



**Chiller Manual
Installation, Operation
& Maintenance**

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Chiller Manual Installation, Operation & Maintenance

INTRODUCTION

Turbo Refrigerating is a supplier of fluid chillers, icemaking, and ice storage equipment. TURBO® does not engineer or design fluid chilling systems, ice systems, ice plants, or processing lines. TURBO can provide assistance in locating qualified companies familiar with the installation and operation of TURBO chillers. Contact the factory at the address or telephone numbers listed at the end of this section.

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

You must read all of the information carefully and make sure that all personnel involved in the installation have also read and understood the information and safety instructions. This

will help avoid injury to personnel and/or damage to the equipment. Both are valuable assets to your operation. Take the time to protect them.

Read the manual contents before you start your installation or operation. This will save time by ensuring that all necessary materials and tools are available when the equipment arrives.

History

TURBO has been producing a line of fluid chillers since 1984 equipment as well as icemakers and ice generators for the ice industry since 1960. The chillers described in this manual are part of a family of products designed specifically for the industrial market for a variety of cooling needs.

Fluid Heat Exchangers

HTD and HF series heat exchangers are designed to instantaneously chill fluids

falling over vertical stainless steel plates in a thin falling film. Because of method of chilling the liquid heat exchangers are often referred to as falling film chillers.

HTD Series

HTD stands for High Temperature Difference. Fluids are chilled or heated over large temperature differences, ranging from 5°F to 60°F in a single pass using R-22, ammonia or glycol as the refrigerant inside the plate. Systems are available in direct expansion (DX), flooded and recirculated models. Flow rates are available over a wide range but are typical considered relatively low. Higher flow rates can be obtained with HF chillers.

HF Chillers

HF stands for High Flow. Fluids are chilled over narrow temperature differences, ranging from 1°F to 2°F. The plate's long narrow geometry enables high fluid flow over the

Read Safety Section before installing or using equipment

plate. Ammonia, R-22 and glycol are all available for use in direct expansion, flooded and recirculated systems.

Applications

HTD/HF chillers are suitable for a variety of applications including:

- Food
- Beverage
- Chemical
- Manufacturing

Models

A number of standard and special chiller plates are available in a variety of configurations to meet many applications. Standard plate sizes include:

- 48" x 60"
- 72" x 60"
- 96" x 60"
- 144" x 24"

Refrigerants/Refrigerant Feed

Chillers are available in R-22, ammonia, and glycol with direct expansion (DX), flooded, and recirculated refrigerant feed. Chillers can be furnished with their own high side and condensing unit or connected to existing refrigeration systems.

Associated Equipment

Icemakers/Ice Generators

TURBO® C-Line

Icemakers

Packaged ice applications require a dry sub-cooled ice

and uniform fragmented nuggets. TURBO has produced the C-line icemaker since 1964. This product line uses a water defrost to produce ice in capacities ranging from 1 ton per dry to 200 tons per day in CAR and CAR-LR (ammonia) and CF (R-22) models.

TURBO® TIG/TIGAR Ice Generators

In industrial applications where ice is being used for processing or for top icing, TURBO produces a series of wet ice generators called the TIG (R-22) and TIGAR (NH3) series. These hot gas defrost icemakers are built with the same high quality standards and engineering as the TURBO® icemakers of the sixties. The only difference is that the icemaking process produces slightly wetter ices due to the hot gas defrost, and the standard system used to produce dry, uniform ice nuggets is eliminated. As a result, a random shaped piece of fragmented ice is produced at a lower cost per ton.

In applications where totally dry, uniform ice is not required; the TIG/TIGAR series offers a low cost alternative.

Typical Applications

- Produce (broccoli, carrots, etc.) – top icing in

the field (trailer mounted units) or in the processing area

- Concrete icing
- Ingredient icing (bakeries)
- Fish icing
- Poultry icing
- Chemical and dye processes
- Emergency cooling loads
- Ice slurries
- Catering trucks
- Salad bars or display ice
- Food processing

Ice Storage Systems

TURBO® rakes and storage bins were introduced in 1967. There are three basic sizes in the hydraulic version as well as two larger versions known as automatic ice rakes (described in this manual). The smaller hydraulic models range in capacity from 20 to 87 tons while the larger automatic ice rakes range from 100 to 300 tons of ice storage. TURBO rakes have been used in USDA inspected installations.

USDA Design

All TURBO® ice storage systems are designed to meet USDA guidelines and meet rugged industrial standards which make them the most reliable in the industry. Each system is designed to make the loading and unloading of the ice storage system as

safe and simple as possible. Regardless of size, all of the ice storage systems operate in basically the same simple yet reliable manner.

The entire load and unload sequence is automatic and does not require the operator to be in contact with the ice or any moving parts in the ice storage system.

The continuous presence of an operator is not required although it is recommended. At the end of the day, the bin is empty (on a design day). The bin refills overnight and is full when personnel return to work.

NOTE: All controls are adjustable to allow the load or unload rate to match the customer's production and/or delivery requirements.

Rake Variations

CB and Automatic rakes are available in a number of standard sizes to accommodate bulk storage capacities ranging from 20 tons to 400 tons. Models are available in standard 10', 12'-6", 15' and 20' widths; 20' to 55' length; heights from 9' to 25' making it possible to produce a variety of standard capacities.

Optional Rake Features

Although TURBO designs and builds the ice storage system to be as flexible as possible, the standard system may not meet a particular application. TURBO can design a storage system to meet almost any need.

TURBO® Block Press

TURBO offers another feature to make optimum profits from your ice production. Instead of throwing away the snow produced by the breaker bar, ice sizer, screw conveyors, or other handling devices, install a TURBO® block press. This block press converts the snow into ten or fifty-five pound blocks of ice.

Introduced in 1977, the block press is a completely automatic, hydraulic powered unit capable of producing from 120 to an excess of 400 ten pound blocks per hour.

The block press is available with a block bagger attachment, which means:

- Eliminates handling until the block is in the bag
- A better product
- Higher profits

Rugged industrial construction and stainless steel or UHMW in all areas of ice contact make the

TURBO® block press the most reliable on the market.

Special Applications

TURBO is in the business of supplying equipment to meet the needs of the customer. If you have an application or a need that is not discussed here, contact:

Turbo Refrigerating, LLC Sales Department

P.O. Box 396

Denton, Texas 76202-0396

Phone: 940-387-4301

Fax: 940-382-0364

Web Site:

WWW.vogtice.com

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.

NOTE: 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.

Read Safety Section before installing or using equipment

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.

(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:

Read Safety Section before installing or using equipment

Exclusions: Limitation of Liability

(a) LIMITED WARRANTY

The Company warrants that at the time of shipment the Equipment manufactured by it shall be merchantable, free from defects in material and workmanship and shall possess the characteristics represented in writing by the Company. The Company's warranty is conditioned upon the Equipment being properly installed and maintained and operated within the Equipment's capacity under normal load conditions with competent supervised operators and, if the Equipment uses water, with proper water conditioning. Equipment, accessories and other parts and components not manufactured by the Company are warranted only to the extent of and by the original manufacturer's warranty to the Company, in no event shall such other manufacturer's warranty create any more extensive warranty obligations of the Company to the Buyer than the Company's warranty covering Equipment manufactured by the Company.

(b) EXCLUSIONS FROM WARRANTY

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

(ii) The Company's warranty is solely as stated in (a) above and does not apply or extend, for example, to expendable items, ordinary wear and tear, altered units; units repaired by persons not expressly approved by the Company, materials not of the Company's manufacture, or damage caused by accident, the elements, abuse, misuse, temporary heat, over-

loading, or by erosive or corrosive substances or by the alien presence of oil, grease, scale, deposits or other contaminants in the Equipment.

(c) WARRANTY ADJUSTMENT

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

returning the Equipment or any part or parts will not be reimbursed by the Company.

(d) SPARE AND REPLACEMENT PARTS WARRANTY ADJUSTMENT

The Company sells spare and replacement parts. This subparagraph (d) is the Warranty Adjustment for such parts. Buyer must make claim of any breach of any spare or replacement parts warranty by written notice to the Company's home office within thirty (30) days of the discovery of any alleged defect for all such parts manufactured by the Company. The Company agrees at its option to repair or replace, BUT NOT INSTALL, F.O.B. Company's plant, any part or parts of material it manufactures which, within one (1) year from the date of shipment shall prove to the Company's satisfactory (including return to the Company's plant, transportation prepaid, for inspection, if required by the Company) to be defective within this Parts Warranty. The Warranty and warranty period for spare and replacement parts not manufactured by the Company (purchased by the Company, from third party suppliers) shall be limited to

the Warranty and Warranty Adjustment extended to the Company by the original manufacturer of such parts, in no event shall such other manufacturer's warranty create any more extensive warranty obligation of the Company to the Buyer for such parts than the Company's Warranty Adjustment covering parts manufactured by the Company as set forth in this subparagraph (d). Expenses incurred by the Buyer in replacing, repairing, or returning the spare or replacements parts will not be reimbursed by the Company.

(e) LIMITATION OF LIABILITY

The above Warranty Adjustment sets forth Buyer's exclusive remedy and the extent of the Company's liability for breach of implied (if any) and express warranties, representations, instructions or defects from any cause in connection with the sale or use of the Equipment. THE COMPANY SHALL NOT BE LIABLE FOR ANY SPECIAL, INDIRECT OR CONSEQUENTIAL DAMAGES OR FOR LOSS, DAMAGE OR EXPENSE, DIRECTLY OR INDIRECTLY ARISING FROM THE USE OF THE EQUIPMENT OR FROM

ANY OTHER CAUSE WHETHER BASED ON WARRANTY (EXPRESS OR IMPLIED) OR TORT OR CONTRACT, and regardless of any advices or recommendations that may have been rendered concerning the purchase, installation or use of the Equipment.

5. Patents

(a) PATENT INDEMNITY AND CONDITIONS

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

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Company's incorporating a design or modification requested by Buyer.

(b) LIMITATION OF LIABILITY

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

6. Prior Use

If damage to the Equipment or other property or injury to persons is caused by use or operation of the Equipment prior to being placed in initial operation ("Start up") by the Company where start up is

included in the purchase price, then Buyer shall indemnify and hold the Company harmless from all liability, costs and expenses for all such damage or injury.

7. Equipment Changes

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

8. Security Interest Insurance

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

fails to comply with any and all provisions of this contract, the Company shall have the remedies available under the Uniform Commercial Code.

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

9. Cancellation

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

10. Loss, Damage or Delay

The Company shall not be liable for loss, damage or delay resulting from causes beyond its reasonable control or caused by strikes or labor difficulties, lockouts, acts or omissions of any governmental authority or the Buyer, insurrection or riot, war, fires, floods, Acts of God, breakdown of essential machinery, accidents,

priorities or embargoes, car and material shortages, delays in transportation or inability to obtain labor, materials or parts from usual sources. In the event of any delay from such sources, performance will be postponed by such length of time as may be reasonably necessary to compensate for the delay. In the event performance by the Company of this agreement cannot be accomplished by the Company due to any action of governmental agencies, or any laws, rules or regulations of the United States Government, the Company (at its option) may cancel this agreement without liability. In no event shall the Company be liable for any loss or damage of any kind, including consequential or special damages of any nature.

**11. Work By Others:
Accessory and Safety
Devices**

The Company, being only a supplier of the Equipment, shall have no responsibility for labor or work of any nature relating to the installation or operation or use of the Equipment, all of which shall be performed by Buyer or others. It is the responsibility of Buyer to furnish such accessory and safety devices as may be

desired by it and/or required by law or OSHA standards respecting Buyer's use of the Equipment. Buyer shall be responsible for ascertaining that the Equipment is installed and operated in accordance with all code requirements and other applicable laws, rules, regulations and ordinances.

