIGAR units are furnished without refrigerant charge. The entire refrigerant system must be evacuated (refer to step 10 – Evacuating the System) 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.

Remote Air or Evaporative Cooled Units (Optional)

Optional condensing 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.

Refrigerant Recirculation Systems (Optional)

Optional refrigerant recirculation vessels are shipped without a refrigerant charge.

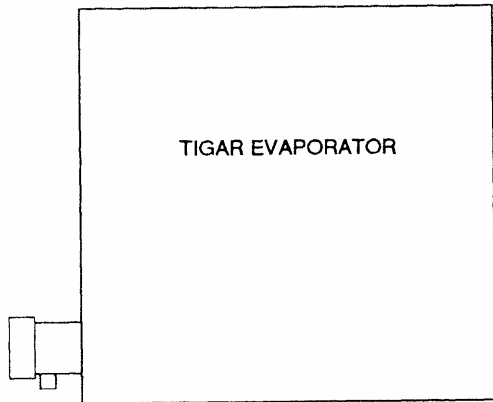
Relief Devices

Relief valves should be installed on all 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 will be required to vent the valve outside for indoor installations or to a location away from exposure to personnel for indoor or outdoor

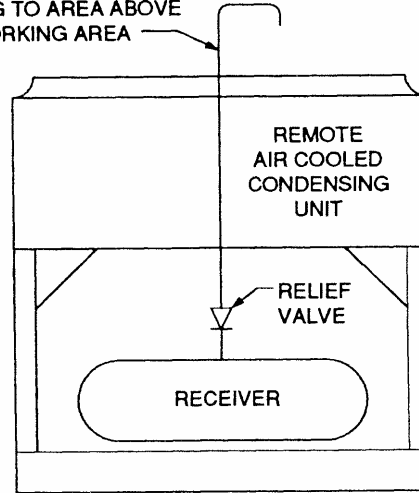
WARNING! Read safety section before this section. Failure to carefully follow these instructions could result in permanent injury or loss of life.

installations. Refer to Figure 3-9, Figure 3-10, and Figure 3-11.

NOTE: REFRIGERANT RECIRCULATION UNIT NOT SHOWN. RELIEF VALVE PIPING SHOWN IS TYPICAL FOR ALL VESSELS.



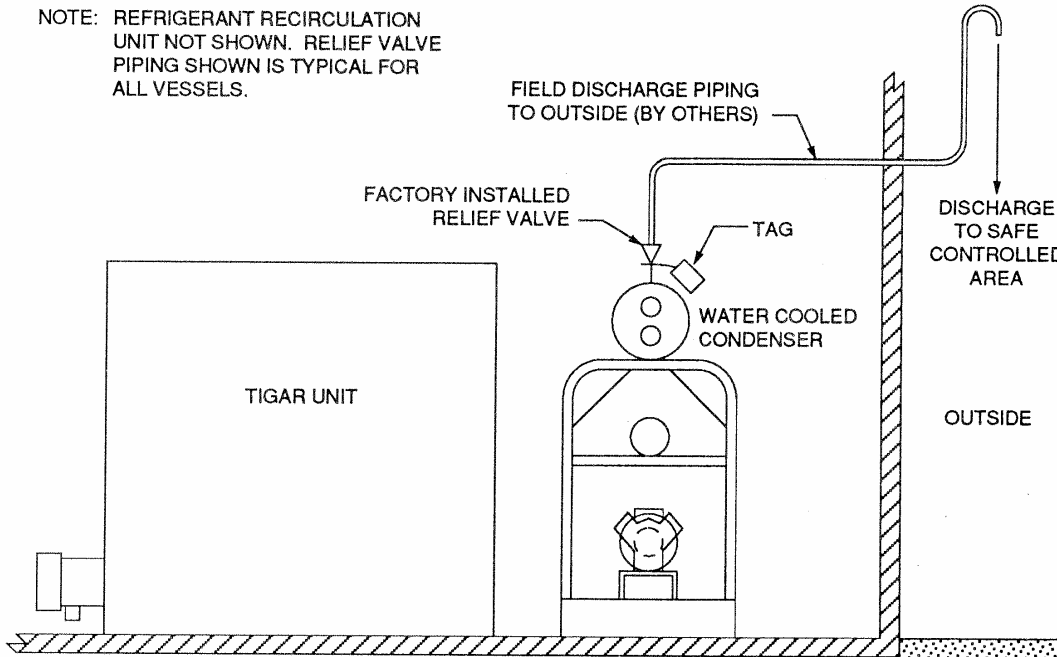
RELIEF VALVE DISCHARGE LINE FIELD PIPING TO AREA ABOVE NORMAL WORKING AREA



TSTIGAR-9411

Figure 3-9 Typical Optional Air Cooled Condenser Relief Valve Field Piping

NOTE: REFRIGERANT RECIRCULATION UNIT NOT SHOWN. RELIEF VALVE PIPING SHOWN IS TYPICAL FOR ALL VESSELS.



TSTIGAR-9412

Figure 3-10 Typical Indoor Installation Relief Valve Piping of Optional Condensing Unit

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

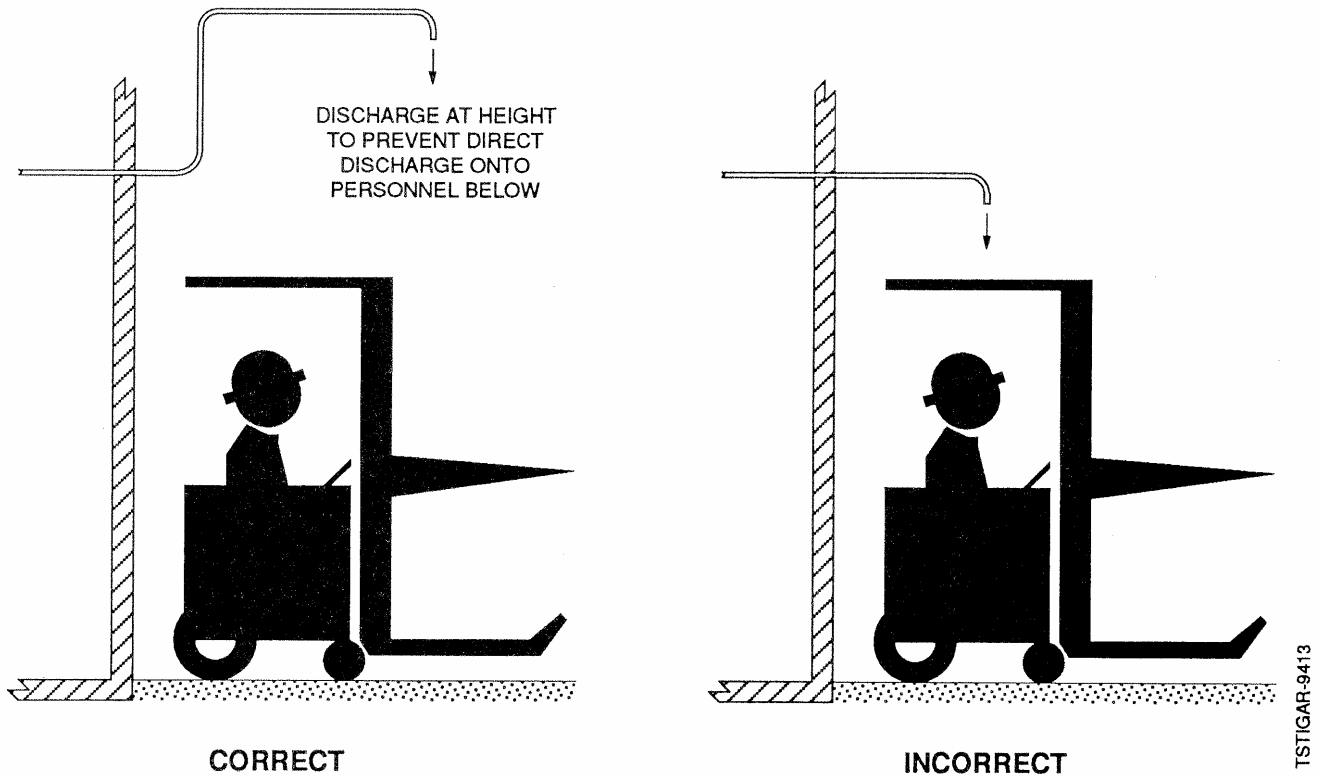


Figure 3-11 Correct and Incorrect Relief Valve Discharge Piping

TURBO provides a relief valve on all vessels supplied with the unit.

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 warning or a similar warning.

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

ANSI/ASHRAE 15-1987 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:

$$L = [0.2146(d^5)(P_o^2 - P_2^2)/fCr^2] - [(d)Ln P_o / P_2] / 6f$$

ASHRAE Addendum 15c-2000

where:

- L = maximum length of relief valve discharge piping (ft)
- P₂ = Absolute pressure at relief valve outlet (PSIA)
- P_o = Absolute back pressure at relief valve outlet (PSIA)
- d = Internal diameter of discharge piping (inches)

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

- Cr = Rated capacity of relief valve (lbs. of air per minute)
- f = Moody friction factor in full turbulent flow (see list below for factors)
- Ln = Natural logarithm

- P_o = 0.15 P + 14.7 for conventional relief valves
- Where P = Set pressure of the relief valve used

Friction factors for typical pipe sizes are:

Table 3-10 Relief Valve Piping Friction Factors

Pipe size	Internal Diameter, inches	Friction factor, f
1/2"	0.622	0.0259
3/4"	0.824	0.0240
1"	1.049	0.0225
1-1/4"	1.038	0.0209
1-1/2"	1.610	0.0202
2"	2.067	0.0190
2-1/2"	2.469	0.0173

For larger sizes consult ASHRAE, the relief valve or TURBO

For selection of relief valve, the calculated discharge rate is:

$$C = fDL_1$$

where:

- C = minimum required discharge capacity of relief valve (lbs. of air per minute)
- f = 0.5 for NH₃
- D = outside diameter of vessel (ft)
- L₁ = length of vessel (ft)

Example:

TIGAR 25 with a water cooled condensing unit using a 12-3/4" diameter x 48" receiver.

Design relief pressure is 300 PSIG.

Refrigerant is NH₃ (ammonia) – refrigerant grade.

Minimum required discharge capacity of the relief valve:

$$C = fDL_1 = (0.5) * (12-3/4/12) * (48/12) = 2.1 \text{ pounds of air per minute required}$$

And maximum discharge piping length:

$$L = [0.2146(d^5)(P_o^2 - P_2^2)/fCr^2] - [(d)Ln P_o / P_2] / 6f]$$

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

Where:

$$P_2 = 14.7 \text{ PSIA}$$

$$\text{Therefore } P_2^2 = 216.09$$

$$P_o = (0.15 * 300) + 14.7 = 59.7 \text{ PSIA}$$

$$\text{Therefore } P_o^2 = 3,564.09$$

$$d = 1.049" \text{ (1-1/4" SCH40 pipe)}$$

$$d^5 = 1.2702$$

$$Cr = 20.5 \text{ pounds of air per minute}$$

Hansen H5600R pressure relief valve 1/2" x 3/4" (inlet x outlet) or equivalent

$$Cr^2 = 420.25$$

$$\ln P_o / P_2 = \ln(59.7/14.7) = 1.401$$

Then:

$$L = [(0.2146 * 1.2702 * (3,564.09 - 216.09)) / (0.0225 * 420.25)] - [1.049 * 1.401 / (6 * 0.0225)] = 85.6 \text{ feet}$$

Therefore, a 1" SCH40 pipe is adequate for installations with relief valve discharge piping less than 86 feet long. If longer piping is required, a larger pipe size may be required. In the example above a 1-1/4" line could be used for relief discharge lines up to 394 feet.

For other applications the tables and formulas above should be used to calculate the relief valve size and the maximum piping distance. For convenience Table 3-11 below shows typical valve selections and piping distances for the relief valves used on standard TURBO models.

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

Table 3-11 Maximum Equivalent Relief Valve discharge Piping

Relief Pressure, PSIG	Relief Valve Size, inches	Capacity, lbs/min of air	Maximum Equivalent Length of Outlet Piping Schedule 40 Pipe Size					
			3/4"	1"	1-1/4"	1-1/2"	2"	2-1/2"
			150	1/2" x 3/4"	10.6	30	119	524
	1/2" x 3/4"	31.3		7	51	125	456	
	1/2" x 1"	35.8		4	37	92	344	
250	1/2" x 3/4"	17.2	22	93	422			
	1/2" x 3/4"	50.5		25	70	298		
	1/2" x 1"	57.7			25	70	298	
	3/4" x 1"	17.2		93	422			
	3/4" x 1"	57.7			25	70	298	
	1" x 1-1/4"	85.4			4	23	124	344
300	1/2" x 3/4"	20.5	19	86	394			
	1/2" x 3/4"	60.1			32	88	370	
	1/2" x 1"	68.6			21	63	278	
	3/4" x 1"	20.5		86	394			
	3/4" x 1"	68.6			21	63	278	
	1" x 1-1/4"	101.6				19	113	319
350	1/2" x 3/4"	24.1	27	113	510			
	1/2" x 3/4"	70.1			46	118	480	
	1/2" x 1"	80.0			32	86	364	
	3/4" x 1"	24.1	27	113	510			
	3/4" x 1"	80.0			32	86	364	
	1" x 1-1/4"	118.5				29	152	419

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

13. PRE-START-UP CHECKLIST

Customer _____

Date _____

Serial No _____

Model _____

Check off the following items prior to start-up of the unit (recirculated or flooded):

1. Verify that all loose components shipped for field installation are at the jobsite and have been installed per the manufacturer's instructions.

Note: The TIGAR is a low side evaporator only. Field connection to a condensing unit and refrigerant recirculation unit or surge vessel are required to complete the system. Field connections may include water piping, refrigerant piping, electrical controls and power, and insulation of vessels and piping. Refer to the wiring and piping diagrams provided with the unit for field connection requirements.

2. Familiarize yourself with the installation site: the location of safety equipment, eye wash and showers for exposure to NH₃, and evacuation plans in the event of an NH₃ release.
3. Review the operating and maintenance manual provided with the equipment. Read the safety section before starting the installation of the equipment.
4. Complete the checklist provided with the condensing unit (if applicable).
5. Complete the checklist provided with the refrigerant recirculation unit or surge drum (if applicable).
6. Verify that all field electrical connections to the evaporator have been completed per the wiring diagram provided with the equipment and per the instructions in the operating and maintenance manual. Circuit breakers and/or electrical disconnects are not supplied by TURBO but are required by code in most locations. Supply and proper installation of the circuit breakers and/or disconnects to meet all applicable codes is the responsibility of others.
7. Verify that all field refrigerant piping connections to the evaporator have been completed per the piping diagram provided with the equipment and per the instructions in the operating and maintenance manual. Supply and proper installation of field refrigerant piping to meet all applicable codes is the responsibility of others.
8. If the unit is to be connected to an existing central system, verify the interface requirements for the evaporator to the central system.
9. Verify that all relief valves have been piped to a safe discharge location (refer to the operating and maintenance manual for guidelines).

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

- 10. Verify that all field water piping connections to the evaporator have been completed per the piping diagram provided with the equipment and per the instructions in the operating and maintenance manual. Supply and proper installation of field water piping to meet all applicable codes is the responsibility of others. Flush and drain all water piping and water tanks.

Note: Water piping may include the make-up water to condensers, oil coolers, or components supplied by others with the condensing unit and/or refrigerant recirculation unit, and the make-up water connection to the evaporator. Water drain and overflow piping is required from the evaporator to the proper disposal points (provided by others).

- 11. Verify that the complete system has been properly evacuated, leak checked, and charged with the proper refrigerant (refrigerant grade NH₃).

Note: Each of the above functions is the responsibility of others. Refrigerant is not supplied with the equipment.

- 12. Note all leaks found and repaired during step number 11.

Checklist Completed By _____

Date _____

If you have any questions concerning the above checklist or any other aspect of equipment installation in preparation for start-up, contact:

Turbo Refrigerating, LLC
Service Department
P.O. Box 396
Denton, Texas 76202-0396
Phone: 940-387-4301
Fax: 940-382-0364

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

14. START-UP CHECKLIST

Page 1 of 2



TIGAR START-UP CHECKLIST

The following items must be checked off prior to and during start-up of the unit.

Customer _____ Date _____ Model _____ Unit Serial # _____

Before start-up of the unit(s), verify that all screw conveyors, covers, guards, and safety panels are properly installed. Notify all personnel that the equipment is being started and that power to the equipment has been connected.

EVAPORATOR					
Check Item	Date	Checked By	Date	Comments	
Refrigeration time, seconds					
Defrost time, seconds					
Evaporator pressure during icemaking (PSIG – design is 15 PSIG)					
Evaporator pressure during defrost (PSIG – design is 68-80 PSIG)					
Hand TXV settings (# of turns open) Note position of all valves.					
Verify DPS switch operation (note setting)					
WATER CIRCUIT					
Check Item	Date	Checked By	Date	Comments	
Water pressure @ TIGAR water inlet (PSIG)					
Water temperature @ pump discharge/water pans (°F)					
Blowdown (overflow) YES/NO					
Water distribution pans secure					
Water flow over plates checked					
Water distribution pan filter pad in place					
Water pan float switch level adjusted					
Water level in water distribution pans (inches – minimum level is 1-1/2")					
EVAPORATOR MOTOR PERFORMANCE DATA					
Motor	Voltage (230 or 460/3/60)	Amp Draw	HP	FLA	Nameplate Data
Harvest screw conveyor					
Water pump #1					
Water pump #2					
Water pump #3					
Water pump #4 (TIGAR 100 only)					
RECIRCULATION MOTOR DATA (by others)					
Check Item	Date	Checked By	Date	Comments	
Refrig. recirc. pump(s)					
Oil pot heater (if so equipped)					

Turbo Refrigerating • 1815 Shady Oaks Dr. • P.O. Box 396 • Denton, TX 76202 • Phone: 944-387-4301 • Fax: 944-382-0364

F-9423

The checklist below is a reduction of the actual checklist. Contact TURBO for a full sized checklist.

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

TIGAR START-UP CHECKLIST

Page 2 of 2

CONDENSING UNIT MOTOR DATA (by others)				
Check Item	Date	Checked By	Date	Comments
Compressor #1				
Compressor #2				
Water cooled models cooling tower pump(s)				
Water cooled models cooling tower fan(s)				
Water cooled models sump heater (if so equipped)				
Evaporative cooled models fan motor(s)				
Evaporative cooled models circulating pump(s)				
Evaporative cooled models sump heater (if so equipped)				
Air cooled models fan motor(s)				
Verify rotation of all motors				

MISCELLANEOUS				
Check Item	Date	Checked By	Date	Comments
Refrigerant charge (lbs) (system – evap., recirc. unit, condensing unit)				
Safety circuit switch settings (by others, refer to the manufacturer's checklist)				

NOTES:

- The screw conveyors from the ice generator to the TURBO® ice rake or other delivery point should be interlocked with the TIGAR controls to prevent operation if they are off or "tripped" on overload.
- Before starting equipment, verify that the wiring diagram, piping diagram, and ladder logic are available for quick reference. If these documents are not available, contact TURBO before proceeding.

Upon completion of the start-up, please mail or fax a copy of the start-up checklist to:

Henry Vogt Machine Company
Refrigeration Division – Turbo Refrigerating
Service Department
P.O. Box 396
Denton, Texas 76202
Phone: 817-387-4301
Fax: 817-382-0364

ACCEPTED BY

Name _____ Date _____ Company _____

print

signature

START-UP BY

Name _____ Date _____ Company _____

print

Turbo Refrigerating • 1815 Shady Oaks Dr. • P.O. Box 396 • Denton, TX 76202 • Phone: 944-387-4301 • Fax: 944-382-0364

E-9423

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



TIGAR Ice Generator Operation & Maintenance Manual

OPERATING INSTRUCTIONS

This section describes the TIGAR ice generator operating sequence and the function of the ice generator components and control panel components. Hints are provided for safe, efficient, and reliable operation of both the recirculated and the flooded evaporator equipment. Only standard features are discussed in this section. For optional features and accessories, refer to section 8 – Optional Features & Accessories.

Controls

All TIGAR models operate in the same basic way and control panel components are the same except for size (larger magnetic starters, etc.). Operating sequences do vary for the packaged ice (consumer ice) applications versus industrial (process icing) applications. Both operating sequences will be described later in this section. For both operating variations the control panel contains:

- Programmable logic controller (PLC)
- Magnetic starter for the:
 - Water pump(s)

Operating Instructions

- Harvest screw(s)
- Magnetic motor starter for the optional evaporative condenser fan and pump (where applicable – SCE models)
- Magnetic motor starter for the fan(s) on optional air cooled condensers (where applicable – SCA models)
- Magnetic motor starter for compressor (on optional high side package)
- Magnetic motor starter for NH₃ recirculation pump (on optional NH₃ recirculation unit)

Note:

Controls necessary for components used to distribute the ice to points of use are not furnished by TURBO. Such controls can be provided as an option.

Control Panel Door

The control panel door contains the following items:

- Master control selector switch – ON/OFF
- Two 10-amp fuses
- Manual defrost switch (MDS) for each section (flooded models have a

- single MDS) – OFF/AUTO/Manual Defrost Positions
- Reset buttons for the magnetic starter overload relays
- Emergency stop button
- Warning labels
- Data nameplate
- Safety failure pilot light(s)

Refer to section 2 – Safety for a list 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.

Note:

Refer to the serial number on the data nameplate when inquiring about the controls. A file is maintained under this serial number. This ensures that all information required to assist you can be accessed quickly and accurately.

WARNING

The selector switch is not a service disconnect. Lock out electrical power to controls before performing service. Have a qualified electrician perform all service. Failure to carefully follow these

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

instructions could result in permanent injury or loss of life.

Electrical Components **Description**

Master Control Switch (ON/OFF)

A two position, cam operated master control switch (MCS) with a normally open (N.O.) contact block is provided to input a signal to the programmable controller. This signal initiates the logic required to start the ice generator and to terminate ice production. Turning the selector switch to the OFF position initiates a shutdown sequence. Actual termination of operation occurs immediately unless a section is in harvest. If a section is in harvest, the unit shuts off at the completion of the harvest sequence. On industrial models, ice remains on the plates on some sections when operation is terminated. Packaged ice versions with the dry harvest sequence have a clean up cycle that harvests all ice before termination of operation.