12. Complete Agreement

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

condition or any of the Company's rights.

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



Chiller Generator Operation & Maintenance Manual

Section 2: 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 chiller, equipment installed with the chiller, and on access panels should be followed. They are shown in Figures 2-1, and 2-2.

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Figure 2-1 Warning Labels on Control Panels



Figure 2-2 Warning Label on Access Panels

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**

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

Involve Your People

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

- Warn them of the danger of miscommunication.
- Turn electricity off and lock it out when working on the chiller.
- 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.

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.

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 suitable for stainless steel. Follow instructions and warnings supplied by the manufacturer of the cleaning agents.

Never open the control panel (by others unless otherwise specified) without disconnecting and locking out electrical service. All electrical work should be performed by a qualified electrician.

When servicing the chiller TURBO recommends that at least two (2) people be present at all times.

If an outside contractor is required to install or service your chiller, 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 refrigerant 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 refrigerant relief valve vent lines must be routed to a safe discharge location having adequate ventilation to dissipate refrigerant discharged

through the relief system. Consideration should be given to prevailing winds to ensure that refrigerant releases are not carried to or trapped in occupied areas. 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.

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 refrigeration system. Fire department personnel should be familiarized with the refrigeration system, including the location of isolation valves and controls for terminating operation of 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

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

escaping refrigerant would prevent access.

All leaks should be reported and repaired immediately.

Each pressure vessel (if supplied) is equipped with a safety relief valve to prevent operation over design limits. Smaller models use a single relief valve. Larger models use dual safety relief type valves 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 refrigeration system safety may be obtained through International Institute of Ammonia Refrigeration (IIAR) for ammonia systems, Refrigerating Engineers and Technicians Association (RETA) for Freon systems, or American Society of Heating,

Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE) bulletin ANSI/ASHRAE 15-1994 – "Safety code for Mechanical Refrigeration".

To request information contact RETA at:

Refrigerating Engineers and Technicians Association
4700 West Lake Avenue
Glenview, Ill.60025-1485
Phone: 847-375-4738
Fax: 847-375-6338
E-mail: info@reta.com

Contact IIAR at:

International Institute of Ammonia Refrigeration
1100 North Glebe Road
Arlington, VA 22201
Phone: 703-312-4200
Fax: 703-312-0065
E-mail: <http://www.iiar.org>

Contact ASHRAE at:

American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.
1791 Tullie Circle, N.E.
Atlanta, GA 30329
Phone: 404-636-8400
Web: <http://www.ashrae.org>

Notes:

1. Per the OSHA Hazard Communication Standard, material safety data sheets for refrigerants and refrigerant oils are on pages 2-9 through 2-16.

2. The safety lockout procedure is on pages 2-9 through 2-11.

Checklist for Lock Out Of Controls-By others unless otherwise specified

To lock out the chiller 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-By others unless otherwise specified

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.

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.

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

2. When working with electrical equipment where the accidental starting of such equipment or release of 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.

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

VIII. Failure to Follow Procedures

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

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

Material Safety Data Sheets (MSDS)

Material Safety Data Sheets (MSDS) are provided for all refrigerants (ammonia, Freon, glycol, refrigerant oils) typically used in chiller applications.

See MSDS sheets attached for details.

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

Material Safety Data Sheet for Freon

A. General Information

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

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

CHEMICAL NAME: Chlorodifluoromethane or monochlorodifluoromethane

FORMULA: CHClF_2

MANUFACTURER'S ADDRESS: (MAILING) (LOCATION)

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

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

CONTACT: (316) 524-3245 or (800) 835-2916

ISSUE DATE: 11/18/85
REVISED DATE:

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

B. First Aid Measures

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

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

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

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

C. Hazards Information

TOXICITY AND HEALTH

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

ACUTE EXPOSURE EFFECTS:

Inhalation --- CFC-22 is relatively non-toxic following acute exposure. Although no long-term comprehensive studies have specifically investigated acute overexposure of humans to CFC-22, experience indicates the cardiovascular and respiratory systems are the primary systems affected. Abuse (intentional inhalation) has caused death. Human exposure to high concentrations (e.g. 20%) may cause confusion, lung (respiratory) irritation, tremors and perhaps coma, but these effects are generally short lived and reversible without late aftereffects when removed to fresh air. LC₅₀ values for rats and mice range from 277,000 to 390,000ppm(vol) over varying time periods of 15 minutes to 2 hours. High atmospheric concentrations of CFC-22 produce stimulation and then depression and finally asphyxiation.

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

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

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

SUBCHRONIC/CHRONIC EXPOSURE EFFECTS:

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

CARDIAC STUDIES:

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

CARCINOGENIC POTENTIAL:

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

TERATOGENIC POTENTIAL:

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

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

FIRE AND EXPLOSION

Nonflammable and nonexplosive. One documented incident has been reported where an explosion occurred during the weld repair of a compressor shell which apparently contained a 50:50 mixture of air and CFC-22. At high temperatures (1170° F, 632° C) under favorable laboratory conditions, CFC-22 is capable of forming weakly combustible mixtures with air. Formation of combustible mixtures, under practical conditions, even at higher temperatures, is extremely unlikely and the fire hazards of CFC-22 are very small.

D. Precautions/Procedures

Do not breathe vapors. Avoid contact with eyes, skin and clothing. Wear protective clothing including goggles and cloth-lined rubber gloves. Not for food, drug or cosmetic use.

Store and use with adequate ventilation. Never use in a closed or confined space. Local exhaust may be necessary to reduce concentrations below TLV (1,000ppm). Store in cool place (<120° F).

When fighting fire near or involving this product, use self-contained breathing apparatus. If CFC-22 contacts open flames or extremely hot metal surfaces, it may decompose to form HF, HCl and traces of carbonyl halides (i.e., phosgene).

In the event of a spill or leak, keep upwind. Ventilate enclosed spaces until gas is dispersed. Do not smoke or operate internal combustion engines in immediate vicinity.

CFC-22 is shipped and stored as a liquefied, compressed gas under pressure.

E. Personal Protective Equipment

Respiratory protection is not needed if concentrations are controlled. If concentrations exceed TLV (1,000ppm), use an approved respirator for organic vapors. In very high concentrations, self-contained breathing equipment should be used.

Protective clothing should minimize exposed skin and include goggles, a full face shield if splashing is possible, and cloth-lined rubber gloves.

F. Physical Data

CFC-22 is a gas at normal conditions of 77° F (25° C) and 1 atm.

Molecular weight 86.5

Boiling Point (1 atm) -41.4° F (-40.8° C)

Vapor pressure @ 77° F (25° C) is 136.7 psig

Vapor density is 2.76 lb/ft³ @ 77° F

Specific gravity of vapor (air = 1) 3.08 @ 1 atm and 77° F

Specific gravity of liquid (water = 1) 1.20 @ 77° F

% volatile @ 77° F and 1 atm 100% (vol)

Solubility in water (% wt) 3 gm/l

Soluble in acetone, ethanol and chloroform

Appearance --- colorless liquid and vapor

Odor --- very slight ethereal odor to odorless

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

G. Reactivity

CFC-22 is stable and relatively nonreactive. It is incompatible with certain elastomers, alkali or alkaline earth metals, powdered aluminum, zinc, beryllium, etc. The Manufacturing Chemists Association (MCA) reported, 1/4/67, that industry experience shows that alkali and alkaline earth metals (i.e., sodium, potassium and barium) in their free metallic form may react violently with fluorocarbons. The MCA also noted that since materials become more reactive when finely ground, metals such as magnesium and aluminum in the powdered form may also react, especially at high temperatures. CFC-22 may decompose into HF, HCl and carbonyl halides (i.e., phosgene) if contacted with open flame or extremely hot metal surfaces.

H. Environmental

No information found.

Disposal of waste material or residue may be subject to Federal, State or Local regulation. Consult with appropriate regulatory agency before discharging or disposing of waste material. Before transporting waste material, see U.S. publication 49 CFR Section 172.

I. References

American Conference of Governmental Industrial Hygienists (ACGIH), *Documentation of the Threshold Limit Values*, 4th Edition, 87-88 (1980).

Patty's Industrial Hygiene and Toxicology, 3rd Revised Edition, Vol. 2B: Toxicology, 3094 (1981).

Litchfield, M. and Longstaff, E., *The Toxicological Evaluation of Chlorofluorocarbon 22 (CFC-22)*, *Fd Chem. Toxic*, Vol 22, no. 6, 465-475 (1984).

Sand, J. and Andrijesk, D., *Combustibility of Chlorodifluoromethane*, *ASHRAE Journal*, 38-40 (May, 1982).

Meeks, R., unpublished review of publicly available literature, U. of Alabama --- Birmingham (September, 1985).

duPont, unpublished review, Haskell Laboratory (March, 1984).

While the information contained herein was derived from sources believed to be reliable, Turbo neither expressly nor impliedly warrants the information is accurate and complete and assumes no responsibility for same. The 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 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 Overexpose: Prolonged contact may cause minor skin irritation.

Toxicological Properties: NDA

Emergency First Aid Procedures:

Eyes: Flush with large amounts of water for at least 15 minutes. If redness or irritation persists, contact a physician.

Skin Contact: Wash with soap and water. Wash clothing before reuse.

Inhalation: None normally required.

If Swallowed: Call a physician.

Section V. Special Protection Information

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

Respiratory Protection (Specify Type): NA

Protective Gloves: Oil resistant rubber

Eye Protection: Chemical splash goggles

Other Protective Equipment: Rubber apron

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.

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.

Material Safety Data Sheet for Propylene Glycol

1 - PRODUCT IDENTIFICATION

PRODUCT NAME: PROPYLENE GLYCOL
FORMULA: CH₃CHOHCH₂OH

COMMON SYNONYMS: 1,2-PROPANEDIOL; 1,2-DIHYDROXYPROPANE;
METHYLETHYLENE GLYCOL;
PROPANE-1,2-DIOL

PRECAUTIONARY LABELLING

FLAMMABILITY - 1 SLIGHT
REACTIVITY - 1 SLIGHT
CONTACT - 2 MODERATE

HAZARD RATINGS ARE 0 TO 4 (0 = NO HAZARD; 4 = EXTREME HAZARD).

LABORATORY PROTECTIVE EQUIPMENT

SAFETY GLASSES; LAB COAT

PRECAUTIONARY LABEL STATEMENTS:

WARNING CAUSES IRRITATION

AVOID CONTACT WITH EYES, SKIN, CLOTHING. KEEP IN TIGHTLY CLOSED CONTAINER. WASH THOROUGHLY AFTER HANDLING.

APPEARANCE & ODOR: COLORLESS, ODORLESS VISCOUS LIQUID.

UNUSUAL FIRE & EXPLOSION HAZARDS

CLOSED CONTAINERS EXPOSED TO HEAT MAY EXPLODE.

5 - HEALTH HAZARD DATA

EMERGENCY AND FIRST AID PROCEDURES

IN CASE OF CONTACT, IMMEDIATELY FLUSH EYES WITH PLENTY OF WATER FOR AT LEAST 15 MINUTES. FLUSH SKIN WITH WATER.

7 - SPILL AND DISPOSAL PROCEDURES

STEPS TO BE TAKEN IN THE EVENT OF A SPILL OR DISCHARGE.

WEAR SELF-CONTAINED BREATHING APPARATUS AND FULL PROTECTIVE CLOTHING.

STOP LEAK IF YOU CAN DO SO WITHOUT RISK. USE WATER SPRAY TO REDUCE VAPORS.

TAKE UP WITH SAND OR OTHER NON-COMBUSTIBLE ABSORBENT MATERIAL AND PLACE INTO CONTAINER FOR LATER DISPOSAL. FLUSH SPILL AREA WITH WATER.