Emergency Stop Push Button

A large, red, mushroom head push button with a normally closed contact block is located on the control panel door and is wired into the main control circuit wiring. If immediate termination of operation is required, the push button is pushed in. This cuts off the

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single phase control circuit power and stops all electrical devices located within the unit, including any optional high side or liquid recirculation units and optional winterizing controls.

WARNING
Never use the emergency stop button as a service disconnect. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Resetting the Emergency Stop Push Button

Turn the keyed MCS switch to the OFF position. Close the isolation valve in the main liquid line to the evaporator and the isolation valve in the high pressure liquid refrigerant line to the optional recirculation vessel.

If the system is off for more than thirty (30) minutes, place the manual defrost switches (MDS) in the OFF position. Verify that the compressor crankcase heaters on the optional high side package have been on long enough to boil off any liquid refrigerant in the crankcase.

Restart the high side package (compressor) and allow it to pump-down the system to prevent liquid slugging of the compressor when the system is restarted. The compressor should shut-off on a low pressure (suction) safety at the

completion of the pump-down. Refer to the compressor manufacturer's specifications.

Return the isolation valve to the open position and place the MDS switches in the AUTO position one at a time as the unit is restarted.

To restart, pull out the emergency stop push button. Turn on the MCS.

If the emergency stop was used, determine why and take action to correct the problem before returning to normal operation.

Control Devices

R-1 Dry Contact

The evaporator is shipped with a jumper installed between the two terminal strip connections (refer to the wiring diagram provided with the evaporator for terminal numbers) in the L1 line to the Emergency Stop button. The jumper may be removed and replaced with normally closed (N.C.) dry contacts of a relay or a remote emergency stop switch. This permits the immediate termination of operation of the evaporator from a remote location(s) other than the evaporator control panel. Before operation can be resumed, the relay or switch must be reset. This contact is for emergency stop only and should not be used for service or normal start/stop of the evaporator.

Operating Instructions

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

When the R-1 contact is opened, the entire control circuit is de-energized. All power to relays, magnetic starters, PLC power, etc. is terminated.

Field wiring by others is required if the R-1 contacts are utilized.

Compressor/NH₃ Pump/Liquid Solenoid Control Relay (CR1) CR1-1 Contacts of CR1

A control relay is provided in the control panel to control the operation of remote components including the compressor/condensing unit, NH₃ pump, and high pressure liquid solenoid. All of these components are supplied by others or as an option by TURBO. Through the logic of the PLC, the CR1 relay is energized via an output of the PLC. When the relay is energized, a normally open (N.O.) dry contact (CR1-1) closes. The control circuit of the recirculation unit should be connected to these dry contacts to initiate the start and stop of the NH₃ pump (i.e., the evaporator and NH₃ pump should be turned on before the compressor is started and turned off upon termination of the icemaking process). For evaporators connected to a central system, the dry contacts can be used to indicate the status of the ice generator (ON/OFF) at a remote control panel such as the central equipment room.

Operating Instructions

Additional relay contacts or an interlock of the NH₃ pump should be used to start the compressor/condensing unit as well as to open and close the high pressure liquid solenoid supplying liquid refrigerant to the recirculating unit.

The following sequence may be used to control the compressor, NH₃ pump, and liquid solenoid:

1. The CR1-1 contact closes to turn the NH₃ pump on.
2. An interlock of the NH₃ pump (by others) is used to input a signal to the compressor (condensing unit) control circuit to initiate start-up of the compressor and to energize the high pressure liquid solenoid valve.
3. An interlock of the compressor starter is used to input a signal to the ice generator PLC indicating the compressor has started. The interlock of the compressor would be connected as a dry contact in series with the NH₃ pump interlock (AP-1) and would provide the same control as the AP-1 interlock.

Note:

For central plant operations only, the NH₃ pump interlock input is required to the PLC.

Bin Level Switch (BLS)

The evaporator is shipped with a jumper installed in the Master Control Switch (MCS) circuit

between two terminal strip connections (refer to the wiring diagram provided with the evaporator for terminal numbers). The jumper may be removed and replaced with normally closed (N.C.) dry contacts of a bin level switch. The bin switch is used to monitor the level of ice in a remote surge hopper or TURBO ice storage system. When the bin or hopper is full, the dry contacts of the bin switch open. This inputs a control signal to the programmable controller to complete the current harvest sequence if a harvest is in process and then shut off. The opening of the BLS contacts produces the same results as turning the Master Control Switch to the OFF position.

TURBO can supply a motor driven bin level switch as an option. A rotating paddle with an integral clutch is stalled when the ice level reaches the paddle and the BLS contacts open. When the ice level drops, the paddle is released and the contacts close to resume normal operation.

If the ice generator is used with a TURBO model ice storage bin (CB or Auto Rake), wire the rake CR1-1 contact in place of the BLS contact. This enables automatic shutdown of the icemaker upon a rake bin full for failure condition.

Field wiring by others is required if the BLS or rake CR1-1 contacts are utilized.

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

NH₃ Pump Interlock (AP-1) - Recirculating Units Only

An interlock of the NH₃ recirculating pump magnetic starter (AP-1) is required as an input to the programmable controller. The normally open (N.O.) dry contact must be field installed by others. The ice generator will not make ice without this input present. Refer to the wiring diagram provided with the evaporator for the terminal strip numbers which the contacts are connected to. The NH₃ recirculating pump can be provided by TURBO as an option.

The AP interlock is a proof of operation for the supply of NH₃ refrigerant to the evaporator plates by the remote recirculating unit. This signal must be received by the PLC logic for the evaporator to operate. If the signal is not received, the PLC logic will terminate operation of the evaporator after a preset time delay (**typically 2 seconds**).

A red pilot light is located on the control panel door to indicate an NH₃ pump failure. The PLC requires a reset signal after such a failure. Turn the MCS to the OFF position and then back to the AUTO position to reset. After resetting, operation should be monitored

to determine the cause of the failure.

Field wiring by others is required for all installations. A jumper is not installed between the terminal strip connections when the evaporator is shipped.

Defrost Pressure Switch (DPS)

A break-on-rise (BOR) pressure switch is installed in the hot gas supply line to the evaporator. When a section is harvested, the programmable controller (PLC) checks the status of the switch contact. If the hot gas pressure is above the setting of the switch, the switch contacts will be open. With the absence of a signal, the PLC knows the pressure is above the minimum required for harvest, and a normal defrost sequence follows. If the switch contact is closed, indicating that the hot gas pressure is below the set point of the switch, the PLC will initiate an extended defrost sequence (typically 60 seconds).

The TIGAR evaporator defrost time was established on a design minimum hot gas pressure of 125 PSIG. Although the evaporator can be operated with lower condensing pressures to obtain the maximum capacity of the compressor, a longer defrost

time is required. The DPS switch initiates an extended harvest sequence that lengthens the defrost time to compensate for the lower hot gas pressure. This allows the equipment to be operated at the lower condensing temperatures without encountering freeze-up problems due to inadequate defrost times.

This switch is generally for winter or cold weather operation. When operating at design operation, it is generally not possible to obtain condensing pressures below 125 PSIG.

On flooded TIGAR units, an outlet pressure regulator is provided for installation in the hot gas line entering the evaporator compartment. This regulator must be set to maintain a pressure of 100 PSIG into the evaporator. The DPS on flooded units will initiate an extended harvest if the pressure falls below 95 PSIG.

Manual Defrost Selector Switch (MAN/OFF/AUTO)

A three position MAN/OFF/AUTO is provided for each evaporator section to provide for selection of the operating mode of each section in the TIGAR. Refer to Table 4-1.

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

Table 4-1 Manual Defrost Selector Switch Functions –Typical for Each Section

Position	Function	Description
MAN	Manual Defrost	The section selected will be placed in defrost until the selector switch is returned to the OFF or AUTO position. Return the switch to the AUTO position immediately upon completing the manual defrost of the section.
OFF	Off	Removes the section selected from operation. This position is intended for use during service only. Refer to the note below.
AUTO	Automatic	The section operates through the refrigeration and harvest sequence programmed into the programmable controller. Under normal operating conditions, the switch should always be in this position.

Note: 1. If the section is to be left off for an extended time period, the hand expansion valve feeding liquid to the section should also be closed and the pressure regulator in the wet suction line manually opened to pump out the section. Without this procedure, ice may build on the plates as a result of the liquid refrigerant remaining in the plates and the continuous flow of water over the plates. The OFF position does not terminate the flow of water over the plates.

2. On current models a momentary switch operator is used to initiate the manual harvest sequence. The momentary switch automatically returns to the AUTO position upon release.

3. Flooded units or units with a dedicated compressor may have a single manual defrost switch. This enables the operator to only defrost one section at a time.

Water Pump (MAN/AUTO)

During normal operation, the MANUAL/AUTO selector switch should always be in the AUTO position. In this position, the evaporator water recirculating pump will run to supply water to the evaporator plates when the programmable controller logic (PLC) output module is ON. At the termination of operation (icemaking), the water pump is turned OFF through the PLC logic.

During service, maintenance, or cleaning of the evaporator plates or water tank, the water pump can be turned ON manually by placing the selector switch in the MANUAL position. In this
Operating Instructions

position, the logic of the PLC is bypassed and the water pump(s) will operate until the switch is returned to the AUTO position. With the switch in MANUAL, the water is circulated over the evaporator plates even if the Master Control Switch (MCS) is in the OFF position.

Upon completion of the service or cleaning operation, the selector switch should immediately be returned to the AUTO position for normal automatic operation.

IMPORTANT
The water system does not have a water level switch to indicate if water is in the water tank. If the switch is placed in the MAN position,

the water pump will run even if the water tank is empty. Damage to the water pump can result from such an operation.

Water Pump Interlock (WP-1)

An interlock is installed on the magnetic starter of the water recirculating pump. The normally open (N.O.) WP-1 interlock is used to input a signal to the programmable controller indicating water is being supplied to the evaporator plates. If the interlock closure is not obtained (i.e., the pump starter fails), the PLC logic will terminate operation of the evaporator after a preset time delay (typically 2 seconds).

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

The WP-1 interlock is a proof of water flow signal that must be input to the PLC for normal evaporator operation.

A red pilot light is located on the control panel door to indicate a water pump failure. The PLC requires a reset signal after such a failure. To reset, turn the MCS to the OFF position and then back to the ON position. Before resetting, determine the cause of the failure and correct.

Screw Conveyor Interlock (SCR-1)

An interlock is installed on the magnetic starter of the screw conveyor located inside the evaporator below the plates to remove the ice during the harvest sequence. The normally open (N.O.) SCR-1 interlock is used to input a signal to the programmable controller indicating that the harvest screw conveyor is operating and that ice can be removed if a harvest sequence is initiated. If the interlock closure is not obtained (i.e., the harvest screw conveyor starter fails), the PLC logic will terminate operation of the evaporator after a preset time delay (typically 2 seconds).

The SCR-1 interlock is a proof of operation signal that must be input to the PLC for normal evaporator operation.

A red pilot light is located on the control panel door to
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indicate a screw conveyor failure. The PLC requires a reset signal after such a failure. To reset, turn the MCS to the OFF position and then back to the ON position. Before resetting, determine the cause of the failure and correct.

Screw Conveyor Interlock (SCR-2)

A second screw conveyor interlock is provided on the harvest screw conveyor magnetic starter. The normally open (N.O.) SCR-2 interlock is a dry contact for field connection to other screw conveyors used to transport the ice from the evaporator to a remote storage location. This dry contact should be used to turn the other screw conveyors (provided by others) ON and OFF as required for the harvesting sequence. Refer to RS-1 below for description of the interlocking of the other screw conveyors to the ice generator PLC.

Note:

The ice generator harvest screw conveyor is controlled by the PLC. A screw conveyor purge timer in the PLC logic is used to set the length of time the screw conveyor operates after the termination of the harvest sequence. Since other conveyors are typically attached to the ice generator screw conveyor, this time is adjustable to ensure that the entire conveyor system is purged of ice before the

conveyors are turned off. The preset of the screw conveyor purge timer can be changed through the hand held programmer (HHP) provided with the PLC. Refer to Appendix A – Programmable Controller Users Manual for the procedure to change the preset of the purge timer and use of the HHP. If the conveyors do not purge all of the ice, the purge time should be extended. If the factory set time is too long, the purge time can be reduced to minimize the conveyor system run time.

Safety Failure Relay (SFR) Dry Contact of SFR (SFR-1)

A control relay is connected to an output of the PLC to indicate that a safety failure has occurred. If any of the safeties trip, the logic of the PLC will energize the SFR relay. Although the control panel does not have a safety failure pilot light on the control panel door, the following pilot lights should be ON if a failure does occur:

- NH₃ pump failure – AP-1 interlock fails to close or opens during operation
- Water pump failure – WP'X'-1 interlock fails to close or opens during operation (if the unit has 3 pumps, then X = 3; for 4 pumps, then X = 4; etc.)
- Screw conveyor failure – SCR-1 interlock fails to close or opens during operation

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

A dry contact of the safety failure relay (SFR-1) is provided for interface to modems, auto dialers, or other remote alarms to indicate that a failure has occurred. All of the failures indicated will terminate operation of the unit. The cause of the failure must be determined and corrected before the SFR is reset. If the failure has been corrected, the SFR can be reset by turning the MCS to OFF and then back to ON.

Terminal strip connections are provided in the control panel for field connections of remote alarms. Refer to the wiring diagram provided with the unit for the terminal strip numbers to which the connection is made.

Roof Screw Conveyor Interlock (RS-1)

Although this interlock is labeled “roof screw”, it can apply to any screw conveyor interconnected to the harvest screw conveyor for operation during the harvest sequence. An interlock of the remote screw conveyors is used as an input to the programmable controller to verify operation. This prevents the operation of the evaporator or harvest screw conveyor if the screw conveyor(s) into which they discharge ice are not operating.

Operation of the harvest screw conveyor without the other screw conveyors will result in a back-up of ice in the system. This will eventually cause the

Operating Instructions

evaporator to bridge with ice and could result in damage to the conveyors and/or the ice generator. The RS-1 interlock must be field installed (by others) to ensure proper operation of the ice transport “system” to the remote storage area. Refer to the wiring diagram provided with the evaporator for the terminal strip connections to which the RS-1 interlock must be connect. The evaporator is shipped with a jumper installed between the terminal strip connections. The jumper should be removed when the field connections for RS-1 are made.

Control Panel Fan (CPF)

A ventilation fan is mounted on the control panel to provide cooling to the electronics and electrical components in the panel. The temperature in the control panel enclosure is maintained below 120°F to ensure proper operation of the controls. The fan draws air from the outside through an inlet grill and filter.

Control Circuit Fuses

A **7 amp** 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, the fuse(s) 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 fuse(s) to blow. Before replacing the fuse(s), 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 fuse(s) protection.

Magnetic Starters with Bimetallic Overload Relay

Each electrical motor used in the ice generator is provided with a magnetic starter to start and stop each motor. Each starter contains an overload relay (bimetallic type) to protect the motor from overloads.

Overloads produce electrical currents that exceed the rating of the overload causing it to produce enough heat to open a circuit in the overload relay. 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.

A reset mechanism is located on the overload relay and a push button is on the control panel door to operate the “reset” mechanism on the starter overload relay.

WARNINGS
Have a qualified electrician determine the cause of the overload before resetting. Never bypass the overload relay. Never use an overload

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

size larger than the size specified by the factory. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Three bimetallic heater elements are factory sized and supplied to match the motor horsepower and voltage.

All magnetic starters are supplied with dual voltage/dual frequency coils (115 or 230 VAC; 50/60 hertz).

Auxiliary interlocks are mounted on the magnetic starters to control auxiliary operations (i.e., the water pump interlock is used to input a signal to the PLC, indicating that the water pump starters are energized).

Additional auxiliary interlocks can be provided. Consult TURBO for information.

Programmable Logic Controller (PLC)

Refer to Appendix A.

An Underwriter's Laboratory (UL) listed programmable logic

controller is used to control the operating sequence of the unit. The PLC consists of the:

- Power supply
- Central processing unit (CPU with EEPROM)
- Input/output modules (I/O)

Each electrical device or group of devices is connected to an I/O contact.

Standard Inputs

- Master control switch
- Safety circuit
- Water pump interlock
- Harvest screw interlocks
- NH₃ pump - recirculated units only (by others)

Outputs

- Electric motor starter coils
 - water pumps
 - harvest screw(s)
- Remote signal to optional equipment (high side, recirculation unit, etc.)
- Hot gas solenoid valve coils
- Suction solenoid pilot coil

Additional I/Os can be provided for remote equipment operation (optional).

All icemaking, harvest, and time delays are programmed into the PLC. Certain time and time-delay presets can be easily field adjusted through the PLC programmer pad supplied.

A keyed switch is located on the PLC programmer to prevent unauthorized access or changes to the program. The PLC programmer may be removed when not in use or password protected to prevent access to the control logic.

Electric Motors

Standard, open, drip-proof 230/460/3/60 motors are used for the compressor, water pump, and harvest screw.

Optional 208 or 575 voltage motors are available for 50 and 60 hertz systems. Each motor is bottom wired to a magnetic starter at the factory. Starter top wiring (incoming power), motor disconnects, and/or circuit breakers should be furnished by others to meet all local electrical codes.

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

RECIRCULATED OPERATION

Typical Daily Start-Up Sequence

The master control switch (MCS) is turned to the ON position.

Through the PLC, a signal energizes the remote optional high side and recirculation units required for operation of the system for a preset time interval.

If all other safety switches are in a “non-trip” status, the water pump(s), compressor motor, and NH₃ pump motor energize and the liquid solenoid remains open.

With the recirculation unit and high side (compressor) on, refrigerant is pumped to the evaporator plates and water flows over both sides of each evaporator plate.

All sections are in the refrigeration mode.

After a preset time, a defrost sequence is initiated.

Note:

The refrigeration time, which controls the ice thickness, can be quickly and easily adjusted through the PLC programmer. The defrost time can also be easily adjusted to optimize the time in harvest. A standard 90 second harvest is factory installed. Depending on Operating Instructions

operating this can be shortened for to increase production without the risk of freeze-up. If the harvest time is changed operation should be verified over a 24-hour period to ensure sufficient harvest time is available.

If the unit fails to start, refer to section 5 – Trouble-Shooting.

Typical Defrost Sequence

Two standard versions of the harvest sequence are used.

Industrial Version

A defrost sequence is started to remove the ice from a group or section of plates.

- The first step of the sequence closes the liquid feed to the evaporator for a preset time prior to harvest.
- Next the PLC turns on the harvest screw conveyor. If the harvest screw does not start, the unit will automatically shutdown to prevent an ice build-up in the ice discharge slide.
- The motor actuated suction solenoid valve (SV) is pulsed by the PLC logic and closes. Refer to Figure 4-1 on page 83. In this mode, the main suction is isolated and the suction flow is metered through the suction bypass (SBV) hand expansion valve piped in parallel to the motor

actuated suction valve.

The hand expansion valve is adjusted to maintain a back pressure between 65 and 80 PSIG to control defrost pressure in the evaporator plates.

- At the same time, the 1/4" hot gas bypass solenoid valve coil (HGP) is energized to equalize the pressure between the hot gas source at the inlet of the main hot gas solenoid valve and the evaporator. After a **five (5)** second delay, the main hot gas solenoid valve (HG) opens to harvest the ice from the evaporator plates. The time delay between the opening of the bypass solenoid valve and the main hot gas solenoid valve is adjustable via the PLC.
- When the hot gas solenoid is energized, the auxiliary water spray system is also turned on to clean up ice build up around the evaporator plate inlet tubes.

Refer to the PLC section of the manual and the ladder logic supplied with the unit for the counter number that contains the time delay preset.

- When the HG solenoid is energized to introduce hot gas into the evaporator, the evaporator pressure and temperature

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

(pressure/temperature relation of the refrigerant) will increase.

- Sub-cooled liquid produced by the section in defrost is metered to the wet suction line through the suction bypass valve.
- The water pumps continue to operate during the entire sequence and assist in the harvest process

The following conditions produce a plate temperature high enough to eliminate the bond between the ice and the plate:

- Removal of refrigeration effect (isolation of the evaporator section)
- Termination of the refrigerant feed to the evaporator
- Addition of hot gas
- Heat in the water that continues to flow over the section in defrost
- The ice falls from the plates into the ice slide/harvest screw which breaks the sheets of ice into fragments.
- Water is drained from the ice through the perforated harvest screw trough. A dry-out section is provided prior to the ice discharge opening located outside the machine.
- After a preset harvest time, the hot gas solenoid is de-energized and the suction valve is pulsed

again by the PLC logic to open the motor actuated valve. The section is returned to the refrigeration mode.

Note:
The harvest screw run time is adjustable to allow complete removal of all ice after the harvest sequence. The factory preset is forty (40) seconds.

- Each section goes through the same sequence. The sequence continues until either:
 - The MCS switch is turned OFF
 - An optional bin level switch opens to indicate that the ice storage is full
 - A safety switch trips

Packaged Ice – Dry Harvest Version

As indicated for this version a dry harvest sequence is used. In this case the sequence is the same as described above except the water pump(s) are turned off during harvest, and ice is discharged from different ends of the ice generator for different sections. A harvest sequence is started to remove the ice from a group or section of plates or multiple sections:

- The first step of the sequence closes the liquid feed to the evaporator section(s) in harvest for a preset time prior to harvest.

- Next the PLC turns on the harvest screw conveyor. If the harvest screw does not start, the unit will automatically shutdown to prevent an ice build-up in the ice discharge slide. For the harvest of section 1 and 2 the harvest screw reversing magnetic starter for forward is energized to discharge the ice from the right side of the ice generator
- The water pump(s) for the sections in harvest is turned OFF to allow the water to drain from the water distribution pan and on the surface of the ice prior to introducing hot gas.
- The motor actuated suction solenoid valve (SV) is pulsed by the PLC logic and closes. Refer to Figure 4-1 on page 83. In this mode, the main suction is isolated and the suction flow is metered through the suction bypass (SBV) hand expansion valve piped in parallel to the motor actuated suction valve. The hand expansion valve is adjusted to maintain a back pressure between 65 and 80 PSIG to control defrost pressure in the evaporator plates.
- At the same time, the 1/4" hot gas bypass solenoid valve coil (HGP) is energized to equalize the pressure between the hot gas source at the inlet of

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

the main hot gas solenoid valve and the evaporator. After a **five (5)** second delay, the main hot gas solenoid valve (HG) opens to harvest the ice from the evaporator plates. The time delay between the opening of the bypass solenoid valve and the main hot gas solenoid valve is adjustable via the PLC.

- When the hot gas solenoid is energized, the auxiliary water spray system is also turned on to clean up ice build up around the evaporator plate inlet tubes.

Refer to the PLC section of the manual and the ladder logic supplied with the unit for the counter number that contains the time delay preset.

- When the HG solenoid is energized to introduce hot gas into the evaporator, the evaporator pressure and temperature (pressure/temperature relation of the refrigerant) will increase.
- Sub-cooled liquid produced by the section in defrost is metered to the wet suction line through the suction bypass valve.
- The water pumps remain off during the entire sequence.

The following conditions produce a plate temperature high enough to eliminate the

bond between the ice and the plate:

- ✓ Removal of refrigeration effect (isolation of the evaporator section)
 - ✓ Termination of the refrigerant feed to the evaporator
 - ✓ Addition of hot gas
 - ✓ Heat in the water that continues to flow over the section in defrost
- The ice falls from the plates into the ice slide/harvest screw which breaks the sheets of ice into fragments.
 - After a preset harvest time, the hot gas solenoid is de-energized and the suction valve is pulsed again by the PLC logic and the valve is opened.
 - The section is returned to the refrigeration mode.
 - A chill cycle begins in which the water flow is still off to allow the evaporator temperature to drop in the plates before the water flow is resumed. After a preset time delay the water pump(s) are turned back ON and ice making resumes.
 - After a preset time interval sections 3 and 4 are harvested. The sequence is the same except the reverse magnetic harvest screw motor starter is energized to discharge the ice harvested from sections 3

and 4 from the left end of the ice generator.

Note:

The harvest screw run time is adjustable to allow complete removal of all ice after the harvest sequence. The factory preset is forty (40) seconds.

- Each section goes through the same sequence. The sequence continues until either:
 - The MCS switch is turned OFF
 - An optional bin level switch opens to indicate that the ice storage is full
 - A safety switch trips

Typical Water Flow Sequence

Make-Up Water Circuit

A ball valve is provided in the make-up water line to shut off water for extended time periods.

Water for producing ice enters the TIGAR unit through the make-up water connection and the auxiliary water spray system. The make-up water is screened through a strainer before entering the TIGAR unit to help screen out solids.

The make-up water goes into the water tank by way of a mechanical float valve on older models, or the make-up water solenoid and auxiliary water spray system on newer models.

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

Models with Float Valves

The float valve will shut off when the level of make-up water in the tank reaches the proper height. Water level is adjustable by raising or lowering the float valve.

The make-up water is distributed throughout the water tank by a make-up water header inside the tank that runs the entire length of the tank.

Models with Water Solenoid Valves

A water solenoid is installed in the make-up water line and is

controlled by a water level switch mounted in the water level column shown below. Reference Figure 4-1.

Note:

A solenoid valve is supplied in the make-up water line to shut the water off during normal operation and if the unit is off for extended time periods. A water level control is provided to control the water solenoid valve.

The water level control assembly shown below is mounted in a bracket next to

the water tank. To change the blown down rate the level assembly can be moved up to increase blow down or down to decrease blow down. For example, systems with reverse osmosis (R.O.) water would not need blow down to maintain good water /ice quality and the water level column would be raised in the mounting bracket until water no longer overflows. The clamp holding the water level column assembly should be secure after the final adjustment is made.



Figure 4-1 Water Solenoid Level Control Assembly

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

Pump and Water Distributor Circuit

The water is drawn from the tank and pumped to the water distribution header through a flow control ball valve. The ball valve can be adjusted to obtain a uniform flow to the individual water distribution pans without excessive splashing.

The water distribution header evenly fills each water distribution pan.

The water distribution pans allow a thin film of water to run over both sides of the evaporator plates. As the water and evaporator reach the proper temperature, ice begins to form on the plate.

A check valve is installed in the pump discharge line to prevent water surges to the tank during shutdown or during the harvest sequence on packaged ice versions. A metering hole is provided in the check valve to allow a controlled drain of all water lines above the check valve back to the water tank. This allows the water line to completely drain when the unit is turned OFF.

The water that does not freeze flows off the evaporator plates onto the ice slide and into the screw conveyor trough. The screw conveyor trough is perforated to allow the water that has fallen from the evaporator plates or has drained from the ice to flow back into

the water tank to be recirculated back through the water distribution circuit.

Overflow Drain Circuit

An overflow drain box or standpipe is provided in the water tank to allow tank overflow for control of the water quality.

If residual solids or minerals in the water are a problem, the float valve in the make-up water line can be raised to increase the overflow of the tank. This overflow will reduce the concentration of solids or minerals in the water tank.

If less water overflow or zero overflow is desired, the float valve actuator can be lowered.

The overflow drain box or standpipe is piped to the outside of the unit for field connection to a drain line.

During shutdown, the water that drains back to the tank from the water circulating system and water distribution pan(s) may cause the tank to overflow.

Auxiliary Water Spray System

Each section of both the industrial and packaged ice versions are equipped with a water spray system consisting of a spray header with adjustable spray nozzles (reference Figure 4-2), a solenoid valve and flow control

valve, and flexible hose connection (reference Figure 4-3). Water from the main make up water source is supplied to the spray header from the main auxiliary water line through the flexible connection. During harvest, the spray header for the sections in harvest turn on to flow water over the inlet tubes of the evaporator tubes to remove any ice that builds up on the tubes during icemaking that could cause freeze ups. The auxiliary spray cycle is particularly important for equipment operating 24 hours per day, seven (7) days a week. For equipment operated for shorter periods it is possible to reduce the frequency and duration of the water spray over the inlet tubes. Consult the factory for additional information.

All spray nozzles are factory adjusted. Field adjustment of the flow rate and spray direction may be required due to movement in shipment and/or different incoming water pressure. Adjustment of the spray nozzle is made by loosening the nut on the nozzle and rotating the nozzle. The entire spray header can also be rotated by loosening the mounting clamps. A flow control valve located on the solenoid valve is used to adjust the flow rate. The complete spray nozzle can be removed for cleaning by lifting on the wire mounting clamp. The entire can be disassembled for cleaning.

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

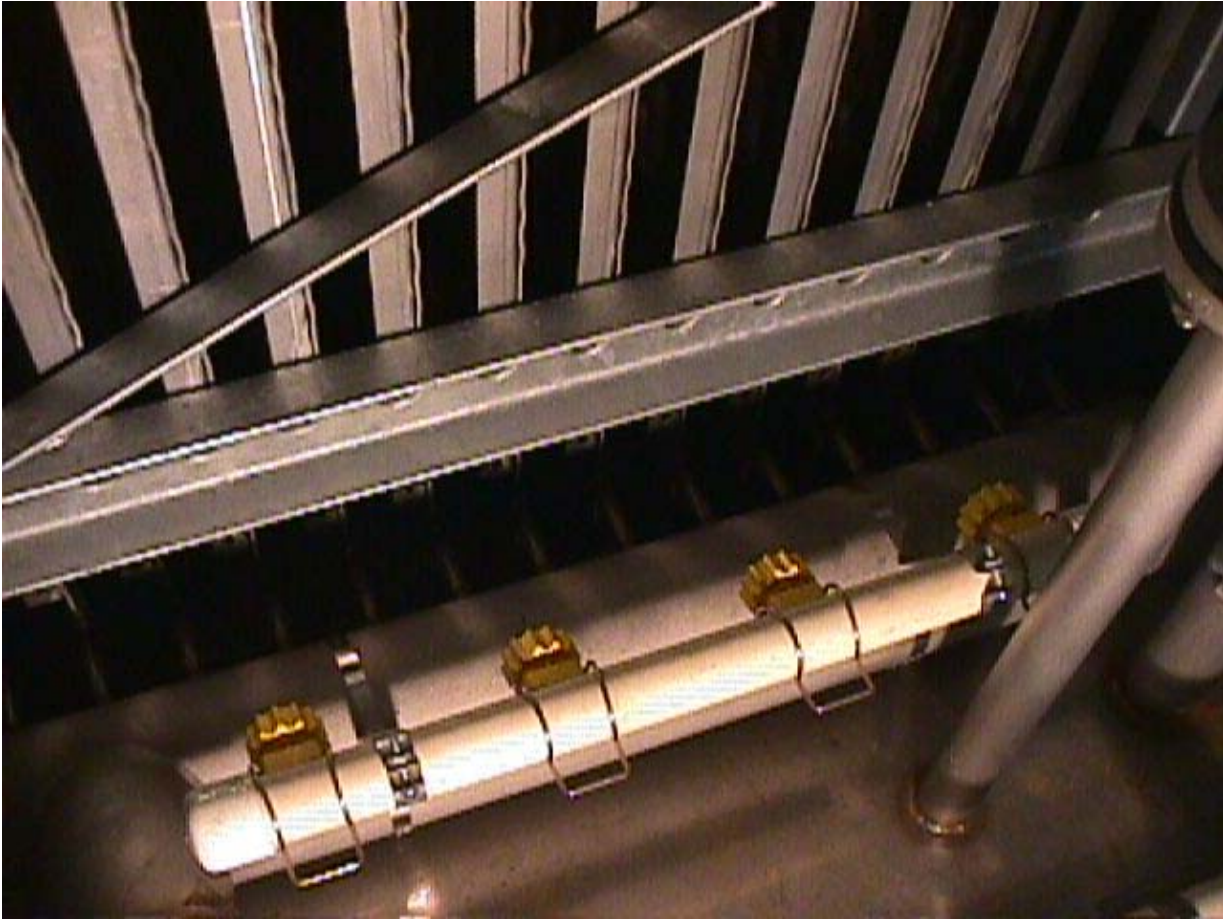


Figure 4-2 Typical Auxiliary Water Spray Header

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

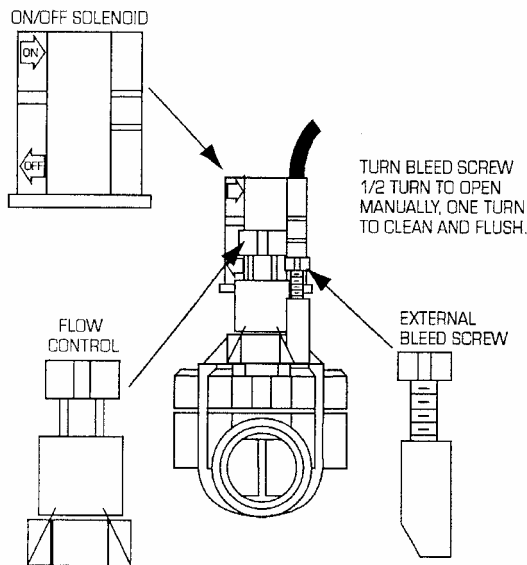


Figure 4-3 Typical Auxiliary Water Spray Header Solenoid Valve

Typical Shutdown Sequence

The TURBO® ice generator can be turned off immediately in two ways – the emergency

stop and the safety failure switches.

Normal shutdown is initiated by turning the master control switch (MCS) to the OFF

position or by a remote signal through the optional bin level switch (BLS) contacts. Any normally closed (N.C.) contact in series with the MCS contact blocks in the control system

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

wiring will initiate the shutdown sequence. This can include:

Normal shutdown:

- Bin-O-Matic Controls or limit switches in remote ice storage bins or hoppers
- Process controls
- Time clocks
- Remote ice delivery equipment

Emergency / immediate shutdown:

- Emergency Stop push button
- Remote safety interlocks

After a normal shutdown sequence is initiated, the main liquid solenoid valve (LS – by others) is de-energized to stop the flow of refrigerant to the recirculation vessel. The compressors, NH₃ pump, and water pump(s) stop.

If an evaporator section is in harvest, the shutdown sequence will not start until the harvest of that section is completed.

Note:

The optional high side and NH₃ recirculation package can be provided with an optional pump-down cycle to keep the refrigeration in a receiver or combination condenser/receiver.

WARNING

TIGAR models equipped with a continuous pump down cycle can restart automatically even if the master control switch is OFF.

Never attempt servicing the compressor without locking out the electrical service. Failure to carefully follow these instructions could result in permanent injury or loss of life.

With the optional pump-down feature, the unit will stay off as long as the evaporator pressure is below the setting of the low pressure safety switch.

If the evaporator pressure rises, due to incomplete pump-down or liquid bypass around the LS, the compressor will automatically restart and run until the system is “pumped down” and the compressor stops again. If this sequence continues more than three (3) times, locate the source of the pressure (defective solenoid valve, etc.) and repair.

Make-up water to the unit is shut off by the mechanical float valve that feeds water to the icemaker water tanks.

Note:

In a normal shutdown sequence, ice will be left on the evaporator plates.

Any ice or water coming from the plates after shutdown will drain through the perforated harvest screw trough into the water tank located below it.

Shutting Equipment Off For an Extended Period of Time

An extended period of time is more than forty-eight (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 “king” valve on the outlet of the optional receiver or optional combination condenser/receiver.

Turn off the three phase electrical power to the compressor, NH₃ pumps, 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 may turn off power to the compressor crankcase heater in the optional high side package and optional winterizing equipment and/or the PLC power supply.

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

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 to ensure that any liquid refrigerant that migrated to the compressor crankcase (by others) is eliminated prior to start-up. Failure to follow these instructions could result in failure or damage to the compressor.

Specifications

Refrigerant

Refrigerant grade NH₃ (ammonia) – do not use agricultural grade NH₃.

Evaporator Temperature

0°F (15 PSIG)

Design Conditions

Water Cooled

Condensing 105°F
214 PSIG
Water in 85°F
Water out 95°F
Design wet bulb: 78°F

Evaporative Cooled

Condensing 95°F
181 PSIG
Design wet bulb: 78°F

Air Cooled

Condensing 120°F
270 PSIG
Design dry bulb 100°F

Note:

For SET (saturated evaporator temperature):
Icemaking mode 0°F

Operating Instructions

THR calculation for condenser sizing 10°F

THR (total heat rejection) is evaporator load plus compressor input for open compressor at 10°F:

Evaporator load (BTU/HR) @ 10°F + compressor BHP @ 10°F x 2,545 = THR

Refrigerant Feed

Pumped liquid at a recirculation rate of 4:1.

Make-Up Water Temperature

At water distribution header inlet 60°F

Make-Up Water Pressure

At inlet to water distribution header 8 PSIG

Make-Up Water Flow

Each plate requires 8 GPM. An adjustable water flow control valve is provided to make the final adjustment of the water flow.

Make-Up Water Feed

Mechanical float valve with adjustable float arm.
Minimum flow 3 GPM
Maximum flow 21 GPM
Operating Pressure 40-100 PSIG

Make-Up Water Blowdown

0 to 25% (adjustable)

Evaporator Plates

304 Stainless Steel
Hydraulically blown to inflate to proper rise.

Design Operating Pressure

200 PSIG

Burst Pressure

1,500 PSIG

Optional Features

Condenser Discharge Pressure Control

Water Cooled

Optional pressure actuated water regulating valve(s) are field installed. Optional cooling tower and cooling tower pumps are available.

Evaporative Cooled

An upstream pressure regulator is in the discharge line entering the condenser. A hot gas bypass through a downstream pressure regulator is provided to maintain receiver pressure during “cold” start-up. Factory installed on SCE models; supplied for field installation on SCER models.

A variable speed fan motor control (optional) adjusts the RPM of the condenser fan motor to maintain a desired discharge pressure.

Air Cooled

Fan cycling can be used in place of flood-back controls in some installations. Air cooled units are provided with flood-back controls as standard. Variable speed drives are also available.

Refrigerant Level Float Switches (FSHL) - Electronic Level Probe

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

Although the recirculation unit/liquid level assembly is supplied only as an option from TURBO, it is required for the system to function properly. Inputs from the electronic level probe and the FSHL switch are required to control the operating, low, and high liquid level in the recirculation drum. If the level reaches the high refrigerant level sensor of the electronic level indicator, operation of the recirculator, condensing unit, and evaporator are terminated immediately. The FSHL is a mechanical float switch used as a maximum liquid level control and is wired in parallel to the electronic level probe as a secondary switch to terminate operation if the electronic switch should fail.

The electronic probe has a probe column installed in the liquid column. This column has three (3) sensors. One sensor is for the high level cut-out. The second sensor is used to control the high pressure liquid solenoid valve that supplies refrigerant to the surge drum. When the liquid level drops below the setting of the operating level sensor, the contacts of the sensor close to energize the liquid solenoid valve to feed liquid refrigerant to the vessel. When the liquid level reaches the proper operating level, the sensor contacts open, and the high pressure liquid solenoid valve closes.

The third sensor is used to terminate operation of the NH₃ recirculating pump if the refrigerant level in the recirculation vessel is not adequate (too low) to supply liquid to the NH₃ pump. The liquid level is continuously monitored by the electronic level controls during operation.

Typical Refrigerant Sequence

Liquid NH₃ is pumped to the top of each plate bank. Liquid enters the evaporator plates through orificed headers. Water is circulated over the outside of the vertical evaporator plates. The water is ON anytime the unit is running (i.e., the water flow is not cut off during defrost).

As the refrigerant leaves the plates, the liquid-vapor mixture is collected in the wet suction header. A branch wet suction line is piped into each suction header. This line tees off to the evaporator pressure regulator with the electric wide open feature. The evaporator suction valve is wide open during the icemaking mode. The wet suction branch line is connected to the wet suction main going back to a surge drum (by others). The vapor is separated from the liquid in the surge drum and returned to the refrigeration high side via the dry suction lines.

Liquid refrigerant is maintained at a level of approximately 3" in the bottom of the surge drum to ensure an adequate liquid

supply to the recirculation pump(s) at all times.

During the above cycle, ice is formed on both sides of the evaporator plates. At the end of a preset cycle time, the programmable controller will initiate a defrost cycle. Cycle time can vary depending on the application, but in general, with a 0°F evaporator temperature, it will be approximately 20 minutes to produce 1/8" to 1/4" thickness.

Ice thickness should be kept to a minimum to ensure maximum overall system efficiency. One of the distinct advantages of a TURBO® ice harvesting system is that a clean surface is available after each harvest cycle to ensure maximum heat transfer.

Each bank of plates is defrosted separately and defrosts are equally spaced (i.e., the time between the harvest of section #1 is the same as the time between sections #2 and #3, and between #3 and #1).

Harvest Mode

1. The hot gas bypass solenoid is energized to equalize the pressure at the inlet and outlet of the main hot gas solenoid valve.
2. At the same time, the motor actuated suction valve is closed. With the suction valve closed suction flow is metered to the main suction through the suction bypass

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

valve to create a higher (back) pressure in the evaporator. During defrost, a back pressure of approximately 65 to 80 PSIG is maintained in the evaporator plates.

3. After a five (5) second time delay, the main hot gas solenoid valve (HG) opens to supply hot gas to the evaporator for defrost.
4. As the pressure in the plates increases, the temperature also increases and the ice separates from the plates and drops into the harvest conveyor located below the plates. Liquid refrigerant in the plates flows out of the plate through the suction header and suction bypass valve into the wet suction return line.
5. After a preset defrost time, the programmable controller de-energizes the hot gas solenoid valve and the motor actuated suction valve opens to return the evaporator to the icemaking mode.

Notes:

- Installations with multiple ice generators should interconnect the controls to harvest only one section at a time. This may be accomplished manually by staggered start-up of the icemakers and ice generators or via external time delay relays and selector switches for automatic staggered start-

Operating Instructions

up. Operation of multiple units from a central PLC with communication cables to each unit is also available as an option. Consult the factory for additional information on the various methods available.

- An extended defrost sequence is initiated and occurs every twelve (12) hours through the PLC controls to prevent ice build-up during continuous operation or long periods of operation. During the extended defrost sequence, forty (40) seconds is added to each defrost for all sections (i.e., for a typical unit with a 40 second defrost time, an additional 40 seconds is added for a total of 80 seconds).
6. The above sequence is repeated for each bank of plates in the unit, and the sequence repeats until either the unit is turned off or a remote contact (bin full, etc.) opens to terminate operation.

Hot Gas Supply Line

A strainer is installed in the hot gas supply line upstream of a pressure sensing switch (Mercoid). A pressure gauge is mounted in parallel to the pressure switch.

During the defrost sequence, the programmable controller initiates the harvest by energizing the 1/4" hot gas bypass solenoid valve to

equalize the pressure on the inlet and outlet of the main hot gas solenoid valve.

A throttling valve is located in the bypass line upstream of the solenoid valve. This permits throttling of the hot gas flow, if required, and for isolation of the bypass solenoid valve for service.

After a short time delay (typically 3-5 seconds), the main hot gas valve is opened to harvest the ice on the plates by introducing hot gas in sufficient quantity into the evaporator plates. The time delay between the hot gas solenoid valve and the main hot gas solenoid valve can be adjusted through the programmable controller.

Note:

Due to variations in field piping and operating conditions, a liquid hammer can occur when the main hot gas solenoid valve opens. Adjustment of the bypass solenoid valve time delay and/or flow control will eliminate this condition. The time delay is factory set for five (5) seconds and the flow control valve is wide open. If necessary, the time delay can be increased up to 10 seconds and the flow control valve throttled (turned counterclockwise to reduce the gas flow) to eliminate any hammer observed during the defrost sequence.

During defrost, the hot gas solenoid valve to the section in defrost opens, allowing hot gas

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

to enter the evaporator. Because of the volume of the evaporator plates and the 32°F water flowing over the plates, the discharge pressure will drop during defrost. In most cases, this will not cause a problem; however, in cases where the system is operated at a relatively low condensing temperature (below 85°F SDT/150 PSIG), a positive defrost cannot be assured with the standard defrost time.

Therefore, when the high pressure switch mounted on the hot gas line senses a pressure below 150 PSIG, a set of normally closed contacts close. Above 150 PSIG, the normally closed contacts open. When the contacts close during defrost, the input to the programmable controller initiates an extended defrost sequence. That is, the normal defrost time will elapse and then a second time span (typically 40 seconds) will elapse.

The setting of both the normal defrost time and the extended defrost time will vary depending on the installation. In general, normal defrost time is forty (40) seconds and the extended defrost time adds forty (40) seconds to the defrost time.

During the refrigeration cycle, the input of the high pressure switch has no effect on the operation of the system. The system discharge pressure can be run below 150 PSIG without

affecting the overall operation of the equipment.