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

DISPOSAL PROCEDURE

DISPOSE IN ACCORDANCE WITH ALL APPLICABLE FEDERAL, STATE, AND LOCAL ENVIRONMENTAL REGULATIONS.

8 - PROTECTIVE EQUIPMENT

VENTILATION:

USE ADEQUATE GENERAL OR LOCAL EXHAUST VENTILATION TO KEEP VAPOR AND MIST LEVELS AS LOW AS POSSIBLE. IF AIRBORNE CONCENTRATION IS HIGH, USE AN APPROPRIATE RESPIRATOR OR DUST MASK.

EYE/SKIN PROTECTION:

SAFETY GOGGLES, UNIFORM, APRON, PROPER GLOVES ARE RECOMMENDED.

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



Chiller Operation & Maintenance Manual

Section 3: INSTALLATION & PRE-START-UP REQUIREMENTS

To install and prepare the TURBO® HTD, HF or uHTD chiller, you will need two to three 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 chiller. Your chiller has been tested and inspected at the factory prior to packing and shipping.

Installation Sequence

1. Delivery Inspection
2. Hoisting or Moving
3. Site Preparation
4. Mounting and Leveling
5. Electrical Connections
6. Water Connections
7. Refrigerant Piping
9. Testing Refrigeration System for Leaks
10. Evacuating the System
11. Refrigerant Charging
12. Post Installation Clean Up
13. Optional High Side
 - a. Air-Cooled Condensers

- b. Evaporative-Cooled Condensers
 - c. Water-Cooled Condensers
14. Optional Refrigerant Recirculation System
 15. Optional Flooded System Components

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 instructions completely before installation.
- Gather all required tools.
- Standard water and refrigerant connections are located on the front of the Chiller as you face the inlet water connection on the Chiller. The water connections for the reservoir (sump) are located on the right side of the Chiller /reservoir assembly.

- Inlet and Outlet refrigerant connections are on the front of the evaporator section. Connections can be made from either side.
- Hinged access doors are located on both ends for cleaning access.
- Hinged roof panel(s) with a mechanism to hold roof panel open are provided on top.
- All doors and hinged roof panels have slip hinge pins for easy removal.
- Reference Figure 3-1 for typical chiller configuration.

NOTE: The refrigerant and water connections on the chiller can be reversed by rotating the chiller (upper section) on the reservoir during installation. Unless otherwise specified the connections will be as shown in Figure 3-1.

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

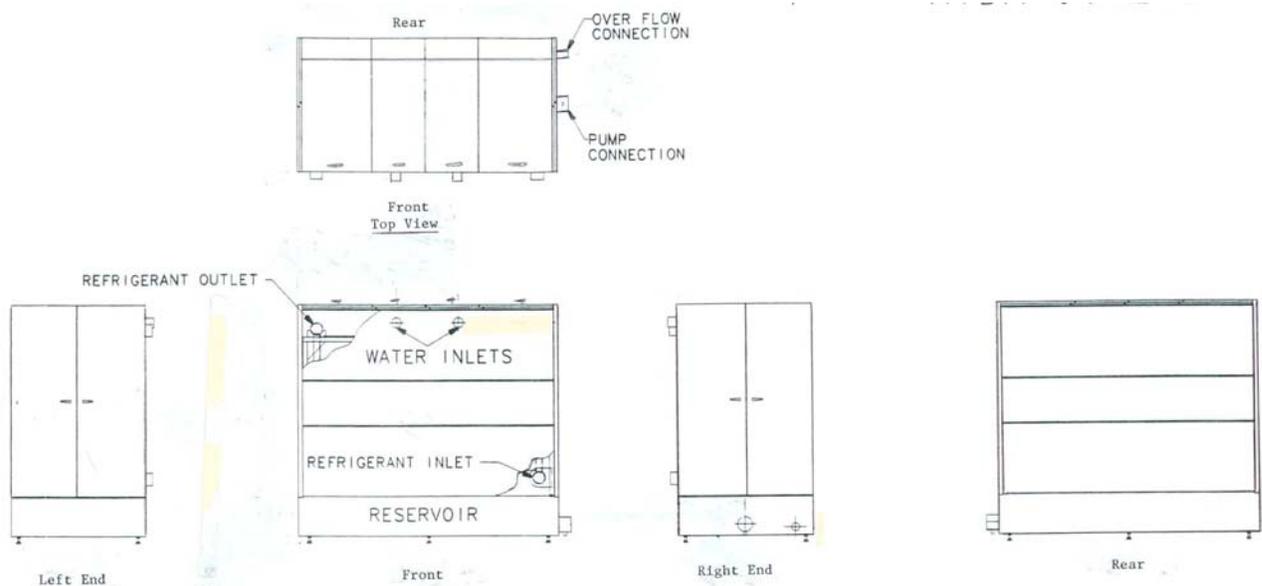


Figure 3-1 Typical Chiller Orientation (Typical HTDA9612XX Shown)

Recommended Service and Cleaning Clearances

Minimum recommended clearances for service and cleaning:

- 48" on all sides
- 36" above the chiller for access to the water distribution pan(s) and header(s) for cleaning.

Access doors are provided on the front, rear, and top of the chiller.

Note: To locate the connections on the opposite

rotate the upper chiller section 180° when placing it on the chiller sump.

Tools Required for Installation

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

- Wrenches and sockets (a full set up to 1 1/8")
- Phillips (not cross-point) and standard (slotted) screw drivers
- Level (four feet long)
- Tape measure (thirty feet long)
- Pry bar
- Lifting straps (2000#)
- Welder suitable for carbon-to-stainless steel
- Framing square
- Forklift or crane

Always remember –SAFETY FIRST!!!

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 Chillers and reservoirs (if supplied) are inspected at the factory to assure shipment of a mechanically sound piece of equipment. If provided electrical controls and options are also factory tested

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

Inspect the Chiller and reservoir 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:

- Using the Packing List provided with the shipment examine the Chiller and/or loose parts shipped with the unit to ensure everything on the list has been received.
- 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 (if applicable) and piping.
5. Damage and missing parts must be noted on bill of lading at the time of receipt.

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

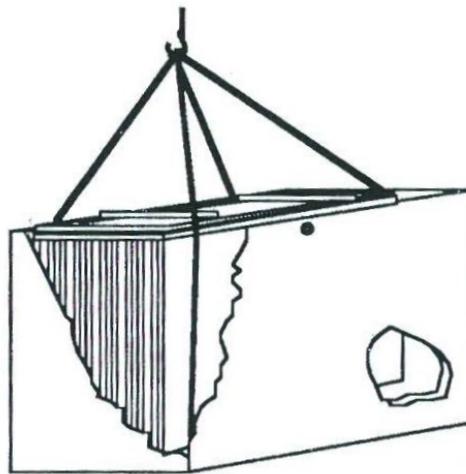
2. HOISTING OR MOVING

Equipment Rigging Instructions

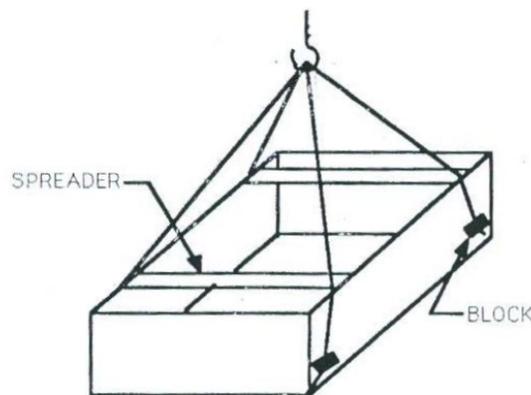
The Chiller should be lifted by the lifting straps (slings) around the plate bank inside the frame.

A spreader bar and blocks may be required to protect the plates. The hinged roof panels and front and rear doors should be removed during the rigging operation.

Figure 3-2 shows the configuration with lifting slings around the plate bank and reservoir (sump).



Slings Beneath Plates - Using Top And Bottom Spreaders



Chiller Sump Lifting Orientation

Figure 3-2 Chiller Lifting Configuration

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

Hoisting or Moving

If a Chiller 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 plates from being damaged. A competent rigging and hoisting contractor can handle the job without danger or damage to the Chiller.

If a Chiller 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 a large forklift on both ends should be used. 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 Chiller with devices fastened to the top frame structure. Lift the Chiller only from the bottom of the plate bank.

Before hoisting, the rigger must ensure that the load is properly balanced to prevent tilting or tipping of the Chiller. 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.

The following tables list the shipping weights of all standard chillers and reservoirs. Consult the factory for shipping weights of special or self-contained chiller that include the high side or other options.

Table 3-1. Standard HTD Chiller Models Shipping Weights

48" Plate Chiller Models					
MODEL	SHIP WT (LBS)	OPERATING WT (LBS)	MODEL	SHIP WT (LBS)	OPERATING WT (LBS)
HTD "X" -48-06-01	1,482	2,466	HTD "X" -48-12-07	2,540	4,634
HTD "X" -48-06-02	1,587	2,637	HTD "X" -48-12-08	2,645	4,805
HTD "X" -48-06-03	1,692	2,809	HTD "X" -48-12-09	2,750	4,977
HTD "X" -48-06-04	1,797	2,981	HTD "X" -48-12-10	2,855	5,149
HTD "X" -48-06-05	1,902	3,153	HTD "X" -48-12-11	2,960	5,320
HTD "X" -48-06-06	2,007	3,324	HTD "X" -48-12-12	3,065	5,492
HTD "X" -48-06-07	2,112	3,496	HTD "X" -48-12-13	3,170	5,664
DIMENSIONS (IN)	L	W	DIMENSIONS (IN)	L	W
	68	36		68	60

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

72" Plate Chiller Models

MODEL	SHIP WT (LBS)	OPERATING WT (LBS)	MODEL	SHIP WT (LBS)	OPERATING WT (LBS)
HTD "X" -72-06-01	1,856	3,227	HTD "X" -72-12-07	3,347	6,296
HTD "X" -72-06-02	2,014	3,488	HTD "X" -72-12-08	3,505	6,557
HTD "X" -72-06-03	2,172	3,749	HTD "X" -72-12-09	3,663	6,818
HTD "X" -72-06-04	2,330	4,011	HTD "X" -72-12-10	3,821	7,079
HTD "X" -72-06-05	2,488	4,272	HTD "X" -72-12-11	3,979	7,340
HTD "X" -72-06-06	2,646	4,533	HTD "X" -72-12-12	4,137	7,601
HTD "X" -72-06-07	2,804	4,794	HTD "X" -72-12-13	4,295	7,862
DIMENSIONS (IN)	L	W	DIMENSIONS (IN)	L	W
	92	36		92	60

96" Plate Chiller

MODEL	SHIP WT (LBS)	OPERATING WT (LBS)	MODEL	SHIP WEIGHT (LBS)	OPERATING WEIGHT (LBS)
HTD 'X'-96-06-01	2,321	4,087	HTD 'X'-96-12-07	4,147	7,959
HTD 'X'-96-06-02	2,531	4,436	HTD 'X'-96-12-08	4,357	8,308
HTD 'X'-96-06-03	2,741	4,786	HTD 'X'-96-12-09	4,567	8657
HTD 'X'-96-06-04	2,951	5,135	HTD 'X'-96-12-10	4,777	9,007
HTD 'X'-96-06-05	3,161	5,485	HTD 'X'-96-12-11	4,987	9,357
HTD 'X'-96-06-06	3,371	5,834	HTD 'X'-96-12-12	5,197	9,706
HTD 'X'-96-06-07	3,581	6,184	HTD 'X'-96-12-13	5,407	10,056
DIMENSIONS (IN)	L	W	DIMENSIONS (IN)	L	W
	116	36		116	60

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

96" Plate Chiller

MODEL	SHIP WT (LBS)	OPERATING WT (LBS)	MODEL	SHIP WT (LBS)	OPERATING WT (LBS)
HTD 'X'-96-18-14	6,195	12,192	HTD 'X'-96-30-20	8,055	14,623
HTD 'X'-96-18-15	6,405	12,542	HTD 'X'-96-30-21	8,265	14,959
HTD 'X'-96-18-16	6,615	12,891	HTD 'X'-96-30-22	8,475	15,296
HTD 'X'-96-18-17	6,825	13,241	HTD 'X'-96-30-23	8,685	15,632
HTD 'X'-96-18-18	7,035	13,590	HTD 'X'-96-30-24	8,895	15,968
HTD 'X'-96-18-19	7,245	13,939	HTD 'X'-96-30-25	9,105	16,304
HTD 'X'-96-18-20	7,455	14,289	HTD 'X'-96-30-26	9,315	16,640
			HTD 'X'-96-30-27	9,525	16,976
			HTD 'X'-96-30-28	9,735	17,313
			HTD 'X'-96-30-29	9,945	17,649
			HTD 'X'-96-30-30	10,155	17,985
DIMENSIONS (IN)	L	W	DIMENSIONS (IN)	L	W
	116	83½		116	83½

Consists of standard insulated reservoir with 3" legs, evaporator section, water distribution pan, PVC water distribution header, splash curtains and insulated panels. Door configuration is top and end. Chillers are shipped in two pieces with a charge of inert gas.