Refer to Table 4-2 for control devices (input/output of controller) and Figure 4-4 for a typical piping arrangement for each section.

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

Table 4-2 Control Devices (Input/Output of Controller) Refer to Figure 4-1.

Control Device	No.	Operates	Location	Controlled By	Status		Comments
					Icemaking	Harvest	
Suction Stop Valve (SV)- motor actuated butterfly valve	1 per section	Wet suction return -connected to PLC output	Branch suction line of each section	Programmable controller output	ON –wide open	OFF-closed	Field adjustment of hand expansion valve in bypass around SS during harvest is required
Suction Bypass Valve (SBV)	1 per section	Suction gas flow during harvest cycle	Branch suction line of each section	Manual adjustment	Open – Parallel flow to SV	Open – Meters suction gas flow to maintain proper back pressure for harvest	Adjusted during installation /start up. Unless operating conditions change no further adjustment required
Hot gas bypass solenoid valve (HGP)	1 per section	Flow of hot gas to equalize pressure between inlet and outlet of main hot gas solenoid	Piped in parallel to the main hot gas solenoid valve	Programmable controller output	OFF	ON	Energized only during defrost; energized prior to main hot gas solenoid to equalize pressure
Hot gas solenoid valve (HG)	1 per section	Flow of hot gas to evaporator plates during harvest	Hot gas branch line to each section	Programmable controller output	OFF	ON - Energizes 15 seconds after harvest begins	Energized only during harvest; solenoid opens to feed hot gas to section(s) in harvest
Harvest pressure switch – Mercoid (DPS)	1	Senses discharge/hot gas pressure; extends harvest time if pressure is below 125 PSIG	Hot gas main supply line to evaporator	Mercoid switch – normally closed (NC) contact	PLC ignores signal during icemaking	NC contact opens if pressure is above 125 PSIG; contacts close if pressure is below 125 PSIG	During operation at low condensing pressures, standard harvest time may be too short to complete harvest; pressure switch sense low pressure and automatically extends harvest through PLC logic
Liquid line solenoid (LS)	1 per section	Flow of liquid refrigerant to evaporator plate inlet	Branch liquid line to each section	Programmable controller output	ON	OFF	Liquid solenoid closes prior to harvest during normal operation; all solenoids when unit is OFF
Hand expansion valve	1 per section	Balance refrigerant flow to each section	Branch liquid line to each section	Manual adjustment	Open	Open	Adjusted during installation /start up. Unless operating conditions change no further adjustment required

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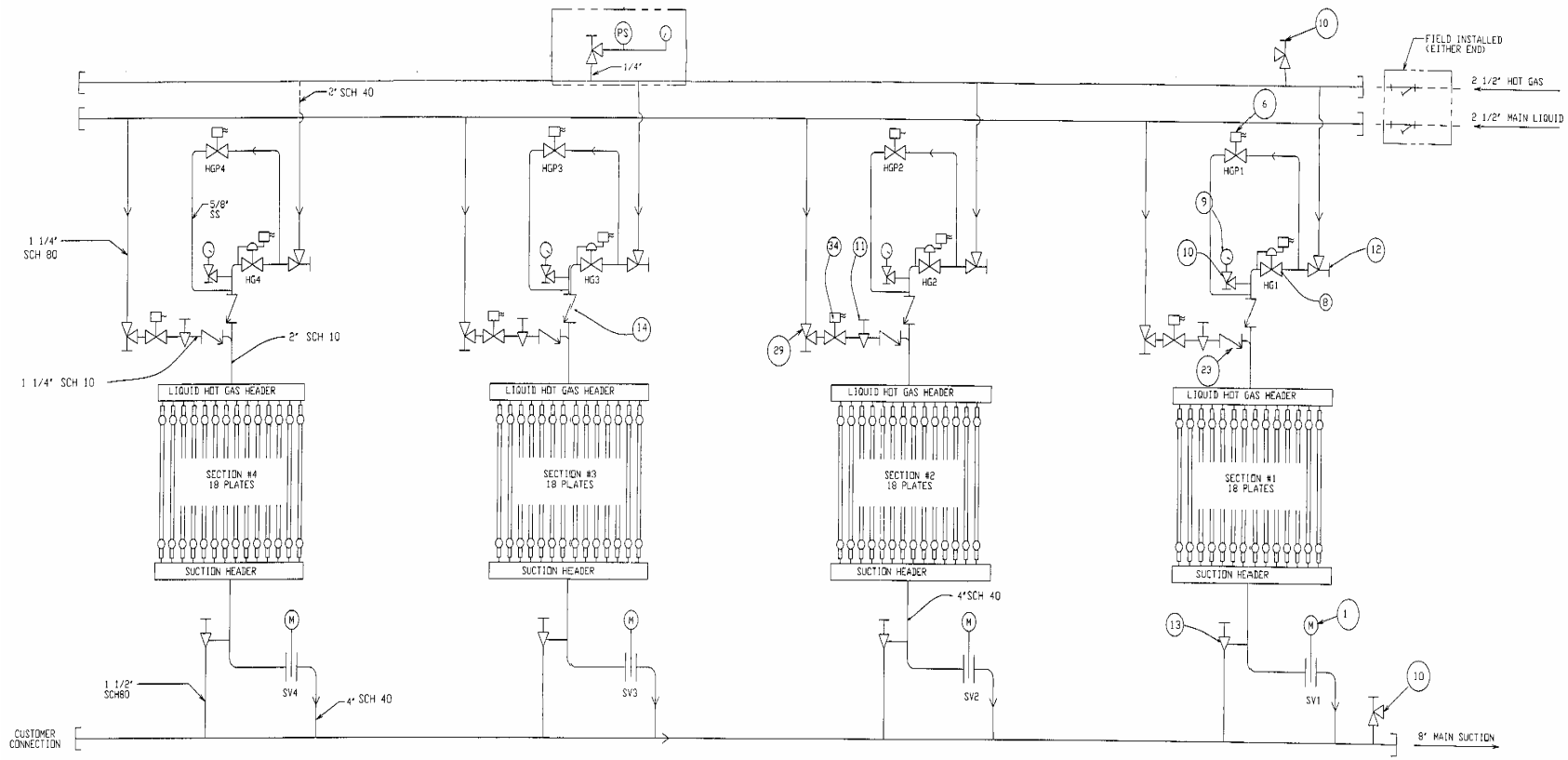


Figure 4-4 Typical Recirculated Ammonia Piping Arrangement

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

Oil Accumulator Drum **(Optional)**

To prevent oil from accumulating in the evaporator, an oil accumulator drum is provided for installation at the bottom of the liquid leg from the surge drum. Included with the oil accumulator is a pressure relief valve, isolating valves for the oil inlet, an oil pot vent, and oil drain connections. A pipe plug is provided for the oil drain valve in case of leakage through the valve or accidental opening of the oil drain valve.

During normal operation, the oil inlet valve and oil pot vent valve will always be open. The oil drain valve is closed. As the liquid refrigerant and oil flows down the liquid leg, the velocity is very low, allowing the heavier oil to separate and go to the bottom of the liquid leg along with the liquid refrigerant where it is drained into the oil accumulator. Oil will continue to displace the liquid in the oil accumulator until it reaches a level requiring it to be removed.

To drain the oil from the oil accumulator, isolate the oil accumulator by closing the oil inlet valve and the oil pot vent valve. After the oil accumulator warms up, check the oil drain valve to make sure it is tightly closed and then carefully remove the pipe plug from the valve outlet. Remove the plug slowly because gas or small amounts of liquid could be

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trapped in the valve outlet. Next, connect a hose or some other means of draining the oil to the outlet of the valve. The end of the hose should be placed in a bucket of water to absorb the NH₃ removed with the oil.

Once the oil is removed, close the oil drain valve and replace the plug. Open the oil vent line first, then the oil drain inlet valve.

WARNING
Never leave the oil accumulator isolated for extended periods of time. Excessive pressure will develop in the isolated drum. A relief valve is provided as a safety device. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Isolation of the drum for extended periods of time means that the small oil pot built into the bottom of the liquid leg may not hold all of the oil accumulated. The excess oil would then go to the evaporator, resulting in poor or erratic operation including failure to harvest properly.

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

FLOODED OPERATION

Operating Sequence

Refer to the wiring diagram and ladder logic provided with the unit for complete information on TIGAR-FL model controls.

Field connections are required to the:

- Optional operating level refrigerant switch
- Solenoid coils on the suction pressure regulators (SS'X') located above the evaporator
- Optional high pressure liquid solenoid valve

Also refer to operating instructions for additional field connected devices.

As indicated in Figure 4-2, typical wiring, the switches must be connected to the designated input module of the PLC for the evaporator to operate properly.

Controls

Compressor Relay (CR1)

A control relay is provided in the control panel to control the operation of a remote high side (by others). Through the logic of the PLC, the relay is energized via an output of the PLC. When the relay is energized, a normally open (N.O.) dry contact closes. The control circuit of the remote

high side should be connected to these dry contacts to initiate the start and stop of the system (i.e., for systems with dedicated compressors, the evaporator should be turned ON before the compressor operation is started, and turned OFF upon termination of the icemaking process). For evaporators connected to a central system, the dry contacts can be used to indicate the status of the ice generator (OFF/ON) at a remote control panel (central equipment room).

Defrost Pressure Regulator (DPR'X')

The defrost pressure regulators are also known as the suction solenoids (SS'X'). Figure 4-2 illustrates the typical connection of the coils for the pressure regulator with the electric wide open feature to the output of the PLC. The PLC logic energizes the coil during icemaking to open the regulator. During defrost, the PLC de-energizes the coil and the regulator modulates to control the upstream pressure in the evaporator plates.

Optional Refrigerant Level Float Switches (FSHL) - Electronic Level Probe

Although the surge drum/liquid level assembly is supplied only as an option from TURBO, it is required for the system to

function properly. Inputs from the electronic level probe and FSHL switch are required to control the operating and high liquid level in the surge drum. If the level reaches the high refrigerant level sensor of the electronic level indicator, operation of the surge drum, condensing unit, and evaporator are terminated immediately. The FSHL is a mechanical float switch used as a maximum liquid level control and is wired in parallel to the electronic level probe as a secondary switch to terminate operation if the electronic switch should fail.

The electronic probe has a probe column installed in the liquid column. This column has two (2) sensors. One sensor is for the high level cut-out. The second sensor is used to control the high pressure liquid solenoid valve that supplies refrigerant to the surge drum. When the liquid level drops below the setting of the operating level sensor, the contacts of the sensor close to energize the liquid solenoid. When the liquid level reaches the proper operating level, the sensor contacts open and the high pressure liquid solenoid valve closes. The liquid level is continuously monitored by the electronic level controls during operation.

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

On flooded models, a liquid level failure indicator light is provided on the control panel. This light is connected to a signal from the optional surge drum/liquid level assembly. If the operating level in the surge drum is above 50%, the high level refrigerant float switch (FSSL) should close. Upon closure of the switch contact, the input to the programmable controller (PLC) immediately terminates operation of the evaporator. Field connection of the FSSL switch is required to ensure adequate protection for

the high side equipment (by others).

High Pressure Liquid Solenoid Valve (HPLS)

The refrigerant make-up feed to the optional surge drum is controlled by the high pressure liquid solenoid valve shown in Figure 4-3. The surge drum/liquid level controls are optional. However, the control of the HPLS should be connected to the controls of the evaporator. Field wiring (by others) is required between the

evaporator control panel and the remote surge drum. The coil of the HPLS is connected to the output of a PLC module. Refer to the wiring diagram provided with the evaporator for the terminal strip numbers in the evaporator control panel to which field connections are required.

The HPLS opens, feeding refrigerant to the surge drum when the FSOL is closed, indicating a low level.

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

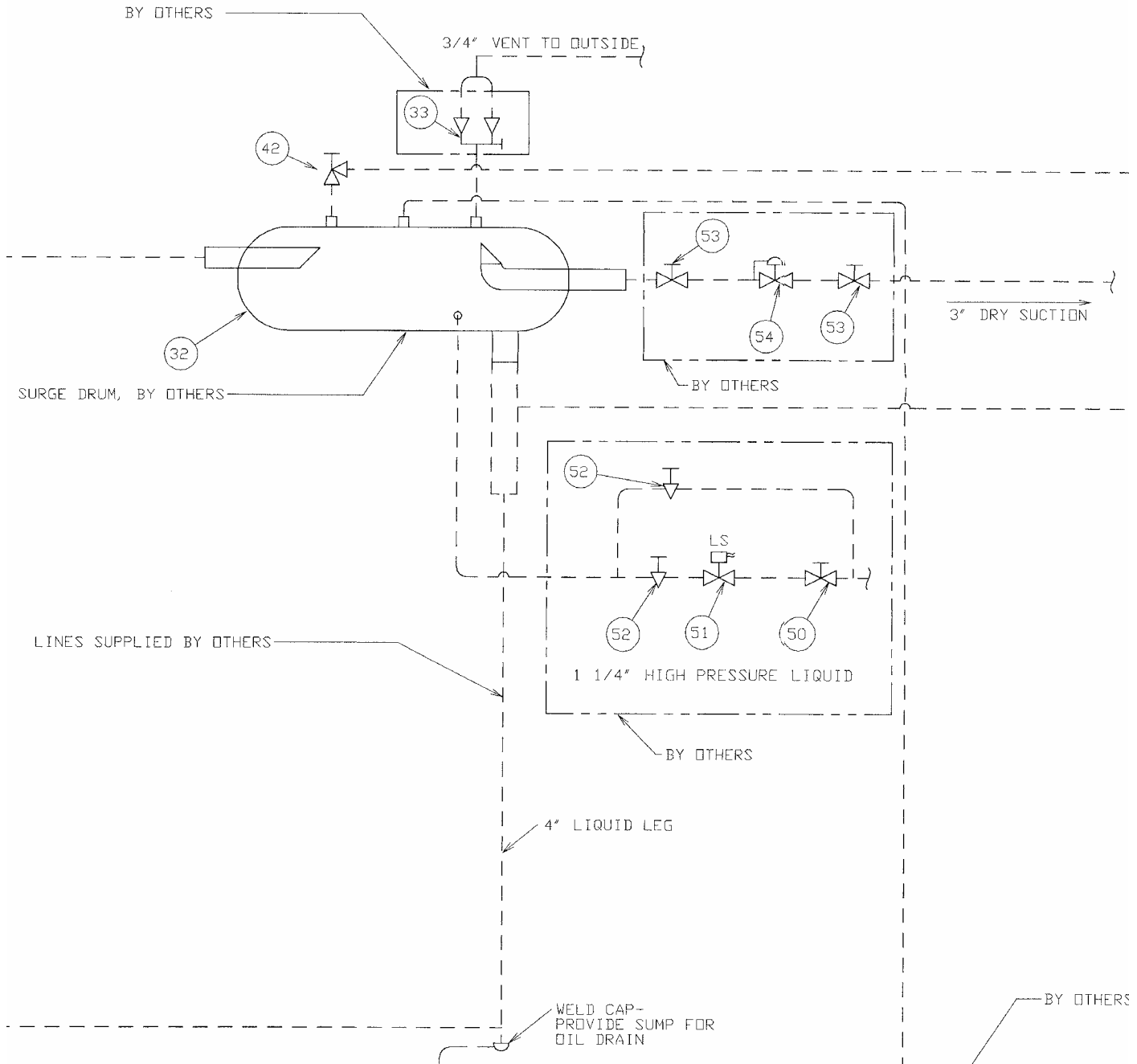


Figure 4-5 Typical Optional Surge Drum/Liquid Level Controls

Typical Water Systems

Make-Up Water Circuit

A ball valve is provided in the make-up water line to shut off

water for extended time periods.

Water for producing ice enters the TIGAR unit through the make-up water connection. The make-up water is screened

through a strainer before entering the TIGAR unit to help screen out solids.

The make-up water goes into the water tank by way of a mechanical float valve. The

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

float valve will shut off when the level of make-up water in the tank reaches the proper height. Water level is adjustable by raising or lowering the float valve.

The water is distributed throughout the water tank by a make-up water header.

Note:

A solenoid valve should be installed in the make-up water line if the unit is off for extended time periods. The solenoid valve is optional.

Pump and Water Distributor Circuit

The water is drawn from the tank and pumped to the water distribution header through a flow control ball valve. The ball valve can be adjusted to obtain a uniform flow to the water distribution pans without excessive splashing.

The water distribution header evenly fills the water distribution pans.

The water distribution pans allow a thin film of water to run over both sides of the evaporator plates. As the water and evaporator reach the proper temperature, ice begins to form on the plate. This water runs continuously while the machine is in operation.

A check valve is installed in the pump discharge line to prevent water surges to the tank during shutdown. A metering hole is provided in the check valve to

Operating Instructions

allow a controlled drain of all water lines above the check valve back to the water tank.

The water that does not freeze flows off the evaporator plates onto the ice slide and into the screw conveyor trough. The screw conveyor trough is perforated to allow the water that has fallen from the evaporator plates or has drained from the ice to flow back into the water tank to be recirculated back through the pump water distribution circuit.

Overflow Drain Circuit

An overflow drain box or standpipe is provided in the water tank to allow tank overflow for control of the water quality.

If residual solids or minerals in the water are a problem, the float valve in the make-up water line can be raised to increase the overflow of the tank. This overflow will reduce the concentration of solids or minerals in the water tank.

If less overflow or zero overflow is desired, the float valve actuator can be lowered.

The overflow drain box or standpipe is piped to the outside of the unit for field connection to a drain line.

During shutdown, the water that drains back to the tank from the water circulating system and water distribution pan(s) may cause the tank to overflow.

Typical Shutdown Sequence

The TURBO® ice generator can be turned off immediately in two ways – the emergency stop and the safety failure switches.

Normal shutdown is initiated by turning the master control switch (MCS) to the OFF position or by a remote signal through the optional bin level switch (BLS) contacts. Any normally closed (N.C.) contact in series with the MCS contact blocks in the control system wiring will initiate the shutdown sequence. This can include:

- Bin-O-Matic Controls or limit switches in remote ice storage bins or hoppers
- Process controls
- Time clocks
- Remote ice delivery equipment
- Remote safety interlocks

After a normal shutdown sequence is initiated, the main liquid solenoid valve (LS – by others) is de-energized to stop the flow of refrigerant to the surge drum. The compressors and water pump(s) stop.

If an evaporator section is in harvest, the shutdown sequence will not start until the harvest of that section is completed.

Note:

The high side package can be provided with an optional pump-down cycle to keep the refrigerant in a receiver or

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

combination condenser/receiver.

WARNING

TIGAR models equipped with a continuous pump down cycle can restart automatically even if the master control switch is OFF. Never attempt servicing the compressor without locking out the electrical service. Failure to carefully follow these instructions could result in permanent injury or loss of life.

With the optional pump-down feature, the unit will stay off as long as the evaporator pressure is below the setting of the low pressure safety switch.

If the evaporator pressure rises, due to incomplete pump-down or liquid bypass around the LS, the compressor will automatically restart and run until the system is “pumped down” and the compressor stops again. If this sequence continues more than three (3) times, locate the source of the pressure (defective solenoid valve, etc.) and repair.

Make-up water to the unit is shut off by the mechanical float valve that feeds water to the icemaker water tanks.

Note:

In a normal shutdown sequence, ice will be left on the evaporator plates.

Any ice or water coming from the plates after shutdown will

drain through the perforated harvest screw trough into the water tank located below it.

Shutting Equipment Off For an Extended Period of Time

An extended period of time is more than forty-eight (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 “king” valve on the outlet of the receiver or optional combination condenser/receiver.

Turn off the three phase electrical power to the compressor, 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 may turn off power to the compressor crankcase heater in the optional high side package and optional winterizing equipment.

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 to ensure that any liquid refrigerant that migrated to the compressor crankcase (by others) is eliminated prior to start-up. Failure to follow these instructions could result in

failure or damage to the compressor.

Optional Features

Condenser Discharge Pressure Control

Water Cooled

Optional pressure actuated water regulating valve(s) are field installed. Optional cooling tower and cooling tower pumps are not supplied.

Evaporative Cooled

An upstream pressure regulator is in the discharge line entering the condenser. A hot gas bypass through a downstream pressure regulator is provided to maintain receiver pressure during “cold” start-up. Factory installed on SCE models; supplied for field installation on SCER models.

A variable speed fan motor control (optional) adjusts the RPM of the condenser fan motor to maintain a desired discharge pressure.

Air Cooled

The fan cycling with flood-back controls consists of an upstream regulator in the condenser drain line to the receiver. The downstream regulator is in the hot gas bypass line to the receiver inlet.

Icemaking Mode

Liquid refrigerant is fed from the surge drum to the bottom of each plate bank. Water is circulated over the outside of

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

the vertical evaporator plates. The water is ON anytime the unit is running (i.e., the water flow is not cut off during defrost).

As the refrigerant leaves the plates, the liquid/vapor mixture is collected in the wet suction header. A branch wet suction line is piped into each suction header. This line tees off to the electric wide-open evaporator pressure regulator. The evaporator pressure regulator is wide open during the icemaking mode. An isolation valve is located at the outlet of the evaporator pressure regulator. After leaving the isolating valve, the wet suction branch line is connected to the wet suction main going back to the surge drum. The vapor is separated from the liquid in the

surge drum and returned to the refrigeration high side via the dry suction lines.

Liquid refrigerant is maintained at a level of approximately three (3) to six (6) inches in the bottom of the surge drum to ensure an adequate liquid supply to the evaporator at all times.

During the above cycle, ice is formed on both sides of the evaporator plates. At the end of a preset cycle time, the PLC will initiate a defrost cycle. Cycle time can vary depending on the application.

TIGAR models operate at a 0°F evaporator temperature with cycle times to produce from 1/8" to 1/2" thick ice. Most units are factory set at a fifteen

(15) minute cycle to produce 3/8" thick ice. The cycle time for these models can be decreased to twelve (12) minutes to produce 1/4" thick ice or increased up to twenty-five (25) minutes to produce 1/2" thick ice.

Each bank of plates is defrosted separately and defrosts are equally spaced (i.e., the time between the harvest of sections #1 and #2 is the same as the time between sections #2 and #3, and between #3 and #1).