DESIGN NOTE:

HTD 'X' 96-30-XX is not suitable for flooded applications. Consult Factory.

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

Table 3-2. Un-insulated (uHTD)Chiller Shipping Weights

uChiller		
MODEL	SHIP WT. (LBS)	OPERATING WEIGHT (LBS)
UHTD "X" -48-06-01	1,395	2,370
UHTD "X" -48-06-02	1,500	2,485
UHTD "X" -48-06-03	1,620	2,610
UHTD "X" -48-06-04	1,725	2,740
UHTD "X" -48-06-05	1,840	2,780
UHTD "X" -48-06-06	1,965	3,025
UHTD "X" -48-06-07	2,085	3,026
DIMENSIONS (IN)	L	W
	68	36

Consists of standard insulated reservoir with 3" legs, un-insulated evaporator section panels, water distribution pan, all constructed of stainless steel, and PVC water distribution header. Door configuration is top and end. Chillers are shipped in two pieces with a charge of inert gas.

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. High Flow(HF) Chiller Shipping Weights

144" Plate Hi Flow Chiller

MODEL	SHIP WT. (LBS)	OPERATING WEIGHT (LBS)	MODEL	SHIP WT. (LBS)	OPERATING WEIGHT (LBS)
HF 'X'-144-06-01	1,935	4,355	HF 'X'-144-12-07	3,325	7,700
HF 'X'-144-06-02	2,065	4,495	HF 'X'-144-12-08	3,460	7,895
HF 'X'-144-06-03	2,195	4,635	HF 'X'-144-12-09	3,585	8,080
HF 'X'-144-06-04	2,340	4,840	HF 'X'-144-12-10	3,715	8,275
HF 'X'-144-06-05	2,485	5,045	HF 'X'-144-12-11	3,885	8,510
HF 'X'-144-06-06	2,625	5,250	HF 'X'-144-12-12	3,995	8,680
HF 'X'-144-06-07	2,765	5,450	HF 'X'-144-12-13	4,105	8,920
DIMENSIONS (IN)	L	W	DIMENSIONS (IN)	L	W
	163	36		163	60

Consists of standard insulated reservoir with 3" legs, evaporator section, water distribution pan, PVC water distribution header, splash curtains and insulated panels. Door configuration is top and end. Chillers are shipped in two pieces with a charge of inert gas.

144" Plate Hi Flow Chiller

MODEL	SHIP WT. (LBS)	OPERATING WEIGHT (LBS)
HF 'X'-144-12-07	3,325	7,700
HF 'X'-144-12-08	3,460	7,895
HF 'X'-144-12-09	3,585	8,080
HF 'X'-144-12-10	3,715	8,275
HF 'X'-144-12-11	3,885	8,510
HF 'X'-144-12-12	3,995	8,680
HF 'X'-144-12-13	4,105	8,920
DIMENSIONS (IN)	L	W
	163	60

Consists of standard insulated reservoir with 3" legs, evaporator section, water distribution pan, PVC water distribution header, splash curtains and insulated panels. Door configuration is top and end. Chillers are shipped in two pieces with a charge of inert gas.

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

Table 3-4. Reservoir Shipping Weights and Capacities.

Size	# OF PLATES	CHILLER MODEL	OVERALL TANK DIMENSION			WATER LEVEL (IN)	GAL / IN	SUMP WEIGHT (SEE NOTE)		# OF LEGS	ACTUAL CAPACITY (GAL)	
			L	W	H			SHIP WT	OP WT			
STD	1 THRU 6	HTD-48-06	68	36	17½	12½	8.875	271	1,188	6	110	
		HTD-72-06	92				12.2	346	1,614		152	
		HTD-96-06	116				15.53	422	2,048		195	
	7 THRU 12	HTD-48-12	68	60				380	2,006		195	
		HTD-72-12	92					21.35	482		2,709	267
		HTD-96-12	116					27.18	583		3,419	340
	14 THRU 30	HTD-96-XX		83½			38 1/2	741	4,786		482	
MEDIUM	1 THRU 6	HTD-48-06	68	36	37½	32 1/2"	8.875	185	1,669		288	
		HTD-72-06	92				12.2	228	2,271		397	
		HTD-96-06	116				15.53	270	2,856		505	
	7 THRU 12	HTD-48-12	68	60				228	2,813		505	
		HTD-72-12	92					21.35	270		3,831	694
		HTD-96-12	116					27.18	313		4,842	883
	14 THRU 30	HTD-96-XX		83½			38 1/2	355	6,751		1,252	

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

HIGH	1 THRU 6	HTD-48-06	68	60			15.53	410	3,704		505
		HTD-72-06	92				21.35	504	5,024		694
		HTD-96-06	116				27.18	598	6,336		883
	7 THRU 12	HTD-48-12	68	92			24.4	528	5,515	8	793
		HTD-72-12	92				33.56	639	7,511		1,091
		HTD-96-12	116				42.71	750	9,490		1,388
EXTRA HIGH	1 THRU 30	HTD-48-XX	68	92	45½	40 1/2"	24.4	824	8,146	8	988
		HTD-72-XX	92				33.56	1,003	11,069		1,359
		HTD-96-XX	116				42.71	1,182	13,984		1,730

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 Chiller in an area where the ambient temperature does not fall below 40°F or rise above 100°F. The chiller and reservoir (sump) on all HTD/HF chillers are insulated against excessive heat infiltration. Most Reservoirs are optional on HF series chillers are provided without reservoirs. uHTD chiller cabinets are not insulated.

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

Outdoor Installation

Insulated chillers are suitable for outdoor installation. For ease of maintenance and cleaning as well as access under all weather conditions indoor installations are preferred. Outside installation typically require additional installation considerations including but not limited to:

- Provisions for chiller operation in conditions where the ambient is below 40°F to prevent freeze up. Operation for short intervals (less than 8 hours per day) is possible without problems. For operations requiring 24/7 (24 hours per day; seven days a week)

outdoor installations are not recommended.

- A cover over the roof panels to prevent debris, rain, snow, and other outdoor contaminants from collecting on the roof and preventing normal opening of the roof panel for cleaning without contaminating the interior of the chiller. Optional roof vinyl covers are available.

IMPORTANT

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

Concrete Slab

If the Chiller 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. Leveling legs are provided on all chiller reservoirs for final leveling after the chiller/reservoir are set in place.

IMPORTANT

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

Location of all leveling feet on the chiller reservoir is shown on

the data sheet provided with the chiller.

Raised Curbing

A raised curbing around the outside of the Chiller is recommended to contain any condensate, leakage, or cleaning fluid during maintenance from the unit. A curbing height of two (2) to three (3) inches is typically sufficient. Refer to Figure 3-6.

Elevated Installation

Some installations require mounting the Chiller 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 3-4.

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

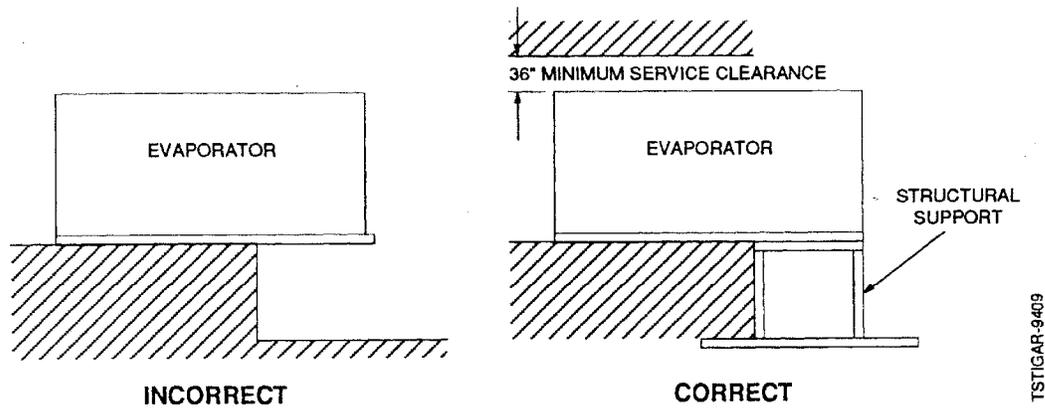


Figure 3-4 Elevated Installation

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 Chiller, 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 (by others) 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 Chillers use minimum 5 PSIG city water pressure or water pumped from storage at the inlet to the chiller. If available water pressure is below 5 PSIG at the inlet water connection, 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 Chiller. Expansion tanks may be required on some systems with high water pressure to prevent water hammer.

Floor Drain

The Chiller reservoir requires periodic cleaning. Make provisions for a floor drain to

dispose of this water and for the unit overflow drain.

Water Treatment

Optional make-up water strainers are available 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 water 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. MOUNTING AND LEVELING

Set the Chiller on a solid, level base or floor. Refer to step 3. Reference "Site Preparation" on page 3-6 for additional details.

IMPORTANT

It is imperative that the Chiller be level in both length

and width. Failure to level the Chiller in both directions will disturb the water flow patterns and may cause incomplete coverage of the chilling surfaces.

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

As indicated in step 3 leveling legs are provided on all reservoirs for leveling the Chiller/reservoir assembly.

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

5. WATER SYSTEM

General Chiller Requirements

Water temperature and flow are used to determine the number of evaporator plates required for the chilling service to be provided. All chiller capacities are based on the entering water temperature, leaving water temperature, specific heat of the fluid, and the flow rate over the chiller plates. The number of plates is determined by the load calculated from the data above and the saturated evaporator temperature which is typically between 26°F and 30°F for applications using water as the fluid being chilled.

The holes sizes in the water distribution pan and the water distribution header are also based on the water flow over the plates. To minimize fouling of the holes in the header and pan, the maximum diameter size allowable without impacting water distribution is used.

Water Quality

When the fluid to be cooled is water, the water quality can affect the performance and corrosion resistance of the system if proper corrective action is not taken.

Minerals in the water can cause a scale build up on the surface of the heat transfer surface. If this fouling is not removed from the plates the leaving water

temperature can not be obtained. Refer to the maintenance section for cleaning procedures.

Free chlorine is released from the water as it is discharged from the distribution header. As the chlorine level of the water increases or if the water is super chlorinated, the free chlorine level can concentrate and cause corrosion of even stainless steel surfaces that are not wetted during operation. These surfaces include the chiller frame, parts of the water distribution pan, exterior panel surfaces, and refrigerant headers. The free chlorine must be vented to reduce the concentration level. Venting can be obtained by installing optional vents or typically by weekly cleaning procedures to remove the stagnant water that collects on the non-wetted surfaces and vent free chlorine. Cleaning procedures are described in the maintenance section. Opening the cabinet doors releases trapped chlorine. If followed by a fresh water wash down of all the surfaces on a weekly basis the system will typically remain in a passive state and corrosion free. Weekly cleaning also eliminates scale build that requires more aggressive cleaning methods to remove.

Water Temperature

Entering water temperatures on typical chiller installations can range from 90°F down to 35°F. For entering water temperatures over 90°F consult the factory. Leaving water temperatures to within 0.5°F of the fluid freeze point are obtainable.

The fluid to be cooled is brought into the chiller through the water inlets located at the top of the chiller. Entering fluid is discharged from the PVC fluid distribution system located inside the chiller into the stainless steel water distribution pan to ensure optimum distribution to all plates in the system. From the water distribution pan, the fluid flows over the exterior of the chiller plates and is discharged into the reservoir located below the chiller. Pump, drain, and overflow connections are located in the reservoir.

High flow (HF) chillers for some application do not use a reservoir below the chiller plates. For these applications the chilled fluid is discharged directly into the process, over a processing conveyor carrying the product, or directly into a chilled fluid tank.

Reference the Maintenance Section for additional information on cleaning, and the “Handling and Post Installation” section of the

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

Installation Instructions for additional steps to follow to ensure the long term integrity of the chiller. If you are uncertain about the quality of the water or fluid to be used in the chiller consult the factory for assistance.

Water Distribution Header

A PVC water distribution header is located inside the unit. This is designed for easy disassembly for cleaning. The laterals that branch off of the main lines can be removed from the fittings into which they are inserted for cleaning. Plastic caps are located on the end of the laterals to permit full access to the lateral interior from both ends. These parts are not glued together to allow for disassembly for cleaning.

Holes in the water distribution header are sized for even distribution of the fluid into the pan and large enough to pass solids in the fluid stream. Reference “Water Distribution Pan Filter” below for removal of solids and debris from the fluid stream.

Larger chillers normally use multiple water distribution headers to make them easier to remove for cleaning.

Stainless steel water distribution headers with sanitary fittings for easy disconnect and removal of the complete water distribution system are available as an option.

Water Distribution Pan

A stainless steel water distribution pan is located on top of the chiller plates to uniformly distribute the fluid over all the plates. The size and number of holes in the pans are selected to match the flow requirements specified by the customer. At design rate rates the water level in the pans is at approximately the 50% full level. All pans are designed to maintain proper flow over a 2:1 flow range that covers a water level from approximately 1” minimum to 4” maximum in the pan.

NOTE: Water levels below 1” in the water distribution pan will result in water wicking (separation of the fluid flow over the plates) and will result in freeze ups due to erratic fluid flow to the plates.

Water levels above 4” can result in excessive splashing and also result in freeze-ups due to the splashing freezing on the refrigerant headers or other surfaces that are normally not wetted.

Larger chillers normally use multiple water distribution pans to make them easier to remove for cleaning.

Water Distribution Pan Filter

A filter pad is located in the bottom of the water distribution pan for all non-USDA applications to filter debris that is large enough to plug the holes

in the water distribution pan. For USDA applications a perforated PVC sheet is used in the bottom of the water distribution pan to filter the water before it plugs the holes in the water distribution pan. The PVC filter requires more frequent cleaning to ensure proper water distribution at all times.

Insulation

Fluid lines connected to the chiller should be insulated to reduce heat infiltration and condensation. Insulation of these lines is 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

Standard chillers consist of the upper evaporator section and lower reservoir. No electrical components are required for these components. Control of the chiller and/or water system is an option or typically supplied by others and integrated into the control systems for other parts of the processing plant.

The options section can be referenced for optional kits required for a complete system and the electrical requirements for each.

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 for optional control systems are located in each control panel

and are furnished with each operating manual. Consult these diagrams before making electrical service connections.

Electrical Service Connections

Chillers can be furnished with optional features factory wired. Electrical service connections to the following is required by others:

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

All of these connections are made on the terminal blocks located inside the optional Chiller control panel if supplied. Installation of disconnect switches or circuit breakers is by others in the incoming power lines ahead of the control panel on the chiller. Field wiring is required from the electrical source to disconnects and/or circuit breakers, and from

disconnects/circuit breakers to the terminal blocks in the chiller. All field wiring is provided by others.

Checking Pump Rotation

The water pump (by other unless otherwise specified) rotation is typically indicated on the pump housing. Pump rotation can be verified by observing the fan rotation on the pump motor or by measuring the amp draw of the motor. The correct motor amp draw will be higher than the amp draw in the reverse rotation. Rotation can be changed by reversing two of the phases on the motor starter; i.e. reverse the wiring connections to L2 and L3 if the rotation is not correct.

Note:

When checking rotation, only the power to the pump should be on. Turn the three phase power to the other components in the system 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

Water Pump Connection

A MPT connection is provided at the bottom of the reservoir for connection to a water pump to be used to pump the chilled water to the process or final distribution point.

This connection is typically located at the same end as the overflow and drain connection.

Multiple pump connections or connections in different locations including the bottom of the reservoir are available as options.

Water Overflow Connection

A connection for water overflow is located on the front of the chiller above the pump connection. This is piped to an overflow drain for disposal if the pump fail, water flow to the chiller exceeds design flow, or the lines become plugged. Piping to a safe discharge location is by others.

Drain Connection

A female coupling is factory installed in the bottom of the pump connection. The reservoir is shipped from the factory with a plug installed in the connection. The plug may be removed and replaced by a shut off (isolation) valve for draining the reservoir for service or

cleaning. The shut off valve should be closed during normal operation. Installation of the valve and piping are by others.

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

Connection Size and Location

Refer to the Data Sheet supplied with the manual for connection sizes and locations. The locations shown in Figure 3-1 are typical. Locations for special chillers may vary.

Optional Components Water Requirements (Optional Condensing Unit) **Water Cooled Condensers**

Water-cooled condensers supplied on chiller high sides 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.

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 Chiller high side 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.

Evaporative-Cooled Condensers

Evaporative-cooled condensers can also be supplied with optional high side system to be used with TURBO chillers.

The same basic requirements for water quality and temperature apply to evaporative-cooled systems except evaporative-cooled

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

condensers like cooling towers sizing is based on the design wet bulb temperature for the installation location. Standard selections are based on a design wet bulb temperature of 78°F and a saturated condensing temperature of 95°F. For other design conditions consult the factory.

Discharge Pressure Controls

When optional cooling towers 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.

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 and the quality of the water.

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 Chillers are installed in an area where the ambient falls below freezing, refer to section 8 –

Optional Features & Accessories for Winterizing.

Optional evaporative-cooled condensers also require discharge pressure controls to maintain the discharge under all operating conditions. Discharge pressure controls include a variety of methods. Air discharge dampers that modulate in response to the discharge pressure are the most economical. Flood back controls and variable frequency drives (VFD) may be required for applications that operate in a wide range of ambient conditions including low ambient conditions where dampers alone may not be sufficient. Consult factory for additional information.

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

All piping in the chiller is 304L stainless steel. Optional 316L piping is also available. Refrigerant connections are stubbed out on the right side of the chiller for standard installation. These connections can be easily reversed by rotating the chiller on the reservoir during installation.

NOTE: Although the connections can be reversed in the field please specify the side the refrigerant headers should exit when the chiller is ordered to ensure the package along with any options provided can be properly assembled in the field.

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

As indicated all piping inside the chiller is stainless steel. It is; however, acceptable to connect carbon steel pipe to the inlet and outlet connections.

IMPORTANT: When welding carbon steel to stainless steel, the chiller should be covered during all grinding, welding and deburring operations to avoid contamination of the stainless steel surfaces. Failures to follow these instructions could result in pitting or corrosion of the stainless steel. Reference additional information on post-installation clean up in this section.

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

Standard refrigerant connections are butt weld. Threaded connections are not recommended but can be supplied if specified. 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 the Data Sheet in the manual for the refrigerant connection sizes and location. The locations shown in Figure 3-1 are typical. Locations for special chillers may vary.

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

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

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 re-welded. 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 chiller 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.

Test Pressure

The evaporator plates when ASME coded are rated for 202 psig. However, during pressure testing, the maximum recommended test pressure is 150 psig.

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 Chiller 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.

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

- | | | |
|--|---|---|
| 3. Stop the pump and isolate the system. | 2. Allow the pump to operate for two (2) or three (3) hours. | 2. Allow the pump to operate an additional six (6) hours. |
| 4. Allow it to stand at this vacuum for another five (5) to six (6) hours. | 3. Stop the pump and allow the system to stand with this vacuum for a minimum of three (3) hours. | 3. Stop the system and allow it to stand for approximately twelve (12) hours at the low pressure. |
| 5. Break the vacuum. | 4. Break the vacuum with the oil pumped dry nitrogen. | 4. Break the vacuum with the oil free dry nitrogen. |
| 6. Raise the system pressure up to zero (0) with oil free dry nitrogen. | 5. Raise the pressure in the system to zero (0). | 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). |

Second Evacuation

1. Start the second evacuation, again allowing the pump to operate, and reduce the pressure to less than 500 microns.

Third Evacuation

1. Operate the pump until the system pressure is reduced below the 500 micron figure.
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 Chiller (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).

IMPORTANT: Refer to the manual and specifications provided by the supply of all accessories equipment. The information provided in this section applies to optional equipment supplied by TURBO.

Note:

Production capacity of the Chiller is based on an oil free NH₃ refrigerant supply for ammonia systems. 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

Chillers

All Chiller models are furnished without refrigerant charge. The entire refrigerant system must be evacuated (refer to step 9 – 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. If the holding charge is not in the system at the time of receipt or installation notify the factory before proceeding.

NOTE: Freon Chillers sold with the optional high side as self-contained models and shipped within the United States may be shipped with the operating charge factory installed. Ammonia models regardless of options included are shipped only with a holding charge for both domestic and international orders.

Possible Leaks

Chiller 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 8 – 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 9 – Evacuating the System.

Whenever refrigerant is added to any Chiller system, extreme care should be taken in charging refrigerant into the system.

The Chiller unit should be placed in operation and the liquid level observed during the first five minutes of operation and every hour after that until the oil level is stable

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 and/or receiver (depending the configuration of the system) is stable, the unit is fully charged.

The unit data nameplate lists the unit model, refrigerant type, and refrigerant charge of the evaporator only. Always monitor and record how much refrigerant is added. Additional refrigerant will be required for field piping and/or other components added to the systems by others. Never exceed the refrigerant charge specified by the “system” supplier.

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. Ammonia (NH₃) and Freon™ (R-22) are standard refrigerants for all Chillers. Refrigerant 404A is available as an option.

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 per Plate

Plate Size	Ammonia, pounds	Freon R-22, pounds	20% Propylene Glycol, pounds
48" x 60"	8.1	14.5	19.7
72" x 60"	12.5	22.0	30.0
96" x 60"	17.0	30.0	40.8
24" x 144"	9.1	16.4	22.3

Note: To determine the total evaporator charge, multiply the number of plates in the chiller by the weights shown per plate in the table. For example a HTDA480606 chiller is an ammonia chiller with six (6) 48" x 60" plates. The total operating charge of the chiller only would be 48.6 pounds of ammonia (6 plates x 8.1 pounds per plate). Additional charge will be required for piping and other components in the system.

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 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.