Harvest Sequence

Figure 4-6 shows the typical piping arrangement for a flooded unit. The defrost sequence is as follows:

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

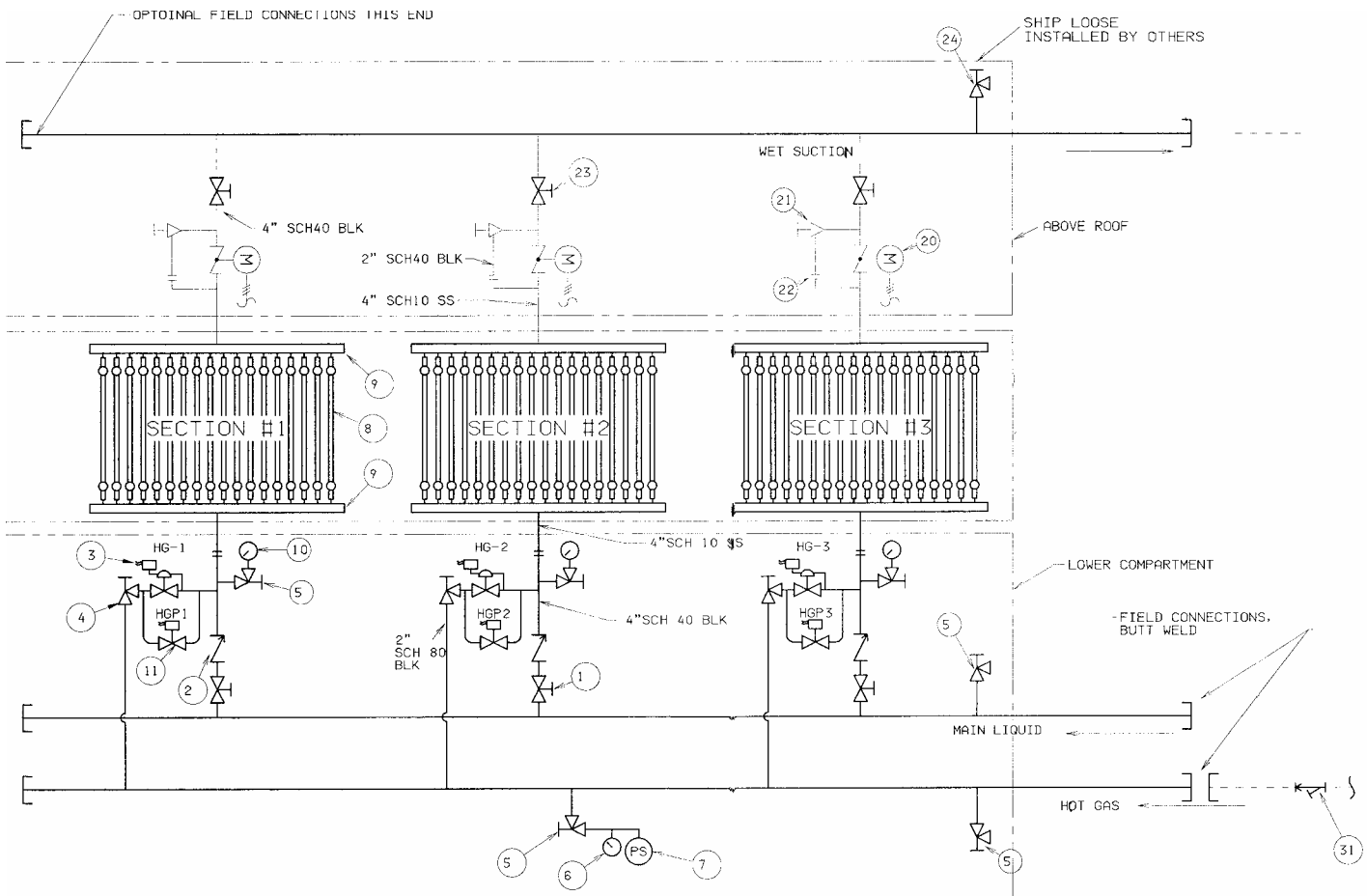


Figure 4-6 Typical Flooded Evaporator Piping Schematic

1. The electric wide open pressure regulator (SS'X') is de-energized and the regulator modulates to maintain a back pressure in the evaporator section (typically 65 PSIG).
2. At the same time, the hot gas solenoid valve (HG'X') is energized to feed hot gas into the liquid/hot gas header. As the pressure in the plates increases, the temperature also increases and the ice separates from the plates and drops into the tank below. Liquid in the plate flows out of the plate through the wet suction header. The higher pressure of the plate bank in defrost will drive the inline check valve in the liquid line closed.
3. After a preset defrost time, the PLC de-energizes the hot gas solenoid and energizes the suction solenoid, thus returning the section to the refrigeration mode.
4. The above sequence is repeated for each bank of plates in the unit, and the sequence repeats until the unit is turned off.

Optional Equipment

Table 4-3 lists the control devices for a flooded TIGAR.

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

Table 4-3 Control Devices (Input/Output Of Controller) Refer to Figures 4-3 and 4-4.

Control Device	No.	Operates	Location	Controlled By	Status		Comments
					Icemaking	Harvest	
Suction Stop Valve (SV)-motor actuated butterfly valve	1 per section	Wet suction return - connected to PLC output	Branch suction line of each section	Programmable controller output	ON –wide open	OFF-closed	Field adjustment of hand expansion valve in bypass around SS during harvest is required
Suction Bypass Valve (SBV)	1 per section	Suction gas flow during harvest cycle	Branch suction line of each section	Manual adjustment	Open – Parallel flow to SV	Open – Meters suction gas flow to maintain proper back pressure for harvest	Adjusted during installation /start up. Unless operating conditions change no further adjustment required
Hot gas bypass solenoid valve (HGP)	1 per section	Flow of hot gas to equalize pressure between inlet and outlet of main hot gas solenoid	Piped in parallel to the main hot gas solenoid valve	Programmable controller output	OFF -	ON	Energized only during defrost; energized prior to main hot gas solenoid to equalize pressure
Hot gas pressure regulator (HG)	1 per section	Flow of hot gas to evaporator plates during harvest	Hot gas branch line to each section	Programmable controller output	OFF	ON - Energizes 15 seconds after harvest begins	Electric wide open regulator. Energized only during harvest; solenoid opens to feed hot gas to section(s) in harvest at regulator set point – typically 70-85 PSIG
Harvest pressure switch – Mercoid (DPS)	1	Senses discharge/hot gas pressure; extends harvest time if pressure is below 125 PSIG	Hot gas main supply line to evaporator	Mercoid switch – normally closed (NC) contact	PLC ignores signal during icemaking	NC contact opens if pressure is above 125 PSIG; contacts close if pressure is below 125 PSIG	During operation at low condensing pressures, standard harvest time may be too short to complete harvest; pressure switch sense low pressure and automatically extends harvest through PLC logic
Liquid line solenoid (LS)	1 per section	Flow of liquid refrigerant to evaporator plate inlet	Branch liquid line to each section	Programmable controller output	ON	OFF	Liquid solenoid closes prior to harvest during normal operation; all solenoids when unit is OFF
Hand expansion valve	1 per section	Balance refrigerant flow to each section	Branch liquid line to each section	Manual adjustment	Open	Open	Adjusted during installation /start up. Unless operating conditions change no further adjustment required

Note: For dedicated central systems operating at 15 PSIG, a single stage pressure regulator is supplied with the optional surge drum. For central systems operation at suction pressure below 15 PSIG, a dual pressure regulator can be provided as an option.

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

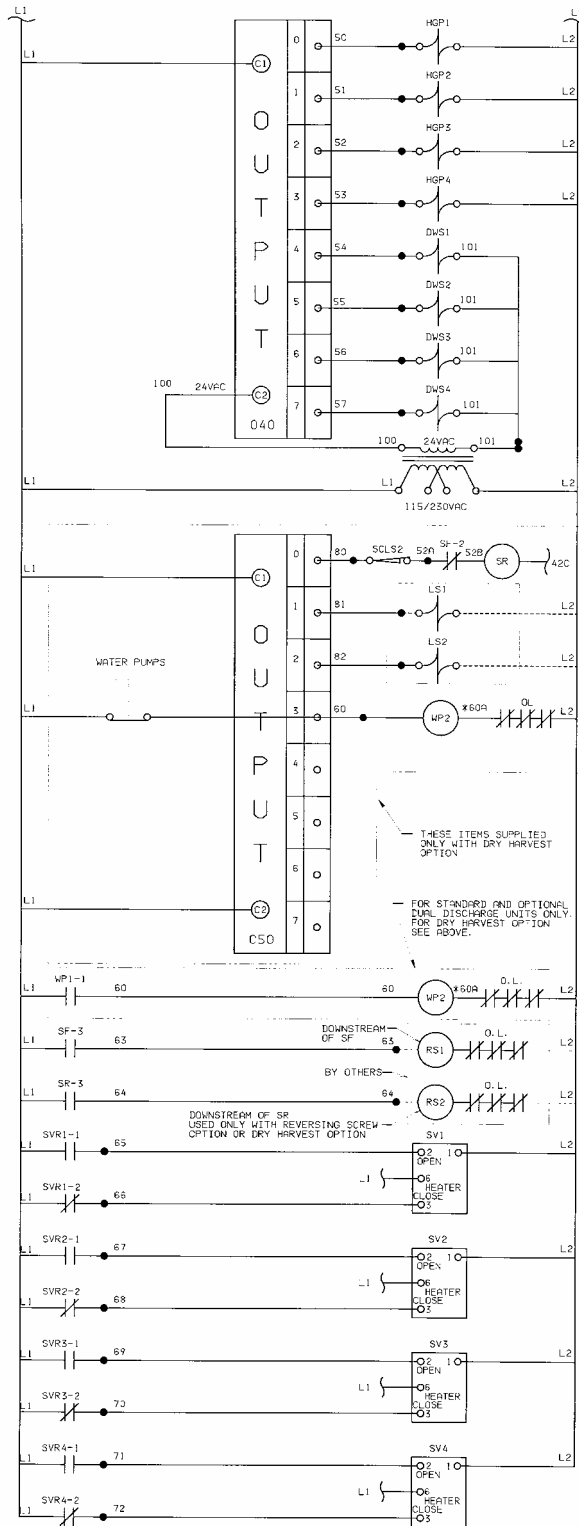


Figure 4-7 Typical Flooded TIGAR Wiring and Controls-Outputs

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

Refrigerant Float Switch

Operating Level (Electronic Probe Sensor)

Inputs from the electronic level probe are required to control the operating liquid level in the surge drum. The operating level is typically 3" for a smaller system and up to 4"–6" for larger units. This level is factory set.

The electronic probe has a probe column installed in the liquid column attached to the surge drum. This column has two (2) sensors. The lower sensor is used to control the high pressure liquid solenoid valve that supplies refrigerant to the surge drum. When the liquid level drops below the setting of the operating level sensor, the contacts of the sensor close to energize the liquid solenoid. When the liquid level reaches the proper operating level, the sensor contacts open and the high pressure liquid solenoid valve closes. The liquid level is continuously monitored by the electronic level controls during operation.

The refrigerant is dropped to evaporator pressure through the hand expansion valve. For a 0°F system, the pressure is reduced from a condenser pressure of 150-250 PSIG to 15 PSIG. A certain amount of the liquid refrigerant boils off as a gas due to this sudden reduction in pressure. The gas goes to the top of the surge drum and is removed through the dry suction.

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High Level (Electronic Probe Sensor)

The second probe in the probe column is located at the high refrigerant level. This sensor is typically located at the 50% level of the surge drum. If the refrigerant level reaches the high refrigerant level sensor of the electronic level indicator, operation of the surge drum, condensing unit, and evaporator are terminated immediately. The contacts of the sensor open to indicate a failure condition. If the liquid drops after operation is terminated, the unit will not restart. After the cause of the high refrigerant level is determined and corrected, the controls must be reset before normal operation can resume.

IMPORTANT

The system should be pumped down after a high refrigerant level trip before normal operation is resumed. This will eliminate the possibility of a liquid slug or liquid carry-over from the surge drum.

High Level (FSHL)

A mechanical float switch is wired in parallel to the electronic probe high level sensor to provide back-up to the primary high refrigerant level controls. The FSHL switch provides the same protection as the electronic probe. Although this should provide adequate surge protection for the compressor, systems with multiple evaporators may require an additional "knock-out" drum at the compressor.

A set of electrical contacts in the float switch opens or closes as the float in the float chamber rises or falls with the liquid level. The normally open contacts are connected to the PLC and remain open during normal operation. If the liquid solenoid sticks open or the system surges, raising the liquid level in the surge drum, the float raises in the float chamber and the normally open contacts close to signal the PLC that a high level exists.

The PLC immediately shuts the unit off to prevent liquid carryover to the compressor. A high liquid level shut down requires resetting the controls before the unit can be restarted.

IMPORTANT

Determine the cause of the surge or high liquid level before returning the unit to normal operation.

The float valve components include the float valve and two (2) isolating valves. A connection is provided in the surge drum for the vent line from the top of the float switch to a point always above the maximum liquid level. The bottom connection should be installed in the liquid leg from the bottom of the surge drum. This line should be pitched down to prevent trapping refrigerant oil in the bottom of the float switch.

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

High Pressure Liquid Line

This set of valves consists of two (2) isolating valves, a strainer, a liquid solenoid valve, and a hand expansion valve. High pressure liquid refrigerant is metered into the surge drum through the hand expansion (pressure reducing) valve. A signal from the refrigerant float switch energizes the liquid solenoid valve when the liquid level in the surge drum is below the set point.

When the liquid solenoid opens, high pressure liquid refrigerant enters the hand expansion valve and is dropped to evaporator pressure. The hand expansion valve can be adjusted to maintain a steady flow of refrigerant to the surge drum. If the hand expansion valve is overfeeding, there will be a tendency for the float switch and liquid solenoid to short cycle and cause erratic pressure controls. Closing the valve too much will cause the liquid level to drop faster than the liquid being added, thus starving the evaporators.

A bypass hand expansion valve is provided to allow operation with the main liquid feed line closed. This allows service of the strainer and liquid solenoid valve without interrupting operation. The isolation valve and hand expansion valve are closed and the bypass valve opened for this mode of operation.

Dual Pressure Relief Valve Assembly

Two (2) relief valves are mounted on a three way manifold with the common connection going to the safety valve connection located on the top of the surge drum. Each valve has an FPT outlet connection which should be piped to the outside or other safe venting area.

In the event that a relief valve does open, the cause of the excessive pressure should be immediately determined and corrected. The relief valve in service at the time should be isolated and replaced.

Oil Accumulator Drum

To prevent oil from accumulating in the evaporator, an oil accumulator drum is provided for installation at the bottom of the liquid leg from the surge drum. Included with the oil accumulator is a pressure relief valve, isolating valves for the oil inlet, an oil pot vent, and oil drain connections. A pipe plug is provided for the oil drain valve in case of leakage through the valve or accidental opening of the oil drain valve.

During normal operation, the oil inlet valve and oil pot vent valve will always be open. The oil drain valve is closed. As the liquid refrigerant and oil flows down the liquid leg, the velocity is very low, allowing the heavier oil to separate and

go to the bottom of the liquid leg along with the liquid refrigerant where it is drained into the oil accumulator. Oil will continue to displace the liquid in the oil accumulator until it reaches a level requiring it to be removed.

To drain the oil from the oil accumulator, isolate the oil accumulator by closing the oil inlet valve and the oil pot vent valve. After the oil accumulator warms up, check the oil drain valve to make sure it is tightly closed and then carefully remove the pipe plug from the valve outlet. Remove the plug slowly because gas or small amounts of liquid could be trapped in the valve outlet. Next, connect a hose or some other means of draining the oil to the outlet of the valve. The end of the hose should be placed in a bucket of water to absorb the NH₃ removed with the oil.

Once the oil is removed, close the oil drain valve and replace the plug. Open the oil vent line first, then the oil drain inlet valve.

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

WARNING

Never leave the oil accumulator isolated for extended periods of time. Excessive pressure will develop in the isolated drum. A relief valve is provided as a safety device. Failure to carefully follow these instructions could result in permanent injury or loss of life.

Isolation of the drum for extended periods of time means that the small oil pot built into the bottom of the liquid leg may not hold all of the oil accumulated. The excess oil would then go to the evaporator, resulting in poor or erratic operation including failure to harvest properly.

Hot Gas Supply Line

A strainer is installed in the hot gas supply line upstream of a pressure sensing switch (Mercoïd). A pressure gauge is mounted in parallel to the pressure switch.

During defrost, the hot gas solenoid valve to the section in defrost allows hot gas to enter the evaporator. Because of the volume of the evaporator and the 32°F water flowing over the plates, the discharge pressure will drop during defrost. In most cases, this will not cause a problem; however, in cases where the system is operated at a relatively low condensing temperature (below 125 PSIG and 75°F saturated condensing temperature), a positive defrost

cannot be assured with the standard defrost time.

Therefore, when the high pressure switch mounted on the hot gas line senses a pressure below 125 PSIG, a set of normally closed contacts close. Above 125 PSIG, the normally closed contacts are open. When the contacts close during defrost, the input to the PLC initiates an extended defrost sequence. That is, the normal defrost time will elapse and then a second time span will elapse. The setting of both the normal defrost time and the extended defrost time will vary depending on the installation. In general, normal defrost time is forty (40) seconds and the extended defrost time adds forty (40) seconds to the defrost time.

During the refrigeration cycle, the input of the high pressure switch has no effect on the operation of the system. System discharge pressure can be run below 125 PSIG without affecting the overall operation of the equipment.

Operating Parameters

Saturated Evaporator
0°F (15 PSIG)

Icemaker Operation
Water on plates 32-35°F

Cycle Times
Minimum 12 minutes
Maximum 24 minutes
Refer to data sheet for factory setting of cycle time.

Ice Thickness
Nominal 3/8"
15 minute cycle

Surge Drum Location
Minimum 42"
This distance is from the top of the evaporator plate to the bottom of the drum.

Relief Valve Setting
250 PSIG

Make-Up Water Temperature
Design 60°F
Minimum 35°F

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

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



TIGAR Ice Generator Operation & Maintenance Manual

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 not covered in this section, contact Turbo Refrigerating at: **1-940-387-4301 Ask for the Service Department.** The following pages describe problems you might encounter and provide diagnostic instructions and solutions.

PROBLEMS AND SOLUTIONS

Problem	Causes	Solutions
<p>Compressor will not start. Note: For optional compressor supplied by others or separately, consult supplier's data for additional information.</p>	<p><i>No three phase or control circuit power, tripped circuit breaker.</i></p> <p><i>Blown fuse.</i></p> <p><i>Refrigerant recirculation unit "off" or "tripped".</i></p> <p><i>Improper signal at the programmable controller.</i></p> <p><i>Icemaker MCS turned off.</i></p>	<p>Check fuses and disconnect. Reset tripped circuit breakers.</p> <p>Reset or replace manual reset.</p> <p>Determine cause of low recirculator before restarting.</p> <p>The run and power lights must be on for unit to operate. Check for loose connection and control circuit power to controller.</p> <p>Turn switch to "ON" position. For dedicated system the icemaker should be on before the compressor starts.</p>

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

Problem	Causes	Solutions
	<p><i>Dry contact of control relay in evaporator control panel open.</i></p> <p><i>Emergency stop button depressed.</i></p> <p><i>Overload relay on magnetic starter tripped.</i></p>	<p>Harvest screw water pump trip or safety failure. Determine cause of trip and reset controls.</p> <p>Determine reason emergency stop button was used and correct before resetting.</p> <p>Determine cause of motor overload. Depress manual reset button.</p>
Unit drawing high amps (harvest screw or water pump motors).	<p><i>Loose terminal connections.</i></p> <p><i>Defective motor bearings or motor.</i></p> <p><i>Motor defective.</i></p> <p><i>Debris or restriction preventing normal operation.</i></p> <p><i>Bad bearing on harvest screw.</i></p> <p><i>Screw conveyor bent or end bearing out of alignment.</i></p>	<p>Tighten connections (qualified electrician).</p> <p>Replace. Check compressor/motor alignment and mounting bolts before restarting.</p> <p>Replace or rewind.</p> <p>Clear obstruction and restart.</p> <p>Replace.</p> <p>Straighten or replace.</p>

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

Problem	Causes	Solutions
<p>Unit will not make ice or is not producing full sheet of ice.</p>	<p><i>High discharge pressure:</i></p> <ul style="list-style-type: none"> - <i>Defective water regulating valve (water cooled).</i> - <i>Fouling at condenser (water cooled).</i> - <i>Faulty water pump (water or evaporative cooled).</i> - <i>Fouling at condenser (air cooled).</i> - <i>Flood back valves out of adjustment (air or evaporative cooled).</i> - <i>Belt worn or loose causing belts to slip (air or evaporative cooled).</i> - <i>Fan turning too slow (air cooled).</i> <p><i>NH3 pump off or flow restricted (recirculated system).</i></p> <p><i>Low on NH3.</i></p> <p><i>Leaking defrost valve allowing hot gas bypass.</i></p>	<p>Check pressure sensing connection to regulator. Replace if necessary.</p> <p>Clean condenser by brushing and/or acid treatment. Consult manufacturer for water treatment recommendations.</p> <p>Replace pump. Check pump suction and discharge for obstructions.</p> <p>Clean with air, water hose, or brushing. Remove debris from condenser inlet.</p> <p>Adjust to maintain 180 PSIG.</p> <p>Adjust, replace belts.</p> <p>Change sheave to increase speed up to FLA of motor. Consult factory before restarting. Check for restrictions.</p> <p>Check pump overload. Check pump suction and discharge for obstructions. Check bypass pressure regulator. Rebuild pump.</p> <p>Search for leak and repair. Add refrigerant to maintain proper level in recirculator or surge drum (flooded) and high pressure receiver</p> <p>Repair with valve kit or replace.</p>

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

Problem	Causes	Solutions
	<p><i>Hand expansion valve improperly adjusted.</i></p> <p><i>Plugged or restricted strainer on liquid or recirculation unit (by others).</i></p> <p><i>Plugged or restricted liquid line strainer.</i></p> <p><i>Air or other non-condensable in refrigerant system.</i></p> <p><i>Restriction in piping.</i></p> <p><i>Power off to condensing unit.</i></p> <p><i>Insufficient water flow to condenser (water cooled):</i></p>	<p>Balance all hand expansion valves to maintain adequate refrigerant to all sections. Open the valve(s) on each section not producing full ice sheets and observe – if necessary continue to open until full sheet is produced. Note: It may be necessary to close the hand TXV to other sections to increase flow to section not producing. Adjust hand expansion valve to maintain 15 PSIG in each section.</p> <p>Clean strainer. Restrictions can be observed by temperature drop across the strainer resulting in lower temperature at outlet. If temperature can not be measured isolate the strainer and remove it for visual inspection.</p> <p>Clean strainer. Restrictions can be observed by temperature drop across the strainer resulting in lower temperature at outlet. If temperature can not be measured isolate the strainer and remove it for visual inspection.</p> <p>Bleed air from condenser. Replace refrigerant charge if contamination can not be removed.</p> <p>Check all isolation valves for proper position – open or closed. Except for the hand expansion valves all other valves should be fully open or closed and should not be used for throttling or flow control.</p> <p>Check power, circuit breaker, and disconnects to all motors, starters, and control switches.</p>