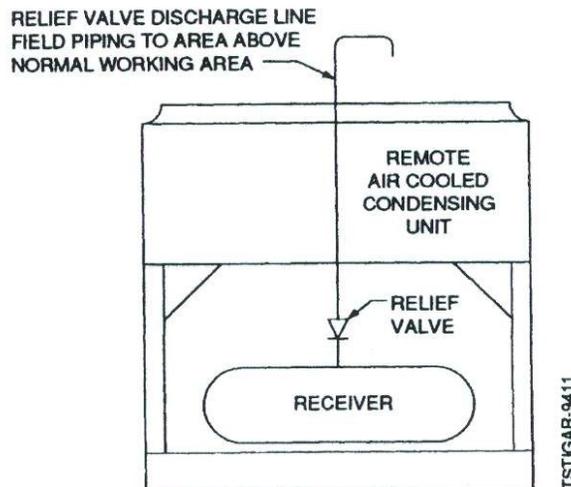


Figure 3-9 Typical Optional Air Cooled Condenser Relief Valve Field Piping

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

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

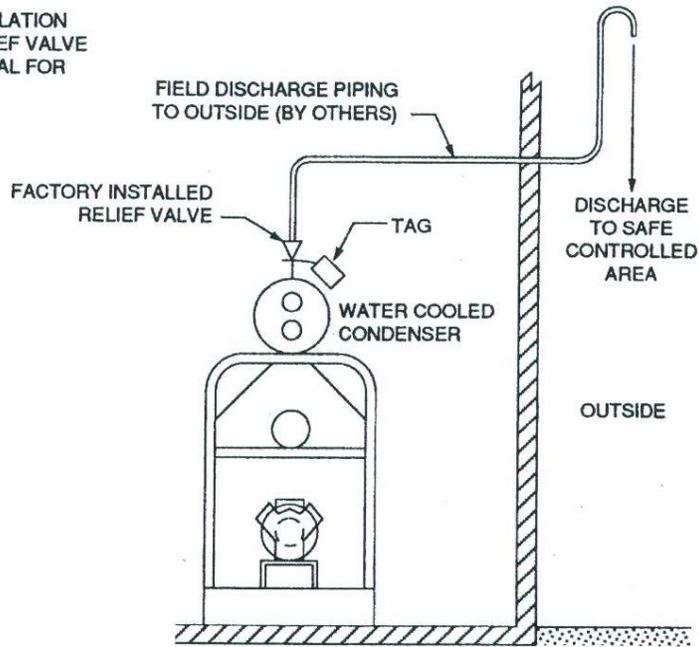


Figure 3-10 Typical Indoor Installation Relief Valve Piping of Optional Condensing Unit

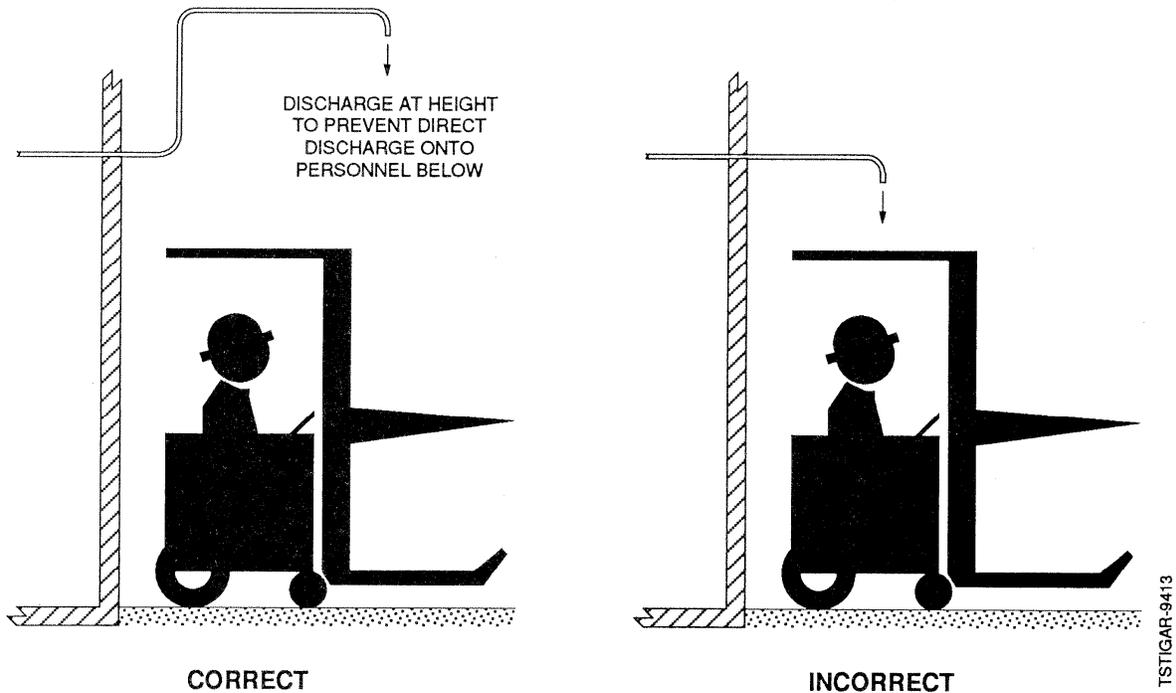


Figure 3-11 Correct and Incorrect Relief Valve Discharge Piping

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

TURBO provides a relief valve on all pressure vessels supplied with optional kits and accessories for are supplied to assist in the proper sizing of relief devices used on the Chiller “system” including components not supplied by TURBO.

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:

$$L = [0.2146(d^5)(P_o^2 - P_2^2)/fCr^2] - [(d)Ln P_o / P_2] / 6f \quad \text{ASHRAE Addendum 15c-2000}$$

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)
- 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:

$$C = fDL_1$$

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

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:

A Chiller 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:

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

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	Relief Valve 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. POST INSTALLATION CLEAN UP

Three critical steps are required to ensure the Chiller operates reliably and is corrosion free for the life of the installation. The three Golden Rules are:

- a. Ship it clean
- b. Install it clean
- c. Keep it clean

Rule #1. Ship it Clean.

The equipment must leave the factory in a clean passive state. All stainless steel has a passive layer that provides a protective barrier against corrosion. To ensure this passive layer exists, TURBO passivates all chillers prior to shipment. Passivation of the entire chiller frame, plate bank, refrigerant headers and water distribution pan in a nitric acid passivation tank ensures contaminants from the manufacturing process are completely removed from the surface of the stainless steel components and a protective passive layer exists.

After passivation the exterior panels are installed and all areas of the chiller are again cleaned to removed

contaminates that could cause corrosion.

During shipment the chiller and reservoir (if supplied) are stretch wrapped to eliminate contamination during transportation to the job site.

Rule #2. Install it Clean.

Installation of the chiller requires connection of carbon steel piping to connections on the chiller as well as other normal grinding, and welding processes that can contaminate the stainless surfaces of the chiller. Every effort must be made to eliminate the possibility of this contamination including covering the chiller to avoid exposure of the surfaces during installation. To ensure the surfaces are clean. Upon completion of the installation process the final step should be a complete cleaning of all surfaces using a citric acid cleaner followed by a fresh water rinse and drying.

Rule #3. Keep it Clean.

After the chiller is put into service it must be cleaned on a regular basis to ensure that it remains clean and the stainless steel surfaces maintain their passive layer. Cleaning and sanitizing procedures may vary depending on the application and plant guidelines. However, as a minimum requirement for any installation the chiller

should be opened at least on a weekly basis and the entire interior and exterior surfaces flushed with fresh water. Areas such as the frame and sides of the water distribution pan should be watched closely. These areas typically have stagnant water droplets that draw free chlorine. If left long enough the concentration will increase to the point that the passive layer is stripped and pit corrosion will result.

The key to a long corrosion free life for your investment is to keep it *clean*. Additional information follows on how to clean the chiller during installation and the basic weekly cleaning process.

Chiller Protection during Installation

A tarp or canvas cover should be used during all piping and installation work done around the chiller after it is set in place and leveled. The cover will protect contaminants from welding, grinding or other installation steps that could come in contact with the chiller surface. After the chiller is set and leveled the exterior panels that were removed during that step in the process should be replaced and closed to protect the interior of the cabinet and the reservoir.

Weld Zone Clean Up

Installation of the chiller includes welding the refrigerant

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

connection to the chiller. After the welding has been completed it is recommended that this be cleaned. Use a wire brush to remove loose scale. Next treat the area with a passivation agent such as DeRustit to passivate the stainless steel next to the carbon-to-stainless steel weld joint. Follow the instructions on the passivating agent or contact TURBO for additional information on passivating agents. After passivating the weld area should be rinsed with fresh water.

IMPORTANT: The passivating process described above is done with a passivating gel applied with a brush to the area to be treated and is not the same as the nitric acid passivation described at the beginning of this section. Nitric acid passivation is done in a tank with the dilute nitric acid solution at elevated temperatures and the chiller immersed in the solution. This process is followed by a neutralization and rinse process. Only specially trained personnel should perform this type of treatment. It is not recommended for local personnel or job site passivation.

When using the passivating gel to do the localized passivation proper safety equipment including eye protection and glove should be used. Follow all instructions on the product

for proper use and safety precautions.

Other Areas

In addition to weld zones any area that has been in contact with carbon steel (tools, pry bars, moving devices, etc.) should be examined for signs of discoloration or contamination and if necessary these areas should also be passivated.

If clean lifting straps were used to hoist the chiller into place the plates should be free of contamination in the area the straps were in contact with the plates. It may be necessary to treat the two outer plates that the straps are in more contact with during the lifting process.

Final Cleaning

Once the installation process has been completed the complete chiller should be cleaned. Using a citric acid cleaning agent in a spray bottle, wet all of the stainless steel surfaces starting on the inside of the chiller. If necessary use a Scotch-Brite™ Light Duty Cleaning Pad No. 66 (white in color) or equivalent. These pads are designed specifically for cleaning stainless steel. Abrasive pads of any type should *not* be used on the stainless steel surfaces. Abrasive pads or heavy scrubbing of the stainless steel surfaces strips the protective passive layer and leads to corrosion. Contact TURBO for additional information.

The final step in the citric acid cleaning is a fresh water (low

chlorine content) rinse to remove the cleaning agent.

NOTE: Citric acid cleaning agents are environmental friendly and can be safely drain to local drain connections.

After the interior surfaces are cleaned and rinsed, the same procedure should be followed to clean the exterior surfaces.

If the chiller is to be put into service no additional action is required. If the chiller will not be put into immediate service it is recommended that it be covered until the time it is activated.

IMPORTANT: Reference Step 7- Refrigerant Piping for additional requirements for securing idle or inactive systems.

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

A. AMMONIA (NH₃) SYSTEMS

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 Chiller 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 ammonia (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 ammonia - 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.

B. DIRECT EXPANSION (DX) FREON SYSTEMS

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 Chiller 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, and evacuation plans in the event of a fire or other hazardous situations.
- 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 high side and condenser (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. Verify the interface requirements for the evaporator to the high side and condenser.
- 9. Verify that all relief valves have been piped to a safe discharge location (refer to the operating and maintenance manual for guidelines).
- 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.

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

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 chiller, condensers, oil coolers, or other components supplied by others with the condensing 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.

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.

C. GLYCOL SYSTEMS

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 Chiller is a low side evaporator only. Field connection to a glycol system are required to complete the system. Field connections may include water piping, glycol 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, and evacuation plans in the event of a fire or other hazardous situations.
- 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 glycol unit (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 glycol 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 glycol piping to meet all applicable codes is the responsibility of others.
- 8. Verify the interface requirements for the evaporator to the glycol system.
- 9. Verify that all relief valves have been piped to a safe discharge location (refer to the operating and maintenance manual with equipment supplied by others for guidelines).
- 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.

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

Note: Water piping may include the make-up water to chiller, condensers, oil coolers, or other components supplied by others with the glycol system, 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, and leak checked.

Note: Each of the above functions is the responsibility of others. Glycol 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

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

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



Chiller Operation & Maintenance Manual

Section 4: OPERATING INSTRUCTIONS

This section describes the Chiller operating sequence and the function of the Chiller components and control panel components (if supplied). Hints are provided for safe, efficient, and reliable operation of both the Chiller and associated equipment for operating R-22, ammonia and glycol systems using direct expansion, recirculated, or flooded systems. Information is also provided on options including recirculators and flooded system components. Only standard features are discussed in this section. For optional features and accessories, refer to section 8 – Optional Features & Accessories.

Operation Sequence of HTD Chiller

General Information

The Turbo high TD chiller consists of a bank of stainless

steel plates mounted in a stainless steel frame. The cabinet is enclosed by two inch insulated panels and doors on the sides and top. The bottom of the unit is open and sits on top of an insulated sump. Chillers can also be provided without a sump for mounting over raceways or existing water collection systems. Optional door and panel arrangements are available. Standard Chillers have doors at both ends and the top.

A water distribution pan (stainless steel) and a PVC distribution header are installed on top of the plates.

Stainless steel refrigerant inlet and outlet headers are provided on the same side as the water inlet connection.

Option kits are available for the Chiller with either flooded or recirculated ammonia or R-22, or glycol. Chillers are also available in direct expansion (DX) models.

Options for flooded chillers include a surge drum, water level controls, high pressure liquid line controls, a dry suction line pressure regulator and controls, a dual relief valve assembly for the surge drum, a surge drum, and oil drain drum.

Options for recirculating systems include the liquid line valve kit, a suction line kit, which includes a pressure regulator, and refrigerant recirculation systems.

Options for DX include the expansion valve group, the liquid line valves, and a filter drier.

High side systems are also available with water-cooled, evaporative –cooled or air-cooled condensers.

Typical operation of flooded, recirculated, direct expansion and glycol chillers is described below.

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

FLOODED SYSTEM OPERATION

Typical Start-Up Procedure Operating Sequence

Refer to the wiring diagram and ladder logic provided with the unit for complete information on CHILLER-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 (Reference Figure 4-1)

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 chilling process). For evaporators connected to a central system, the dry contacts can be used to indicate the status of the Chiller (OFF/ON) at a remote control panel (central equipment room).

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.

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 (FSHL) 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 FSHL switch is required to ensure adequate protection for the high side equipment (by others).

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 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.

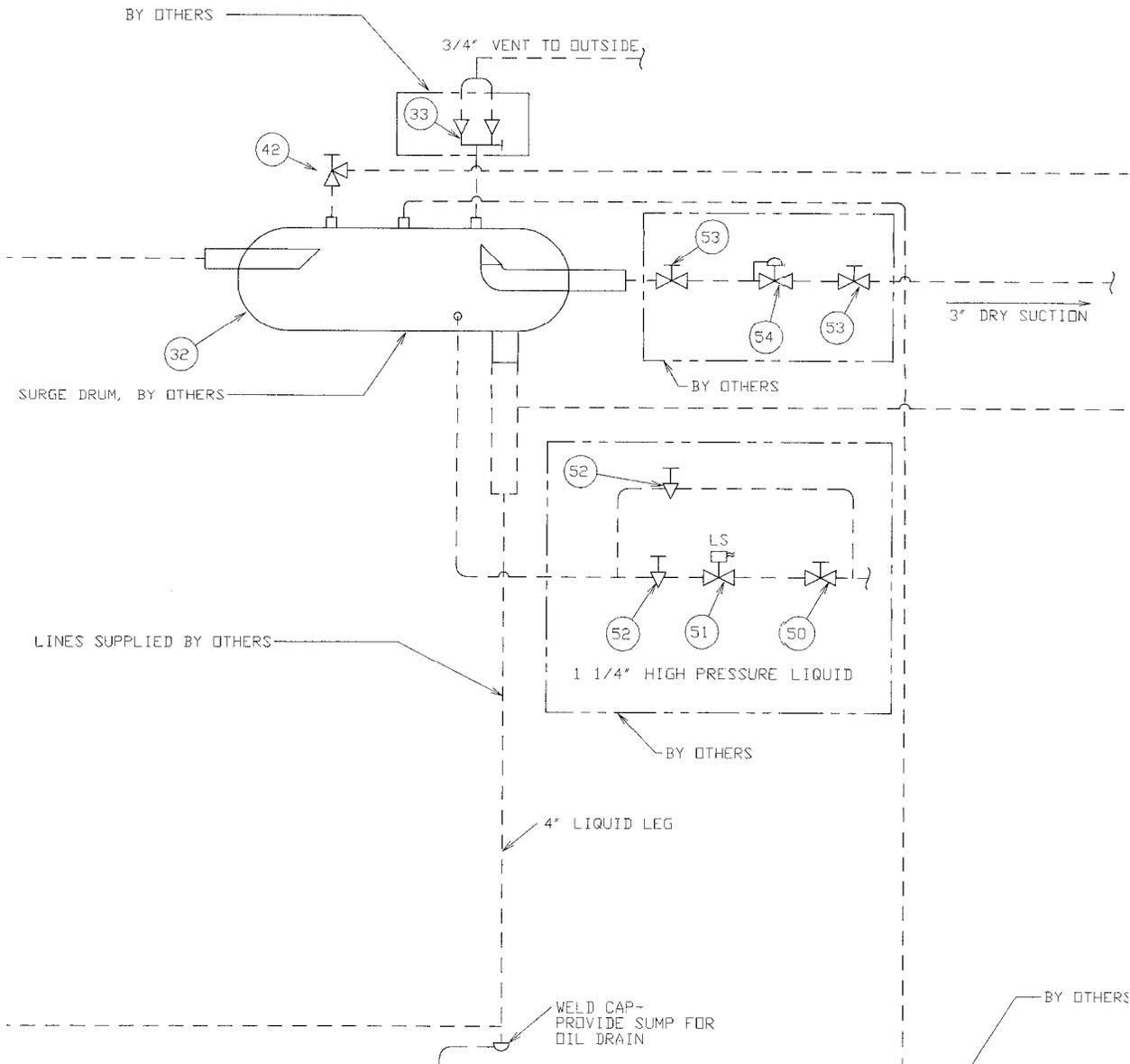


Figure 4-5 Typical Optional Surge Drum/Liquid Level Controls

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

Flooded Ammonia Chiller

The following is control sequence typical for Chillers provided with optional TURBO controls. The operating sequence can be provided by others.

Turn the master control switch (MCS) to the "on" position.

The following sequence should occur (Reference Figure 4-1):

1. Time delay relay (TD1) energizes. Contacts TD1-1 and TD1-2 instantaneously close. A green pilot light indicates that the switch is in the "on" position.
2. When TD1-1 is closed, the compressor control circuit terminals are energized, providing CR2-1 (N.C. contact of CR2) is closed. Under normal circumstances, the CR2-1 contact should be closed. Compressor controls are provided by others.
3. At the same time, TD1-2 closes, energizing the refrigerant liquid feed controls (i.e., the refrigerant float switches and liquid solenoid).
4. When MCS is switched to the "on" position, the water solenoid (WS) (open) contact is energized, operating the water solenoid.
5. During the start-up

sequence, the surge drum refrigerant level should be below the operating level. When the refrigerant feed circuit is energized, the operating level and high level refrigerant switches should both be in their normal positions. OLFS-1 and NLFS-1 should be closed and OLFS-2 and NLFS-2 should be open. CR2 control relay would then be de-energized.

6. Under this condition, CR1 control relay would be energized through NLFS-L OLFS-1, CR1-1, and CR3-1 (water solenoid open) would all be closed, resulting in the refrigerant liquid solenoid (LS) being open.

7. The refrigerant level in the surge drum rises until the level reaches the operating level float switch. As the float rises up in the float chamber, the contacts of the switch reverse (i.e., OLFS-1 opens and OLFS-2 closes). When LS closes, a green pilot light indicates that the refrigerant level has dropped approximately one inch and that the liquid solenoid will open to maintain the surge drum refrigerant level.

— The hand expansion valve on the liquid feed line to the surge drum can be adjusted to obtain a steady modulation of the liquid level within the one

inch differential of the float switch.

8. In the event that the refrigerant liquid solenoid fails to close or the load drops (causing the refrigerant level to raise above the OLFS switch), the high level float switch contacts would reverse. This would de-energize the CR1 control relay causing LS to close. At the same time, the CR2 control relay would energize causing the CR2-1 contacts to open (which shuts off the compressor circuit), and the CR2-2 contacts to close (turning on the red pilot light indicating high level).

9. A set of terminal connections are wired parallel with CR2 relay for connection to a remote alarm circuit.

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

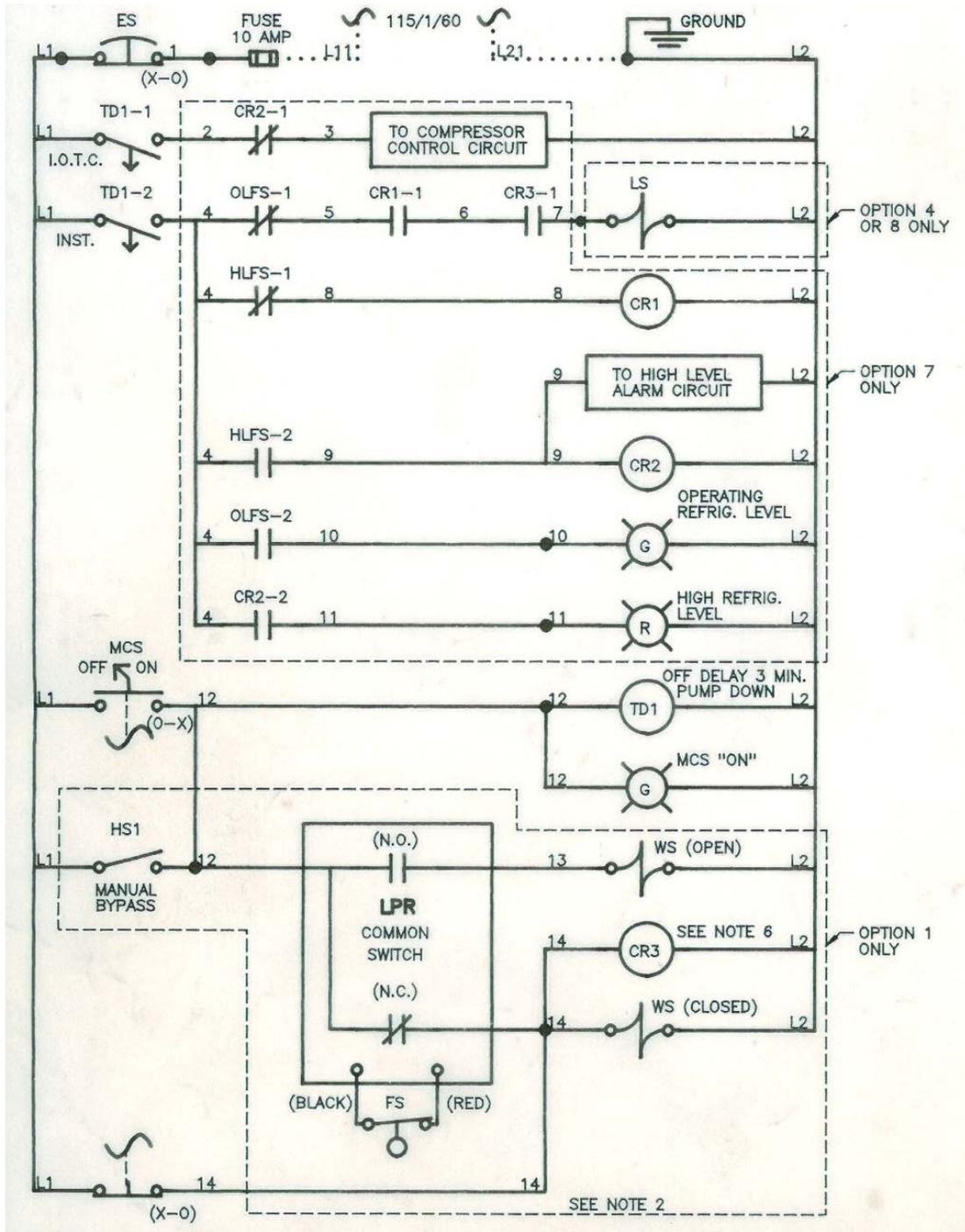


FIGURE 4-1. Typical Chiller Wiring for Flooded system

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

**Shut Down Procedure
(Flooded Ammonia
Chiller)**

Turn the master control switch (MCS) to the "off" position.