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

Problem	Causes	Solutions
	<p>- Strainer plugged. - Float valve defective (make-up water line to cooling tower). - Pump impeller worn</p> <p>Condenser pump prime lost – low water level in sump.</p> <p>Condenser water make-up valve closed or restricted.</p> <p>Recirculating water pump off: - Motor overloads tripped. - Water recirculating pump prime lost. Low water level in reservoir. - Strainer plugged. - Check valve stuck closed.</p> <p>Liquid line check valve at evaporation section inlet closed or restricted.</p> <p>Make-up water in water tank is short circuiting causing temperature stratification in the water to the evaporator plates. - water distribution header plugged or restricted.</p>	<p>Clean or replace. Check adjustment. Replace if required.</p> <p>Check water pump impeller for wear – replace impeller or pump if necessary.</p> <p>Add water to cooling tower. Determine cause of water loss. - leak in sump or piping - water line broken - isolation valve in water line closed</p> <p>Clean, repair, open, or replace valve.</p> <p>Check pump for restrictions. Reset starter overload relay. Locate water feed restriction. Add water to tank.</p> <p>Remove and clean. Remove and clean.</p> <p>Clean, repair, or replace valve. This check is installed and normally located outside the unit at the liquid line connection to the ice generator</p> <p>Check the water inlet distribution header located inside the water tank (piped to the discharge of the make-up water solenoid valve). Verify that the holes in the header are not plugged.</p>

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

Problem	Causes	Solutions
	<p><i>-water connection broken or water supply lost</i></p> <p><i>-water level sensor switch defective</i></p> <p><i>-water solenoid coil failed</i></p> <p><i>Evaporator plates oil logged.</i></p> <p><i>Suction stop valve (SS) stuck. Butterfly valve is not fully opening.</i></p> <p><i>Orifice in liquid header to evaporator plate plugged.</i></p>	<p>Verify connection to the water solenoid valve and check the upstream water piping and valves outside unit.</p> <p>Verify the solenoid opening in response to the water level sensor switch signal. Verify the water level assembly is properly positioned – make sure assembly is firmly in place and has not slipped down in the mounting bracket.</p> <p>Note: Some older models were not equipped with a make-up water header. Consult the factory for additional information.</p> <p>Verify the coil energizes when the output for the water solenoid is on. It can also be tested by applying power from the control circuit L1 to the water solenoid coil using a jumper to temporarily pulse the coil</p> <p>Drain oil from NH3 recirculation unit oil reservoir. Raise evaporator plate temperature by placing manual defrost switch (MDS) in manual position or by spraying plates with warm water (not to exceed 90°F).</p> <p>Motor actuator on valve is defective, replace. Manually open the valve two to three times using the manual operator. If this does not free the valve, isolate the valve, disassemble and clean.</p> <p>Consult factory.</p>
Unit will not harvest	<i>Main hot gas solenoid inoperative.</i>	Check wiring to coil. Check for burned out coil and replace. If coil is okay isolate the valve, disassemble, and clean.

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

Problem	Causes	Solutions
	<p><i>Insufficient water over plates resulting in erratic water flow and ice formation in areas outside active surface of plate.</i></p> <p><i>Discharge pressure too low.</i></p> <p><i>Check valve in liquid line stuck open preventing sufficient flow of hot gas to the evaporator plates.</i></p> <p><i>Hot gas bypass valve improperly set – too wide open to build back pressure.</i></p> <p><i>Ice building on ends of plate causing bridging.</i></p>	<p>Check distribution pans for fouling and clean. Clean strainer if so equipped, clean screen on pick-up at pump. Check pump for proper rotation. Each section is equipped with a flow control valve that can be opened to increased water flow; closed to decrease water flow. Normal water level in the pan is approximately half full.</p> <p>Check condenser pressure controls (100 PSIG for flooded; 125 PSIG for recirculated) to ensure proper discharge pressure. NOTE: Discharge pressure below the settings above can be used but longer harvest time will be required. The Discharge Pressure Switch (DPS) will automatically extend the harvest time during operation below the set point. It may also be necessary to change the harvest (defrost) preset time and/or the harvest extend time preset in the PLC. NOTE: Low discharge or lower discharge pressure during cold weather operator could require adjustment of the hand expansion valves on the liquid line to each section</p> <p>Valve dirty, clean. Pilot solenoid inoperative.</p> <p>Adjust the bypass hand expansion valve to maintain approximately 68-75 PSIG at the evaporator section outlet during harvest.</p> <p>Check for low water flow caused by dirty pan, clean as required. Check for excessive splashing. Check for loose connections on water distribution piping. Check the auxiliary water spray system – verify the auxiliary spray water turns ON during harvest. Verify the nozzles are not plugged and verify the water spray pattern is directed at the area</p>

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

Problem	Causes	Solutions
	<p><i>Suction stop valve (SSV) stuck open. Motor actuator working to open butterfly valve.</i></p>	<p>the 5/8" inlet tube enters the plate – make sure all plates are covered by the spray pattern.</p> <p>Manually open valve two to three times using manual operator provided on the motor actuator housing. Check butterfly valve for damage. Rebuild if necessary.</p>
Low suction pressure.	<p><i>Low on refrigerant.</i></p> <p><i>Obstruction or dirt in liquid line strainer.</i></p> <p><i>Low or erratic water flow over plates.</i></p> <p><i>Hand expansion valves improperly adjusted (starving).</i></p>	<p>Check for leaks, repair. Add refrigerant.</p> <p>Clean strainer.</p> <p>Check water distribution pan for dirt, water flow control valve adjustment, and water pump for performance</p> <p>Check hand expansion valve adjustment. Adjust or replace as required. Open or close the hand expansion valve to maintain approximately 15 PSIG at each evaporator section. To obtain proper balance between all sections it may be necessary to close some valves and open others.</p>
High suction pressure.	<p><i>Water temperature too high.</i></p> <p><i>Leaking defrost valve bypassing high pressure directly to suction.</i></p> <p><i>Improperly adjusted hand expansion valve (overfeeding refrigerant).</i></p>	<p>Water temperature above 60°F (based on incoming city water).</p> <p>Repair or replace hot gas solenoid (bypass or main).</p> <p>Check expansion valve adjustment (close to reduce refrigerant flow). Set to maintain 15 PSIG in all sections.</p>
High discharge pressure. Note: Optional condensing unit	<i>Refrigerant system overcharged.</i>	Verify actual charge. Reduce charge as required.

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

Problem	Causes	Solutions
<p>supplied by others or separately, consult supplier's data for additional information.</p>	<p><i>Dirty condenser.</i></p> <p><i>Non-condensable in refrigerant.</i></p> <p><i>Head pressure controls improperly set.</i></p> <p><i>Discharge line check valve inoperative or partially open.</i></p> <p><i>Check position of all isolation valves and pressure controls.</i></p>	<p>Clean.</p> <p>Air in system. Remove by purging. Readjust to correct setting.</p> <p>Normally 190–220 PSIG for water cooled; 170–190 PSIG for evaporative cooled; 210–250 PSIG for air cooled.</p> <p>Check and replace if required.</p> <p>Open all valves fully open or to correct position. Make sure all pressure controls are properly adjusted and in automatic position.</p>
<p>Low oil pressure. Note: Optional condensing unit supplied by others or separately, consult supplier's data for additional information.</p>	<p><i>Oil reservoir full indicating need for maintenance.</i></p> <p><i>Plugged or stopped up oil strainer.</i></p> <p><i>Low oil level in crankcase.</i></p> <p><i>Defective compressor oil pump.</i></p> <p><i>Oil leak</i></p>	<p>Drain oil reservoir and add new oil to compressor.</p> <p>Clean. Purge line.</p> <p>Consult supplier's data.</p> <p>Check rotation and wear. Replace as required.</p> <p>Check all areas around system for signs of oil leakage. Repair leak and recharge system with oil.</p>
<p>Excessive vibration of motor and compressor. Note: Optional condensing unit supplied by others or separately, consult supplier's data for additional information.</p>	<p><i>Misalignment.</i></p> <p><i>Loose motor/compressor hold down bolts.</i></p> <p><i>Flooding of compressor.</i></p>	<p>Realign to within specifications.</p> <p>Tighten. Check alignment.</p> <p>Adjust high pressure liquid line hand expansion valve setting. Check refrigerant level controls on NH3 recirculation unit to</p>

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

Problem	Causes	Solutions
	<p><i>Defective or worn bearing.</i></p> <p><i>Structural support under unit insufficient.</i></p>	<p>ensure high refrigerant level switch is operative.</p> <p>Remove coupling and check bearing.</p> <p>Reinforce structural support. Shim as required. Consult factory for guidelines.</p>
<p>Excessive motor temperature. Note: Optional condensing unit supplied by others or separately, consult supplier's data for additional information.</p>	<p><i>Voltage drop at motor starter/contactors.</i></p> <p><i>Loose connection at starter/contactors causing high amp draw.</i></p> <p><i>Restricted or inadequate air ventilation.</i></p>	<p>Phase imbalance. Consult electric company. Check for loose wires and terminal connections</p> <p>Tighten connection (qualified electrician).</p> <p>Clean obstructions or increase source of lower temperature air for cooling.</p>



TIGAR Ice Generator Operation & Maintenance Manual

MAINTENANCE

To help you get the best performance from your TIGAR system, follow the maintenance instructions listed below. If you have questions concerning the maintenance or upkeep of your equipment, contact:

**Turbo Refrigerating
Service Department
P.O. Box 396
Denton, Texas 76202
Phone: 940-387-4301
Fax: 940-382-0364**

Daily Inspections

Inspect the icemaker at least twice a shift to determine that the unit is operating properly.

When starting, observe that the discharge and suction pressures are correct on the gauges and are stable.

Weekly Inspections

Check the oil level in the compressor.

Check for signs of oil leakage.

Check the refrigerant liquid level in the receiver (if applicable) or during pump-down to ensure that the level is proper and has not changed

Check the receiver. Inspect valve packings and relief valve for indications of refrigerant loss.

Check for 20-30% refrigerant level in the receiver (or the supplier's recommendation) while operating.

Check unit at least once a week. A visual inspection includes and is not limited to:

- Leaks
- Vibration of piping on other components
- Capillary tubes rubbing
- Unusual noises
- Tight bolts, nuts, screws
- General neat housekeeping

After Initial Ten Hours of Operation

Retighten all bolts.

After Initial Fifty Hours of Operation

Retighten all bolts.

Have a qualified electrician check the control panel for loose connections or loose lugs on the magnetic starter.

Every Six Weeks

Grease all greasable fittings on the shaft bearings.

Water Scale Build-Up

One of the main concerns with the TIGAR or any icemaker is water (scale build up):

- Solids form on the plates
- Solids build-up in the pan
- Solids build-up on the interior of water cooled condenser (if so equipped)

To avoid these problems, consult a local water treatment consultant and follow these guidelines below.

Plates Forming Scale

Flush plates with an acceptable ice plate cleaner. Have water analyzed.

Icemaking Surface Cleaning

Scale on the icemaking plates resulting from mineral deposits in the water and other sources of contamination can reduce the efficiency of the plate. If left untreated, it may result in deterioration of the metal surface thus reducing the life of the plates.

The life and efficiency of the plates are dependent on proper care and cleaning of the surface. Since conditions and installation of equipment vary from location to location, it is difficult to provide a simple solution to selecting a cleaning and sanitizing method. To obtain the best care for your unit, contact a local reputable supplier of chemical and cleaning sanitizing products. Based on the knowledge of the local water conditions, the material to be cleaned (304 stainless steel), and the operating conditions of the equipment, they can recommend a cleaning and sanitizing product to meet your specific needs.

Helpful Hints

1. Chlorine will attack stainless steel. Most water supplies contain chlorine in levels too low to cause concern. Some cleaning agents contain high levels of chlorine and should be avoided unless the cleaning process can be closely controlled and a thorough rinsing of the plates and any other parts coming in contact with the cleaning agent can be ensured every time.
2. Water scale can be removed using dilute nitric acid under 1% or phosphoric acid under 5% at temperatures no higher than 105°F. These solutions must be free of salt and thoroughly flushed from all surfaces immediately after use with a 1/4% caustic and plain water flush.
3. Hydrochloric and sulphuric acid should not be used.

Scale and Solids Forming In Water Tank

Drain and flush tank at least once a week. Solids can stop up the holes in distribution pans. Clean pan by using an air hose, a vacuum cleaner, or a brush. If excessive or frequent cleaning is required, increase water make-up blow-down to reduce concentrations in tank.

Clean strainer in make-up water line.

Dirty or scaled tubes in water cooled condensers can cause high discharge pressure. Periodically remove the condenser head and use a condenser tube cleaning brush to remove scale. Acids or chemical additives can also be used. Care should be exercised when using acid. Follow directions on the container (consult local chemical treatment supplier).

Cooling towers should be treated for scale and algae when needed.

Air cooled condensers can be washed out using a water hose and flushing out against the airflow. Prior to performing this service, ensure that the electric circuit is disconnected and locked out. Lubricate the fan bearing and tighten belts where equipped according to the manufacturer's specification.

Note:

TURBO recommends that warnings and labels for any additional equipment not supplied by TURBO need to be added to the weekly inspection sheet.

Table 6-1 Harvest Screw Drive Lubrication Schedule

	Lubricant Type*	Frequency
Belts	N/A tension	once a month
Harvest Screw Drive Reducer Floor Screw Reducer	Texaco Lubriplate #8 or equivalent	change first week and every 6 months
Sheaves	Texaco Marine Lubricant or equivalent	every 6 weeks

* All lubricants are food grade.

Table 6-2 Sample Daily Ice Plant Log Sheet

Date _____

Ice Depth

First Shift Start _____
Second Shift Start _____
Third Shift Start _____

First Shift End _____
Second Shift End _____
Third Shift End _____

Vault Temperature

First Shift Start _____
Second Shift Start _____
Third Shift Start _____

First Shift End _____
Second Shift End _____
Third Shift End _____

Icemaker Head Pressure

First Shift Start _____
Second Shift Start _____
Third Shift Start _____

First Shift End _____
Second Shift End _____
Third Shift End _____

Icemaker Suction Pressure

First Shift Start _____
Second Shift Start _____
Third Shift Start _____

First Shift End _____
Second Shift End _____
Third Shift End _____

Compressor Oil Pressure

First Shift Start _____
Second Shift Start _____
Third Shift Start _____

First Shift End _____
Second Shift End _____
Third Shift End _____

Make-Up Water Temperature 1

First Shift Start _____
Second Shift Start _____
Third Shift Start _____

First Shift End _____
Second Shift End _____
Third Shift End _____

Make-Up Water Temperature 2

First Shift Start _____
Second Shift Start _____
Third Shift Start _____

First Shift End _____
Second Shift End _____
Third Shift End _____

Make-Up Water Temperature 3

First Shift Start _____
Second Shift Start _____
Third Shift Start _____

First Shift End _____
Second Shift End _____
Third Shift End _____

Inlet Water Pressure 1

First Shift Start _____
Second Shift Start _____

First Shift End _____
Second Shift End _____

Third Shift Start _____

Third Shift End _____

Inlet Water Pressure 2

First Shift Start _____

First Shift End _____

Second Shift Start _____

Second Shift End _____

Third Shift Start _____

Third Shift End _____

Inlet Water Pressure 3

First Shift Start _____

First Shift End _____

Second Shift Start _____

Second Shift End _____

Third Shift Start _____

Third Shift End _____

Ambient Temperature

First Shift Start _____

First Shift End _____

Second Shift Start _____

Second Shift End _____

Third Shift Start _____

Third Shift End _____

Operators

First Shift _____

Second Shift _____

Third Shift _____

Remarks

First Shift _____

Second Shift _____

Third Shift _____

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



TIGAR Ice Generator Operation & Maintenance Manual

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.

WATER SYSTEM

Part Number	SI	RI	Description	TIGAR Model (qty)							
				25	50	75	100	3620	3636	3656	3672
012-2007-0501	x		Float Valve-models prior to 1999	1	1	1	1				
012-4800-05	x		Solenoid valve-current models					1	1	1	1
014-1600-05	x		Strainer	1	1	1	1	1	1	1	1
028-0800-01		x	Pump - models prior to 1999	1	2	3	4				
028-0900-01		x	Pump, stainless steel –current models					1	2		
028-0900-05		x	Pump, stainless steel –current models							2	2
019-2500-0102		x	Float switch relay					1	1	1	1

WARNING! 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 Power with 115/1/60 Controls)

Part Number	SI	RI	Description	TIGAR Model (qty)							
				25	50	75	100	3620	3636	3656	3672
035-0501-06	x		Relay Coil	1	1	1	1	1	1	1	1
035-0303-09	x		Pilot Light - Red	1	1	1	1	1	1	1	1
035-0303-08	x		Pilot Light - Green	1	1	1	1	1	1	1	1
035-0103-0701		x	Relay	1	1	1	1	1	1	1	1
TIGARE01		x	Starter Water Pump 230 Volt	1	2	3	4	2	2	2	2
TIGARE01		x	Starter Water Pump 460 Volt	1	2	3	4	2	2	2	2
TIGARE01		x	Starter Harvest Screw 230 Volt	1	1	1	1	1	1	1	1
TIGARE01		x	Starter Harvest Screw 460 Volt	1	1	1	1	1	1	1	1

ELECTRICAL SWITCHES & CONTROLS

Part Number	SI	RI	Description	TIGAR Model (qty)							
				25	50	75	100	3620	3636	3656	3672
035-0305-04	x		Contact Block N.O.	1	1	1	1	1	1	1	1
035-0305-05	x		Contact Block N.C.	1	1	1	1	1	1	1	1
TIGARE02	x		Tape with Back-Up Program	1	1	1	1	1	1	1	1
TIGARE03	x		Tape Player (program load/back-up)	1	1	1	1	1	1	1	1
080-0000-32		x	Series 1 5-Slot Rack	1	1	1	1	1	1	1	1
080-0000-30	x		Series 1 CPU	1	1	1	1	1	1	1	1
080-0000-34	x		Series 1 Input Module	1	1	1	1	1	1	1	1
080-0000-36	x		Series 1 Output Module	1	1	1	1	1	1	1	1
080-0000-31		x	Series 1 Programmer (hand held)	1	1	1	1	1	1	1	1

SAFETY SWITCHES

Part Number	SI	RI	Description	TIGAR Model (qty)							
				25	50	75	100	3620	3636	3656	3672
018-0000-22	x		Mercoid Pressure Switch	1	1	1	1	1	1	1	1
017-0110-33		x	Gauge (high pressure 30-300 PSIG)	1	1	1	1	1	1	1	1
017-0110-40		x	Gauge (low pressure 30-150 PSIG)	3	3	3	4	3	3	3	4

Spare Parts List

10/01 Turbo Refrigerating, LLC 7-2

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

HARVEST SCREW COMPONENTS

Part Number	SI	RI	Description	TIGAR Model (qty)							
				25	50	75	100	3620	3636	3656	3672
224-1006-04	x		Safety Cover	1	1	1	1	1	1	1	1
032-0400-55	x		Belts	1	1	1	1	1	1	1	1
052-1112-29	x		Belt Guard	1	1	1	1	1	1	1	1
034-1700-07		x	Motor	1	1	1	1	1	1	1	1
029-0401-20		x	Bearings	1	1	1	1	1	1	1	1
052-2626-20		x	Conveyor Shaft Bolts	4	4			4			
052-2626-22		x	Conveyor Shaft Bolts			4	4		4	4	4
224-1030-11		x	Poly Bearing Plate	1	1	1	1	1	1	1	1

REFRIGERANT SYSTEM

Part Number	SI	RI	Description	TIGAR Model (qty)							
				25	50	75	100	3620	3636	3656	3672
TIGARR04	x		Hot Gas Solenoid Valve Coil	1				1			
TIGARR05	x		Hot Gas Solenoid Valve Coil		1	2	2		1	2	2
TIGARR06	x		Suction Pilot Solenoid Coil	1	1	2	2				
012-4000-0401		x	Hot Gas Solenoid Valve	3				2			
012-4200-1101		x	Hot Gas Solenoid Valve		3	3	4		4	4	4
218-0000-00		x	Evaporative Plate-31"	18	36	54	72				
218-0000-01		x	Evaporative Plate-36"					20	36	56	72
012-0408-0813		x	Check Valve	3				2			
012-0412-0502		x	Check Valve		3	3	4		4	4	4
021-0512-1000		x	Suction Pressure Regulator-old style 3								
021-0512-100		x	Suction Pressure Regulator-old style		3						
021-0512-1001		x	Suction Pressure Regulator-old style			3	4				
TIGARR07		x	Suction Valve Motor Actuator-115v2		4	4	4	2	4	4	4

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

MISCELLANEOUS

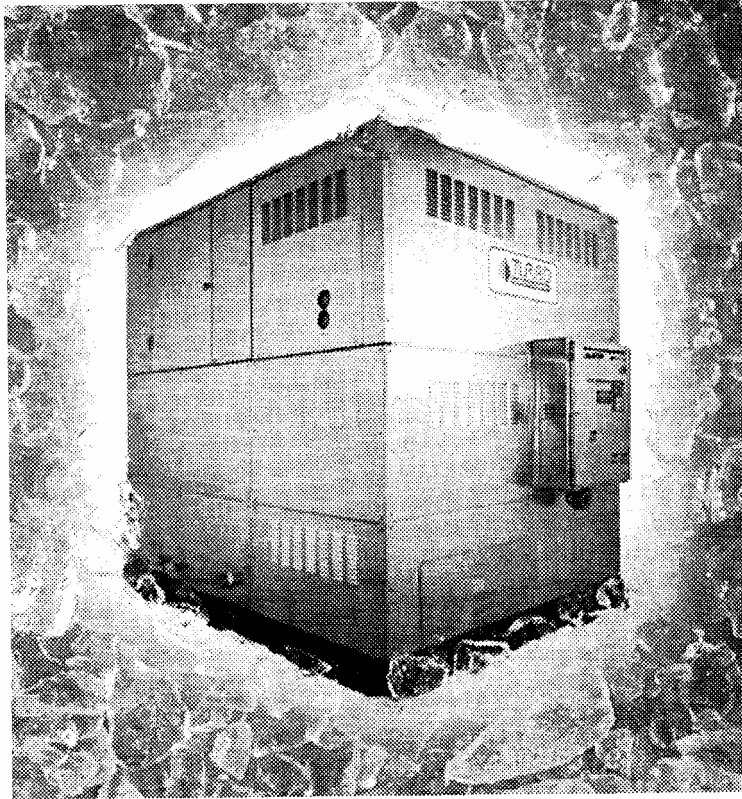
Part Number	SI	RI	Description	TIGAR Model (qty)							
				25	50	75	100	3620	3636	3656	3672
057-0007-00	x		Harvest Screw Gear Reducer Lubricant (one gallon)	1	1	1	1	1	1	1	1
057-0007-02	x		Harvest Screw Bearing Grease (14.5 oz. Cartridge)	1	1	1	1	1	1	1	1

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

SPARE PARTS LIST 1
LEGEND..... 1
WATER SYSTEM..... 1
ELECTRICAL CONTROL PANEL (230/460/3/60)(115/1/60) 2
ELECTRICAL SWITCHES & CONTROLS 2
SAFETY SWITCHES 2
REFRIGERANT SYSTEM 3
MISCELLANEOUS 4

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

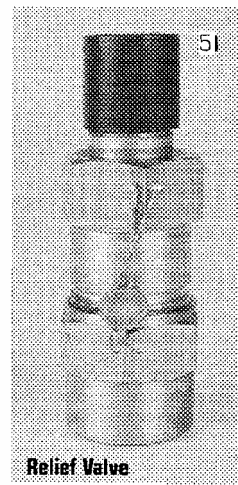
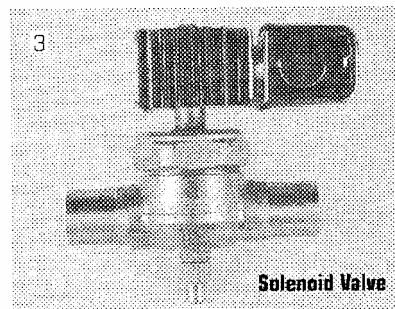
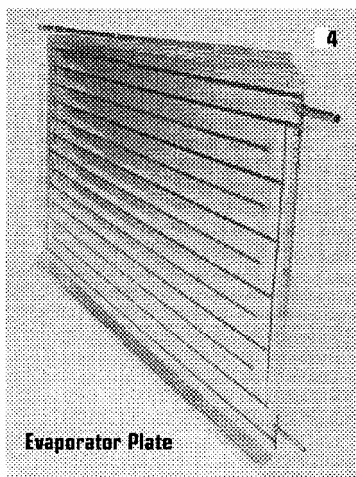
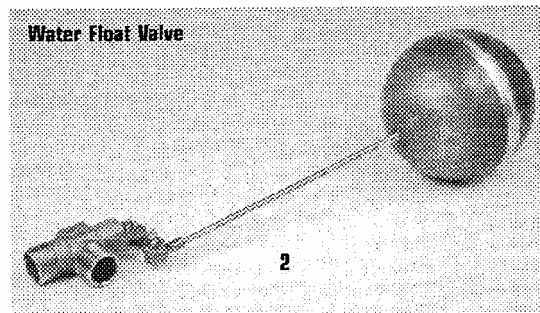
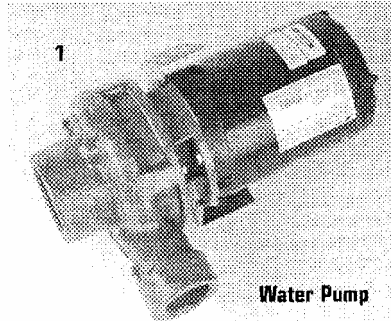
Turbo TIGAR Series Ice Generators



TIG18 with Optional Winterizing Enclosure

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

TIGAR Piping Assembly



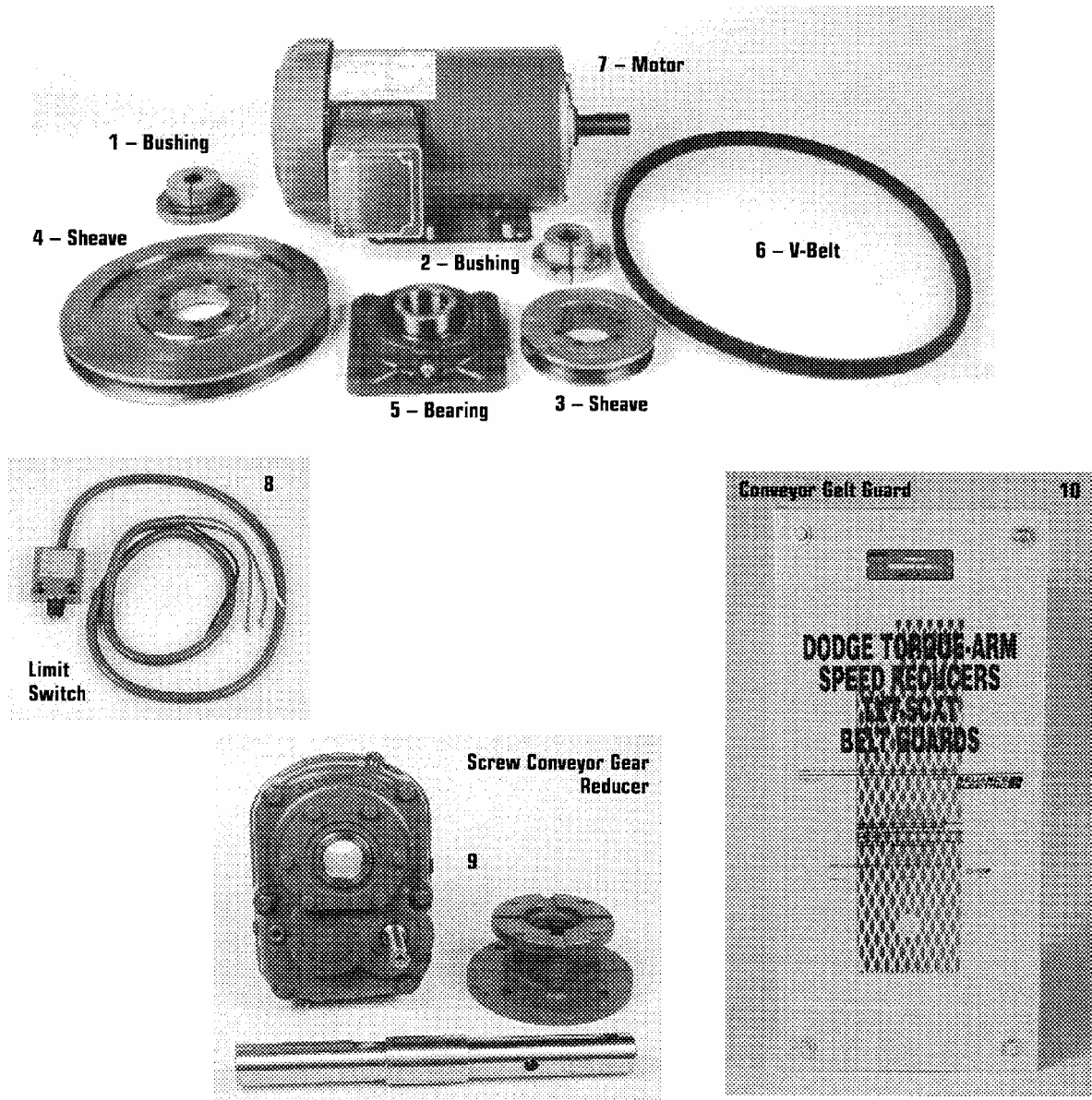
Phone 800-788-4301 Fax 800-380-3081 Photos are for reference only. Some items are not shown.

TIGAR Piping Assembly

Item	Turbo Part No.	Description	Applications (Models)
1	028-0800-01	Water Pump & Motor 1 HP Dual Volt	TIGAR25, TIGAR50, TIGAR50FL, TIGAR75, TIGAR100
1	028-0900-01	Water Pump & Motor 1-1/2 HP Dual Volt	TIGAR 3E 20, TIGAR 3E 3E
1	028-0900-05	Water Pump & Motor 5 HP Dual Volt	TIGAR 3E 5E, TIGAR 3E 72
2	012-2007-0501	Valve Float Water 1" MPT	TIGAR25, TIGAR50, TIGAR50FL, TIGAR75, TIGAR100
3	012-4000-0401	Valve Sol NH3 1-1/4"	TIGAR25
3	012-4000-09	Hot Gas Sol Valve NH3	TIGAR25, TIGAR50, TIGAR75, TIGAR100
3	012-4200-1101	2" Sol Valve NH3	TIGAR50, TIGAR75, TIGAR100
3	012-4200-10	1-1/2" Sol Valve NH3	TIGAR 75
4	218-0000-00	16 Pass Evap Plate -131"	TIGAR25, TIGAR50, TIGAR75, TIGAR100
4	218-0000-01	Evap Plate -3E"	TIGAR 3E 20, TIGAR 3E 3E5, TIGAR 3E 5E, TIGAR 3E / 2
5	012-1608-07	1/2" x 3/4" NH3 Relief Valve	All models

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

TIGAR Screw Conveyor Assembly



TIGAR Screw Conveyor Assembly

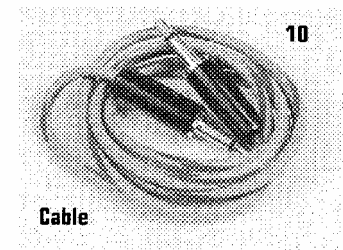
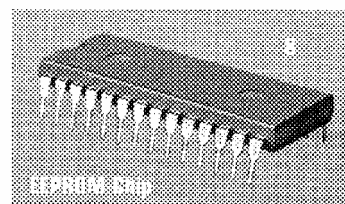
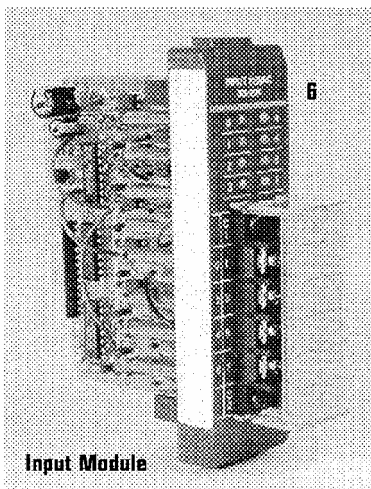
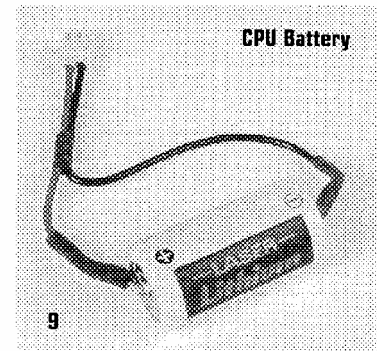
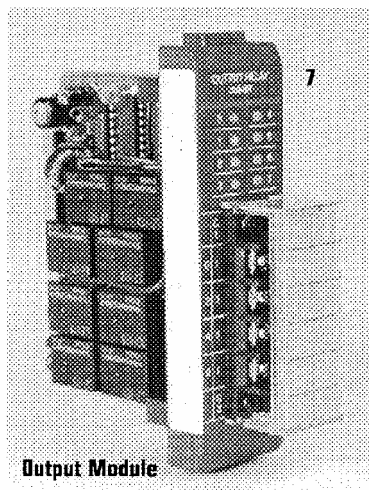
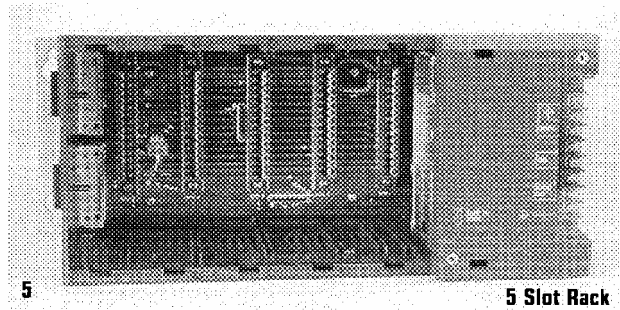
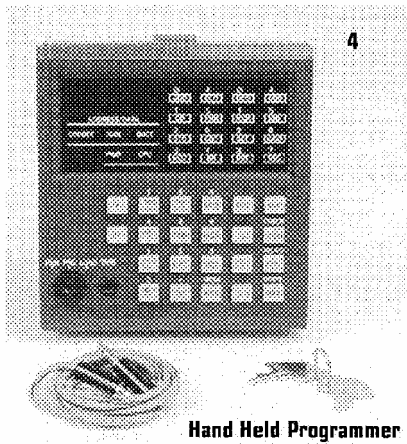
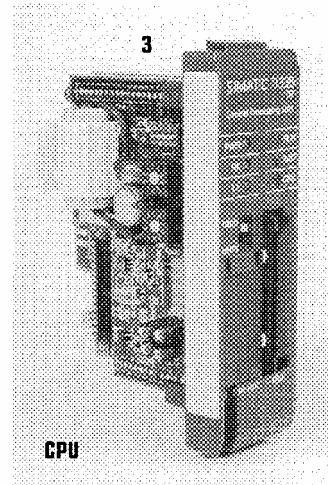
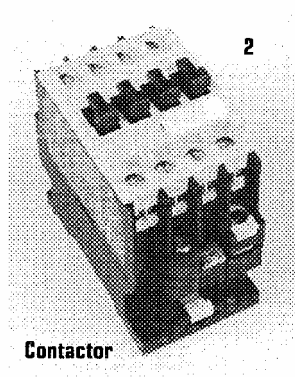
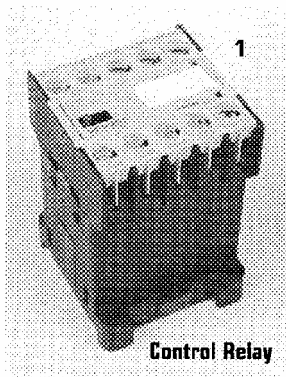
Item	Turbo Part No.	Description	Applications (Models)
1	015-1200-14	7/8" SH Bushing	All TIGAR models
2	015-1300-12	7/8" SDS Bushing	All TIGAR models
3	015-1404-20	4.2 Sheave B-Sec	All TIGAR models
4	015-4108-60	8.6 Sheave B-Sec	All TIGAR models
5	029-0401-20	1-1/2" 4 Bolt Bearing	All TIGAR models
6	032-0400-46	Belt V B46	All TIGAR models
7	034-1700-07	2 HP Motor 1800 RPM Dual Volt	All TIGAR models
8	035-2301-01	Switch Limit 2W814	All TIGAR models
9	052-1001-072502	1-1/2 Gear Reducer	All TIGAR models
10	052-1112-2902	Conveyor Belt Guard	All TIGAR models

Photos are for reference only. Some items are not shown. Phone 800-788-4301 Fax 800-380-3081

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

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

TIGAR Back Plate Assembly



Phone 800-788-4301 Fax 800-380-3081 Photos are for reference only. Some items are not shown.

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

TIGAR Back Plate Assembly

TIGAR Back Plate Assembly

Item	Turbo Part No.	Description	Applications (Models)
1	035-0103-0701	Relay 4 Pole 120 Volt	All models
2	035-0820-009	Contactora 9 Amp 120 Volt	All models
3	080-0000-30	Prog Controller CPU	All models
4	080-0000-31	Hand Held Programmer	All models
5	080-0000-32	5 Slot Rack 115/230 Volt	TIGAR25, TIGAR50,
5	080-0000-33	8 Slot Rack 115/230 Volt	TIGAR75, TIGAR100
6	080-0000-34	8 Point Input Module	All models
7	080-0000-36	8 Point Output Module	All models
8	080-0000-39	EEPROM Chip for CPU	All models
9	080-0000-27	Replacement Battery for CPU	All models
10	080-0000-43	Cable CPU to Hand Held Programmer	All models

Reach Turbo at:

phone: **800-788-4301**
fax: **800-380-3081**
email: kmason@vogtice.com
internet: www.vogtice.com

Photos are for reference only. Some items are not shown

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

TIGAR25

Piping Section Assembly

Item	Turbo Part No.	Description
1	028-0800-01	Water Pump & Motor 1 HP Dual Volt
2	012-2007-0501	Water Float Valve 1" MPT with 10" Rod & 6" Ball
3	012-4000-0401	Valve Sol NH3 S4A-1 1-1/4" Port 120/60
4	012-4000-09	Hot Gas Sol Valve NH3 120/60 Volt
5	021-0507-1101	Regulator Pressure A4AOS 1-1/4" Port 1-1/2" SW Flange
6	021-0512-1000	Pressure Regulator NH3 A4AB-2-2SW 0-150 PSIG 120 Volt
7	012-4501-03	Valve Butterfly 3" Wafer with Act 120/60 Volt
8	018-0000-22	Hot Gas Line Pressure Switch NH3 200 PSI 8 PSI Dif
9	017-0110-33	Hot Gas Line Pressure Gauge NH3 30-300
10	017-0110-40	Gauge Pressure NH3 30-150 3-1/2"
11	218-0000-00	Replacement 16 Pass Evap Plate

Screw Conveyor Assembly

Item	Turbo Part No.	Description
12	015-1200-14	Bushing 7/8" Type SH
13	015-1300-12	Bushing 3/4" Type SDS
14	015-4101-20	Sheave B-Sec 1 Groove 4.2
15	015-4108-60	Sheave B-Sec 1 Groove 8.6
16	029-0401-20	Bearing 4 Bolt 1-1/2" Bore
17	032-0400-46	Belt V B46
18	034-1700-07	Motor TEFC 1800 RPM Tri/Volt 2HP
19	035-2301-01	Limit Switch 2WB14
20	052-1001-072502	Gear Reducer SCXT 125A 1-1/2" 25:1
21	052-1112-2902	Belt Guard Conveyor

Back Plate Assembly

Item	Turbo Part No.	Description
22	035-0103-0701	Relay 4 Pole 120 Volt S&S
23	035-0820-009	Contactors 3 Pole 9 Amp 120 Volt S&S
24	080-0000-30	Prog Controller CPU 3.7K Ram
25	080-0000-31	Prog Controller Hand Held
26	080-0000-32	Prog Controller 5 Slot Rack 115/230 Volt
27	080-0000-34	Prog Controller 8 Point Input Module 115 Volt
28	080-0000-36	Prog Controller 8 Point Output Module 115/230 Volt
29	080-0000-39	Prog Controller EEPROM Chip for CPU
30	080-0000-27	Replacement Battery for CPU
31	080-0000-43	Cable CPU to Hand Held Programmer



Reach Turbo at:

fax: **800-380-3081**

email: kmason@vogtice.com

internet: www.vogtice.com

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TIGAR50

Piping Section Assembly

Item	Turbo Part No.	Description
1	028-0800-01	Water Pump & Motor 1 HP Dual Volt
2	012-2007-0501	Valve Float Water 1" MPT with 10" Rod & 6" Ball
3	012-4000-09	Valve Sol NH3 S6N-3/16-1/4SW 120/60
4	012-4200-1101	Valve Sol NH3 R&S S4A 2SW 2" Port 120/60
5	021-0512-100	Regulator PS NH3 A4AB 2-1/2" P 2-1/2" SW Q-150 PSIG 120/60
6	018-0000-22	Pressure Switch NH3 R&S 10-200 PSI
7	017-0110-33	Gauge Pressure NH3 30-300 3-1/2" R&S
8	017-0110-40	Pressure Gauge NH3 30-150 3-1/2" R&S
9	014-0600-0901	Strainer NH3 RSF-2-1/2" with 2-1/2" SW Flanges
10	218-0000-00	Replacement 16 Pass Evap Plate

Screw Conveyor Assembly

Item	Turbo Part No.	Description
11	015-1200-14	Bushing 7/8" Type SH
12	015-1300-12	Bushing 3/4" Type SDS
13	015-4101-20	Sheave B-Sec 1 Groove 4.2
14	015-4108-60	Sheave B-Sec 1 Groove 8.6
15	029-0401-20	Bearing 4 Bolt 1-1/2" Bore SC
16	032-0400-46	Belt V B46
17	034-1700-07	Motor TEFC 1800 RPM TRI/VLT 2 HP
18	035-2301-01	Limit Switch 2W814
19	052-1001-072502	Gear Reducer SCXT 125A/1 1/2" 25:1
20	052-1112-2902	Conveyor Belt Guard

Back Plate Assembly

Item	Turbo Part No.	Description
21	035-0103-0701	Relay 4 Pole 120 Volt S&S
22	035-0820-009	Contactors 3 Pole 9 Amp 120 Volt S&S
23	080-0000-30	Prog Controller CPU 3.7K RPM
24	080-0000-31	Prog Controller Hand Held
25	080-0000-32	Prog Controller 5 Slot Rack
26	080-0000-34	Prog Controller 8 Point Input Module
27	080-0000-36	Prog Controller 8 Point Output Module
28	080-0000-39	Prog Controller EEPROM Chip for CPU
29	080-0000-27	Replacement Battery for CPU
30	080-0000-43	Cable CPU to Hand Held Programmer

Photos are for reference only. Some items are not shown. Phone 800-788-4301 Fax 800-380-3081

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

TIGAR50FL

Piping Section Assembly

Item	Turbo Part No.	Description
1	028-0800-01	Water Pump & Motor 1 HP 230/460 Scott
2	012-2007-0501	Water Float Valve 1" MPT with 10" Rod & 6" Ball
3	021-0507-1101	Regulator Pressure 4AA 1-1/4" Port 1-1/2" SW Flange
4	012-4501-03	Valve Butterfly 3" Wafer with Actuator 120/60
5	018-0000-22	Pressure Switch NH3 10-200 PSI 8 PSI Dif
6	017-0110-40	Gauge Pressure NH3 30-150 3-1/2" R&S
7	017-0110-33	Pressure Gauge NH3 30-300 3-1/2" R&S
8	2012-1608-07	Valve Relief NH3 1/2" FPT x 3/4" FPT 250 PSI
9	012-1707-03	Valve Relief Dual 3 Way Shut Off 1/2" FPT
10	014-0600-0901	Strainer Std NH3 RSF-2 1/2"
11	218-0000-00	Replacement 16 Pass Evap Plate

Screw Conveyor Assembly

Item	Turbo Part No.	Description
12	015-1200-14	Bushing 7/8" Type SH
13	015-1300-12	Bushing 3/4" Type SDS
14	015-4104-20	Sheave B-Sec 1 Groove 4.2
15	015-4108-60	Sheave B-Sec 1 Groove 8.6
16	029-0401-20	Bearing 4 Bolt 1-1/2" Bore
17	032-0400-46	Belt V B46
18	034-1700-07	Motor TEFC 1800 RPM TRI/VLT 2 HP
19	035-2301-01	Limit Switch 2W814
20	052-1001-072502	Gear Reducer SCXT 125A/1 1/2" 25:1
21	052-1112-2902	Conveyor Belt Guard

Back Plate Assembly

Item	Turbo Part No.	Description
22	035-0103-0701	Relay 4 Pole 120 Volt S&S
23	035-0820-009	Contactors 3 Pole 9 Amp 120 Volt S&S
24	080-0000-30	Prog Control CPU 3.7K Ram
25	080-0000-31	Prog Cntl Hand Held Programmer
26	080-0000-33	Prog Cntl 8 Slot Rack 115/230 Volt
27	080-0000-34	Prog Cntl 8 Point Input Module 115 Volt
28	080-0000-36	Prog Cntl 8 Point Output Module 115/230 Volt
29	080-0000-39	Prog Cntl EEPROM Chip for CPU
30	080-0000-27	Replacement Battery for CPU
32	019-0401-01	Control Temp Penn A19 30-110F
31	080-0000-43	Cable CPU to Hand Held Programmer
33	036-0005-30	Heater Strip 150W 120 Volt

Phone 800-788-4301 Fax 800-380-3081 Photos are for reference only. Some items are not shown.

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

TIGAR75

Piping Section Assembly

Item	Turbo Part No.	Description
1	028-0800-01	Water Pump & Motor 1 HP 230/460 Scott
2	012-2007-0501	Valve Float Water 1" MPT with 10" Rod & 6" Ball
3	012-4200-10	Valve Sol NH3 R&S S4A 1-1/2" SW 1-5/8" Port 120 Volt
4	012-4200-1101	Valve Sol NH3 R&S S4A 2" SW 2" Port 120/60
5	012-4000-09	Valve Sol NH3 S6N 120/60 Volt
6	021-0507-11	Regulator Pressure 1-5/8" A4A 120 Volt
7	021-0507-11	Regulator Pressure 1-5/8" A4A 2" SW Connection 120 Volt
8	021-0512-1001	Regulator Pressure A4A 3-35W 0-150 PSIG 120/60
9	012-4501-04	Valve Butterfly 4" Wafer with Act 120/60 150 NH3 Valve
10	018-0000-22	Pressure Switch NH3 10-200 PSI 8 PSI Dif
11	017-0110-33	Gauge Pressure NH3 30-300 3-1/2" R&S
12	017-0110-40	Gauge Pressure NH3 30-150 3-1/2" R&S
13	012-1608-07	Valve Relief NH3 1/2" FPT-3/4" FPT 250 PSI
14	012-1707-03	Valve Relief Dual 3 Way Shut Off 1/2" FPT
15	014-0600-1401	Strainer NH3 RSF 2" Port 1-1/2" SW
16	218-0000-00	Replacement 16 Pass Evap Plate

Screw Conveyor Assembly

Item	Turbo Part No.	Description
17	015-1200-14	Bushing 7/8" Type SH
18	015-1300-12	Bushing 3/4" Type SDS
19	015-4104-20	Sheave B-Sec 1 Groove 4.2
20	015-4108-60	Sheave B-Sec 1 Groove 8.6
21	029-0401-20	Bearing 4 Bolt 1-1/2" Bore
22	032-0400-46	Belt V B46
23	034-1700-07	Motor TEFC 1800 RPM TRI/VLT 2 HP
24	035-2301-01	Switch Limit 2W814
25	052-1001-072502	Gear Reducer SCXT 125A 1-1/2" 25:1
26	052-1112-2902	Conveyor Belt Guard

Back Plate Assembly

Item	Turbo Part No.	Description
27	035-0103-0701	Relay 4 Pole 3N/O 1N/C 120 Volt S&S
28	035-0820-009	Contactors 3 Pole 9 Amp 120 Volt S&S
29	080-0000-30	Prog Controller CPU 3.7K Ram
30	080-0000-31	Prog Controller Hand Held Prog
31	080-0000-33	Prog Controller 8 Slot Rack 115/230 Volt
32	080-0000-34	Prog Controller 8 Point Input Module 115 Volt
33	080-0000-36	Prog Controller 8 Point Output Module 115/230 Volt
34	080-0000-39	Prog Controller EEPROM Chip for CPU
35	080-0000-27	Replacement Battery for CPU
36	080-0000-43	Cable CPU to Hand Held Programmer

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TIGAR100

Piping Section Assembly

Item	Turbo Part No.	Description
1	028-0800-01	Water Pump & Motor 1 HP 230/460
2	012-2007-0501	Water Float Valve 1" MPT with 10" Rod & 6" Ball
3	012-4200-1101	Valve Sol NH3 R&S S4A 2SW 2" Port 120/60
4	020-0600-01	Hot Gas Sol 5/32" Port 3/8" SW 115/50/60 Volt
5	012-4000-09	Valve Sol NH3 120/60 with Flanges
6	021-0512-1001	Reg Pressure A4A 3SW 0-150 PSIG 120/60
7	018-0000-22	Switch Pressure NH3 10-200 PSI 8 PSI Dif
8	017-0110-40	Pressure Gauge NH3 30-150 3-1/2"
9	017-0110-33	Pressure Gauge NH3 30-300 3-1/2"
10	218-0000-00	Replacement 16 Pass Evap Plate

Screw Conveyor Parts

Item	Turbo Part No.	Description
11	015-1200-14	Bushing 7/8" Type SH
12	015-1300-12	Bushing 3/4" Type SDS
13	015-4104-20	Sheave B-Sec 1 Groove 4.2
14	015-4108-60	Sheave B-Sec 1 Groove 8.6
15	029-0401-20	Bearing 4 Bolt 1-1/2" Bore
16	032-0400-46	Belt V B46
17	034-1700-07	Motor TEFC 1800RPM TRI/VLT 2 HP
18	035-2301-01	Limit Switch 2W814
19	052-1001-072502	Gear Reducer SCX 125A/1 1/2" 25:1
20	052-1112-2902	Conveyor Belt Guard

Back Plate Assembly

Item	Turbo Part No.	Description
21	035-0103-0701	Relay 4 Pole 3N/O 1N/C 120 Volt S&S
22	035-0820-009	Contactors 3 Pole 9 Amp 120 Volt S&S
23	080-0000-30	Prog Cntl CPU 3.7K Ram
24	080-0000-31	Prog Cntl Hand Held Programmer
25	080-0000-33	Prog Cntl 8 Slot Rack 115/230 Volt
26	080-0000-34	Prog Cntl 8 Point Input Module 115 Volt
27	080-0000-36	Prog Cntl 8 Point Output Module 115/230 Volt
28	080-0000-39	Prog Cntl EEPROM Chip for CPU
29	080-0000-27	Replacement Battery for CPU
30	080-0000-43	Cable CPU to Hand Held Programmer



Reach Turbo at:

fax: **800-380-3081**
 email: kmason@vogtice.com
 internet: www.vogtice.com

Photos are for reference only. Some items are not shown

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TIGAR Ice Generator Operation & Maintenance Manual

OPTIONAL FEATURES & ACCESSORIES

You can maximize your TIGAR system's operating potential by adding optional features and accessories. If you would like more details about the options listed below, contact:

**Turbo Refrigerating
Sales Department
P.O. Box 396
Denton, Texas 76202-0396
Phone: 940-387-4301
Fax: 940-382-0364**

Winterizing

When TIGAR units are installed in an area where the ambient temperature falls below freezing, precautionary measures need to be provided to prevent freeze-up of the water pump and water circulating tank.

- When the ambient temperature is below 0°F, insulated lower panels and an electric forced air heater can be furnished to maintain the evaporator cabinet above freezing.
- When the ambient is between 0°F and +32°F, an electric forced air heater can be furnished.

The electric heaters are factory installed in the lower section of the TIGAR unit and are thermostatically controlled.

Draining

For long periods of down time during low or below freezing ambient temperatures, drain the water pump, water tank, and water cooled condenser.

One-quarter (1/4) inch 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:

- Remote water storage tanks if applicable.
- Piping

Water Lines

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. All exposed water lines should be properly

insulated by others when the unit is installed.

Electrical

The magnetic contactor for the optional electric resistance heater is installed in the control panel and is pre-wired. Fused disconnects or branch circuit breakers are furnished by others to provide circuit protection in accordance with local or state codes and regulations.

The heater consists of a three-phase electric heater with a single-phase fan motor. Each heater has a built-in overheat thermostat. Full load amps for the heater element and heater fan are provided for each installation.

Controls

The optional winterizing heater contactor is controlled by an adjustable thermostat located in the lower section of the TIGAR unit and is pre-wired.

As the cabinet interior temperature drops below the set-point, a set of thermostat contacts close to energize the

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heater contactor. When the interior temperature rises above the differential of the thermostat, the contacts open to de-energize the heater contactors. This ensures that the engine compartment interior and the equipment located inside will be maintained above freezing.

Automatic Ice Generator Shut Off for Bin Full - Bin-O-Matic Controls

When the ice generator is used in conjunction with a storage bin, an automatic means of shutting off the ice generator when the bin or delivery point is full should be provided. This will ensure that the ice generator is not accidentally left on, resulting in production delay or overloading the system, and/or causing damage to the equipment. Such a system allows the unit to be operated until the bin is full without having someone at the switch to shut the unit off when the storage bin is full.

Controls for the Bin-O-Matic

The Controls consist of a motorized paddle switch mounted in the storage bin. A set of N.C. (normally closed) contacts of the switch are connected in series with the MCS (master control switch) of the TIGAR unit. All wiring and installation must be done in the field. Guidelines

for installing the Bin-O-Matic Controls and a wiring schematic are provided with each kit. All wiring/wiring connections and conduit/conduit connections are provided by others.

Specifications

Voltage
115/1/60
27 watts

Physical Dimensions
7" x 12 3/4"

Aluminum Housing
Dust tight
7 1/2 pounds
KA model: U/L and
CSA listed

Compressors

All self-contained TIGAR units are equipped with either open reciprocating compressor(s) directly coupled to an open, drip-proof motor, a belt driven open compressor(s), or screw compressor(s). The selection is based on the best fit for the load and application. This motor is suitable to handle the refrigeration load required to make rated capacity.

Open Drive Compressors

Open drive compressors direct coupled to the drive motor are used for applications below 250 horsepower in either

single or dual compressor arrangements. These packages operate at 1750 RPM and can be easily serviced in the field. A minimum of space is required and the controls are simple.

Belt Driven Compressor

Compressors can be provided with a belt drive upon request. Such arrangements may require additional space or modifications of the unit structural base frame. Data sheets are provided on special models provided with belt driven open compressors. Belt driven compressors have the following features:

- Reduces operating speed to increase life of components (requires oversize compressor).
- Reduces noise if run at reduced speed (requires oversize compressor).
- Matches compressor with evaporator load to obtain proper operating conditions.
- Provides rated capacity when operated in 50 HZ system (i.e., at 50 HZ, 1750 RPM motor runs at 1450 RPM; therefore, a belt drive is

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required to obtain rated capacity at 1750 RPM).

- Obtains additional compressor capacity from oversized compressor without using oversized motor required at higher RPM.

Example

If the TIGAR requires 24.3 tons of refrigeration to produce rated capacity using an open compressor at 1750 RPM. The next larger size compressor can be belt driven at 1312 RPM to obtain the same capacity or at 1450 RPM for additional compressor capacity and ice production. The lower RPM should extend the compressor life by reducing wear. For a 50 hertz application, the standard compressor can be belt driven to obtain 1750 RPM and the same capacity as a direct drive at 60 hertz operation.

Screw Compressors

For applications requiring more than 250 horsepower for the compressor input a screw compressor is typically used. The screw operates at 3600 RPM. All screw compressor packages include the microprocessor panel for complete control of the screw compressor operation.

Common Structural Base

The motor, compressor, motor adjusting base, motor sheave, compressor flywheel, belts, and belt guard are all mounted on a common motor/compressor structural base suitable for the load. Drive speed is selected to match the evaporator load and application. The high side structure is typically separate from the low side evaporator assembly but in some cases can be mounted on the same structural base as the ice generator. On packages above 250 horsepower, the high side may be too large to mount on a common base with the evaporator without special permitting for transportation to the job site.

Water –Cooled Condensing systems

A high side supplied with water-cooled condensing will consist of the following:

Water Cooled Condenser

TIGAR SC models are furnished with a shell-and-tube water cooled condenser. SC design conditions are:

- 85°F water entering the condenser
- 95°F water leaving
- 105°F SDT (saturated discharge temperature) (210 PSIG)

To maintain these conditions, the condenser must be sized to reject the total heat of rejection

of the system. Other components of the water-cooled condenser are:

- **Cooling Tower - Control of Water Temperature and Flow**

A means of controlling the water temperature and water flow must be provided. A cooling tower and cooling tower pump provide the means of pumping the water to the condenser and removing the heat absorbed by the water as it flows through the condenser.

The heat rejected to the water flowing through a water cooled condenser must be either removed before the water is recirculated to the condenser or the water must be dumped. If the heat is not removed, the water temperature will continue to rise, resulting in high discharge pressure. Dumping the water (i.e., one time through the condenser) is not economical in most cases. Therefore, a means of removing the heat from the water before it is recirculated must be provided.

A cooling tower provides a system through which the returning water flows over a wet deck surface

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and fans circulate air to remove the heat from the water. Eliminators are provided on the air discharge to eliminate entrained water from the air stream.

As water in the cooling tower evaporates to release the heat from the condenser, some water is lost. A float valve is provided in the cooling tower sump to replace the water lost. Field piping to the make-up water connection is required.

Since evaporation of the returning water is required to remove the heat, cooling tower selections are based on the THR (total heat rejection) and the design wet bulb temperature. As the wet bulb increases, additional surface (larger cooling towers) is required to handle the same THR (i.e., higher wet bulb temperatures suppress the ability of the surrounding environment to absorb additional moisture).

Installation Guidelines

Cooling towers can be mounted indoors or outdoors. Outdoor installations may require sump heaters and other protection from icing or the sump may be located indoors. Indoor

installations require inlet and outlet ducts.

Cooling towers provided by TURBO 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.

Motor starters for fan(s) are not included with the cooling tower.

- **Cooling Tower Pump**

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 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
- 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 (20) feet 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.

Motor starters or controls are not included with the pump.

- **Water Regulating Valve - Control of Water Flow Rate**

Water regulating valves are required on any system with a varying load to maintain a constant discharge pressure as well as to

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prevent the discharge from dropping below factory specifications (170 PSIG).

As the load increases, the flow through the condenser must increase. Conversely, as the load decreases, the water flow must decrease.

To accomplish this, pressure actuated water regulating valves can be provided by TURBO. A pressure line connected to the discharge line senses increases and decreases in the discharge pressure. This pressure modulates the piston in the regulating valve to increase or decrease the flow as required.

These water regulating valves are sized to handle maximum water flow rate without an excessive pressure drop through the regulating valve.

Each valve has an adjusting stem to raise or lower the pressure setting. On larger units, a two valve set is provided with inlet and outlet manifolds for connection to the outlet water line of the condenser.

In parallel compressor operations, temperature actuated valves are sometimes used in place

of the pressure actuated valves.

Air Cooled Condenser

SCA (self-contained air cooled) models are supplied factory piped and wired with an air cooled condenser to remove the THR (total heat rejection) of the system. SCAR (self-contained air cooled remote) models are shipped without the condenser, which is field piped and wired.

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
- 120°F saturated condensing temperature (260 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), inlet and outlet isolation valves, high pressure relief valve, and receiver mounting brackets can be provided as options by TURBO.

Winterizing of the receiver is recommended for installations operating in ambient conditions below 20°F.

Control of the airflow can be accomplished several ways (refer to Head Pressure Controls).

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 models are shipped with a refrigerant holding charge only. All refrigerant and refrigerant charging is by others. Typical air-cooled systems consist of:

- **Air Cooled Condenser Head Pressure Controls**

Air cooled condensers require some means of varying the airflow over the condenser coil in response to increases and decreases in the refrigeration system loading. Several methods are available from TURBO. The standard controls consist of the use of flood-back controls in conjunction with fan cycling. A valve set (3 valves) can be provided to stack liquid in the condenser coil and control receiver pressure during operation in low ambient (below 40°F) or during start up in cool weather. Pressure

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switches are provided to cycle the fan or fans off in response to:

- Low discharge pressure due to abnormal operating conditions
- Low pressure due to the harvest sequence

Damper controls are not recommended for TIGAR units because of the operating sequence of these units and the slow response time of damper controls.

Other methods of discharge pressure control include:

- Variable speed motor controllers (VSM)
- Multi-speed fans

In general, systems supplied with flood-back controls require a larger receiver and refrigerant charge. VSM controls and multi-speed fans both reduce the receiver size and refrigerant charge by reducing the CFM of the system to match the load (thus eliminating the need to flood the condenser coil).

VSM controls provide a uniform control of the airflow over a wide range (i.e., step less control), from 0 to 100%, thus eliminating the sudden increase and decrease of airflow associated with fan cycling.

Multi-speed motors provide airflow control over a more limited range but greatly reduce the number of steps in airflow

reduction associated with fan cycling.

Motor starters for fan motors are not provided with air cooled condensers or head pressure controls. If VSM controls are specified, a magnetic starter(s) is not required (i.e., it is an integral part of VSM controls).

• Receiver

SCA and SCE models are furnished with factory installed receivers and receiver piping. Air cooled and evaporative cooled condensers for SCER and SCAR models are shipped without the receiver and condenser piped and wired. For SCAR and SCER models field installation of the wiring and piping is required.

The receivers supplied with these systems are sized to hold the total refrigerant charge of the system during pump down. Receiver sizing is based on the:

- Operating charge of the evaporator
- Operating charge of the condenser
- Receiver liquid seal
- Flood-back refrigerant charge, if required

Items supplied with receiver:

- Receiver inlet and outlet isolation valves
- High pressure relief valve – typical dual relief valves with three-way valve
- Receiver mounting brackets

Winterizing of the receiver for operation in ambient conditions below 20°F is not provided but is recommended to ensure adequate system pressure during equipment start-up.

Refrigerant charge is not furnished with the receiver.

Evaporative Condenser

SCE models are furnished with an evaporative condenser and receiver mounted on the frame with the evaporator. All piping and wiring is provided. On SCER models, the evaporative condenser is field installed. All piping and wiring from the condenser to the refrigeration high side is provided by others for the SCER model.

Optional evaporative condensers are sized to handle the THR (total heat 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 to prevent excessively

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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.

A typical evaporative condenser system consists of:

- Properly sized receiver(s)
- Receiver inlet and outlet connection isolation valves
- High pressure relief valve
- Receiver mounting brackets
- Receiver winterizing (recommended for installations operating in ambient conditions below 20°F)
- Motor starters for fan(s) and water pumps (not included with the evaporative condenser)

Other components of the system are:

- **Make-Up Water Float Valve**

As water in the evaporative condenser evaporates to release the heat from the condenser, some water is lost. A float valve is provided in the evaporative condenser sump to replace

the lost water. Field piping to the make-up water connection is required.

Since the evaporation of the recirculated water is required to remove the heat, evaporative condenser selections are based on the THR (total heat rejection), and the design wet bulb temperature. As the wet bulb increases, additional surface (larger evaporative condenser) is required to handle the same THR (i.e., higher wet bulb temperatures suppress the ability of the surrounding environment to absorb the additional moisture).

- **Installation Guidelines**

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.

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 models are shipped with a refrigerant holding charge only. All refrigerant and refrigerant charging is by others.

Head pressure controls are available to control the

airflow over the condenser coil (refer to Head Pressure Controls).

Air Intake and 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.

- **Head Pressure Controls**

Evaporative cooled condensers require some means of varying the airflow over the condenser coil in response to increases and decreases in the refrigeration system loading. Several methods are available from TURBO.

The standard controls consist of the use of flood-back controls in conjunction with fan cycling. A set of three (3) valves can be provided to stack liquid in the condenser coil and control receiver pressure during operation in low ambient (below 40°F). Pressure switches are also provided to cycle the fan or fans off in response to low discharge pressure due to abnormal operating conditions or low pressure

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due to the harvest sequence.

Damper controls are not recommended for TIGAR units because of the operating sequence of these units and the slow response time of damper controls.

The water pump is not cycled to control discharge pressure. Cycling causes scaling of the coil surface, due to repeated wetting and drying of the coil.

Other methods of discharge pressure control include:

- Variable speed motor controllers (VSM)
- Multi-speed fans

Systems supplied with flood-back controls require a larger receiver and refrigerant charge. VSM controls and multi-speed fans both reduce the receiver size and refrigerant charge by reducing the CFM of the condenser to match the load (thus eliminating the need to flood the condenser coil).

VSM controls provide a uniform control of the airflow over a wide range (i.e., step less control), from 0 to 100%, thus eliminating the sudden increase and decrease of airflow associated with fan cycling.

Multi-speed motors provide airflow control over a more limited range but greatly reduce the number of steps in airflow reduction associated with fan cycling.

If VSM controls are specified, a magnetic starter(s) is not required since it is an integral part of the VSM controls.

Stainless Steel Auger and Discharge Trough – Standard Feature after 1999

TIGAR units are provided with a hot-dip galvanized harvest auger and discharge trough to discharge the ice from the unit during harvest. The auger trough, located inside the unit, is perforated stainless steel. All components in contact with the ice are either stainless steel or hot-dip galvanized to provide corrosion protection.

In some applications, a higher degree of corrosion protection may be required. A stainless steel auger and discharge trough can be provided for all areas in contact with the ice.

Existing units can be field modified to include the stainless steel auger and discharge trough.

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