The following sequence should occur:

1. Time delay relay TD1 is de-energized and the power to the water solenoid switch relay LPR is removed.

- The WS (closed) switch on the motor actuated water solenoid is energized through a contact block on the MCS switch assembly, causing the water solenoid to close regardless of the sump float switch position.

2. TD1-2 should open instantaneously upon turning MCS "off". This should terminate power to the refrigerant feed circuit and close the refrigerant liquid solenoid.

3. TD 1-1 should start to time open (0-3 minute off delay). With the refrigerant liquid solenoid "off" and the compressor circuit "on", the refrigerant system should start to pump down until either the compressor cycles "off" on suction pressure through the compressor low suction pressure safety switch, or the TD1 time delay times out and the TD1-1 contacts open.

**Pump and Water
Distributor Circuit**

The chilled water is drawn from the sump (reservoir) and pumped to the process or other distribution points. The pump is typically supplied by others.

If the water is recirculated or returns to the chiller the return water should enter at the water connection on the front of the chiller.

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. This water runs continuously while the machine is in operation.

Overflow Drain Circuit

An overflow drain box or standpipe is provided in the reservoir to allow for overflow in case of water surges or interruption of flow to the process.

The overflow drain box is piped to the outside of the unit for field connection to a drain line.

During shutdown, the water that drains back to the reservoir from the

water circulating system and water distribution pan(s) may cause the reservoir to overflow.

**Typical Shutdown
Sequence**

The TURBO® Chiller can be turned off without pump down of the system during daily operation. If the system is to be shut down for longer time periods a pump down of the system including the evaporator plates is recommended. For daily operation the chiller operation is typically terminated by turning the master control switch off. It is also recommended that an emergency stop and the safety failure switches be provided.

Normal shutdown is initiated by turning the master control switch (MCS) to the OFF position or by a remote signal. 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:

- Process controls
- Time clocks
- Remote safety interlocks

After a normal shutdown sequence is initiated, the

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

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.

Note:
The high side package can be provided with an optional pump-down cycle to keep the refrigerant in a receiver or combination condenser/receiver.

WARNING
CHILLER 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.

Shutting Equipment Off For an Extended Period of Time

An extended period of time is more than forty-eight (48) hours.

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, and water pump(s). 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) can also be provided to adjust the RPM of the condenser fan motor to

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

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.

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 26°F system, the pressure is reduced from a condenser pressure of 150-250 PSIG to 40 PSIG for ammonia; 50 PSIG for R-22. 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.

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

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

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.

High Pressure Liquid Line

Operating Instructions
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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

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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.

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
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.

Flooded System Operating Parameters

Saturated Evaporator
26°F Minimum (40 PSIG for ammonia; 50 PSIG for R-22).

Note:
SET (saturated evaporator temperature) for the chilling mode is noted above. For condenser selection use a SET 10°F above Chilling mode SET for calculating the Total Heat of Rejection (THR) used for selecting the condenser. This ensures adequate sizing for start-up and pull down loads.

THR (total heat rejection) is evaporator load plus compressor input for open compressor at selected SET. For example: Chiller SET is 26°F, therefore select condenser based on 26°F + 10°F = 36°F
THR = Evaporator load (BTU/HR) @ 36°F + compressor BHP @ 36°F x 2,545

Fluid Temperature
Water “on” chiller plates: Specified by customer. For entering water temperatures above 90°F consult the factory

Water “off” chiller plates: Minimum 32.5°F for water; consult factory for other fluids

Fluid Flow Rates
Reference Table 4-1

Surge Drum Location
Minimum 42" for ammonia; 72" for R-22

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

This distance is from the top of the evaporator plate to the bottom of the drum.

Relief Valve Setting
250 PSIG

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

Direct Expansion (DX) HTD Chillers

Self-Contained DX Chillers

Direct expansion (DX) chillers are typically supplied with refrigerant R-22 although direct expansion ammonia systems are also available. DX chiller use a thermal expansion valve (TXV) with a refrigerant distributor, and distributor tubes to meter the refrigerant to the evaporator plates. Since the plates are not overfed in the same manner as recirculated chiller, the gas leaving the plates is superheated and free of liquid. The dry suction gas leaving the plates is returned to the suction of the compressor through a dry suction line. This line is connected to a suction accumulator/heat exchanger before the compressor to boil off any liquid refrigerant resulting by momentary overfeed of the TXV or improper adjustment of the TXV superheat setting. Superheat setting is covered later in this section.

Self-contained chillers consist of the DX chiller mounted on a common skid with the condensing unit. The condensing unit

consists of the motor/compressor assembly and condenser.

Various operating conditions are described in this section as well as options available for DX systems.

Controls

All DX Chiller models operate in the same basic way and control panel components are the same except for size (larger magnetic starters for pumps, compressors, condenser fan and pump motors, etc.). The control panel contains:

- Programmable logic controller (PLC)
- Magnetic starter for the:
 - Water pump(s)
 - Compressor(s)
 - Condenser fan and pump(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)

Note:

Controls necessary for components used to distribute the chilled water 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
- 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

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

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 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 and stop the chiller. Turning the selector switch to the OFF position initiates a shutdown sequence. Actual termination of operation occurs immediately.

Operating Instructions

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 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 that are field wired to the control panel by others.

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 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

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

Water Pump Selector Switch (MAN/AUTO)-Option

During normal operation, the MANUAL/AUTO selector switch should always be in the AUTO position. In this position, the Chiller water recirculating pump will run to supply water to the chiller evaporator plates and /or other chilled water distribution points when the programmable controller logic (PLC) output module is ON. At the termination of the chilling operation, the water pump is turned OFF through the PLC logic.

During service, maintenance, or cleaning of the evaporator plates or reservoir, the water pump can be turned ON manually by placing the selector switch in the MANUAL position. In this 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 reservoir. If the switch is placed in the MAN position, the water pump will run even if the reservoir 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 chiller after a preset time delay (typically 2 seconds).

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.

Reservoir Water Level Controls

Refer to the chiller manual Options Section for the operation of the water level controls (Option #1) for the chillers. The operation of the water level controls is the same for both the DX and flooded chillers.

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:

- Compressor failure – CM-1 interlock fails to close or opens during operation
- Water pump failure – WP‘X’-1 interlock fails to close or opens during operation (if

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the unit has 3 pumps, then $X = 3$; for 4 pumps, then $X = 4$; etc.)

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.

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

Operating Instructions

draws air from the outside through an inlet grill and filter.

Control Circuit Fuses

A 10 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 Chiller 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 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).

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

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 (by others)

- NH₃ pump - recirculated units only (by others)

Outputs

- Electric motor starter coils
 - Water pumps
- Remote signal to optional equipment (high side, recirculation unit, etc.)
- Solenoid valve coils on refrigerant control valves (if applicable)

Additional I/Os can be provided for remote equipment operation (optional).

All chiller controls, 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(s), water pump(s), and other motors supplied by TURBO.

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.

Start -Up Procedure

Turn the master control switch (MCS) to the "on" position.

The following sequence should occur:

1. Time delay relay (TD1) energizes. Contacts TD1-1 and TD1-2 instantaneously close. A green pilot light indicates that the switch is in the "on" position.
2. When TD1-1 closes, the compressor control circuit terminals are energized, providing power to the compressor safety circuit and the refrigerant liquid solenoid valve through the TD2-1 contacts. TD1-1 is already closed; therefore, the liquid solenoid opens and the increase in pressure causes the low pressure cut-out switch (LP) to

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"make", starting the compressor. (If the LP switch does not close, the TD2-1 contact times open and closes the liquid solenoid valve. To restart the chiller, MCS must be turned "off" and then back "on" to reset the time delay relays).

3. The refrigerant liquid solenoid valve is held open through a compressor interlock and remains open until the MCS switch is turned "off."

Shut-Down Procedure (DX Chillers)

The shut-down procedure for the DX chillers is the same as for the flooded chillers. Refer to the flooded chiller manual.

In addition to the procedure described in the flooded chiller manual, the TD2-1 contact of TD2 should close instantaneously on the DX chiller. The refrigerant liquid solenoid will still remain closed, allowing the system to "pump-down" since the TD1-2 contact opens at the same time TD2-1 closes.

The system will now pump-down and shut-off on low pressure with refrigerant stored in the condenser or receiver, as applicable. When MCS is turned "on", the system will automatically restart (i.e., TD1-2 contact closes and opens LS through TD2-1. Opening the liquid solenoid raises the pressure in the system causing the low pressure

cut-out to "make" and start the compressor.)

Refrigeration Systems (Self-Contained R-22

Models: SC/SCA/SCE/SCAR and SCER)

Self-contained R-22 models are available in four types: SC water-cooled condenser, SCA air-cooled condenser, SCE evaporative-cooled, SCAR air-cooled remote, and SCER evaporative-cooled remote. SCER and SCAR require installation of the condenser in the field; i.e. the condenser is not mounted on a common skid with the compressor/motor assembly and chiller. All of the self-contained models have the same refrigeration system and functionally are the same.

SC Models

The SC models have a complete refrigeration system within the confines of the unit frame. The liquid refrigerant charge is stored in the lower shell portion of the combination condenser/receiver. A king valve is provided in the liquid line leaving the condenser/receiver. Liquid refrigerant flows from the condenser / receiver through a filter drier, sight glass and liquid solenoid valve and

enters a liquid-to-suction gas heat exchanger where the liquid refrigerant is sub-cooled. The sub-cooled liquid then enters a thermostatic expansion valve where it is metered and fed to a refrigerant distributor and then delivered to the evaporators where the refrigerant load is applied via the water flowing over the outside of the plates. The refrigerant load applied to the plates causes the liquid refrigerant to evaporate into a gas. The refrigerant gas is drawn from the evaporators and flows by means of the suction line through the liquid to suction gas heat exchanger.

This heat exchanger introduces a small amount of superheat into the suction gas that ensures that no liquid droplets of refrigerant will enter the compressor. The suction gas then enters the compressor where it is then discharged to the water-cooled condenser. The water-cooled condenser removes the heat of rejection induced by the refrigeration load at the evaporators and the heat of compression and thereby condenses the hot gas back to liquid and stores the liquid in the lower half of the condenser shell ready

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

for passage through the system again.

The thermostatic expansion valve is controlled by a sensing device, which is temperature actuated, placed on the suction line coming from the suction header, and regulates the area of the expansion valve orifice opening through which the liquid must flow. During the chiller operation, the refrigerant liquid solenoid remains open at all times.

A cooling tower and cooling tower pump are also required for the high side and can be provided as options. The cooling tower is typically not mounted on the skid with the high side water-cooled condenser.

SCA/SCAR Models

The SCA unit has a receiver instead of a combination condenser/receiver and includes an *air-cooled* condenser piped into the refrigerant circuit on the discharge side of the compressor. The hot gas is condensed into a liquid in the air-cooled condenser and then flows to the storage receiver.

The SCAR units operate the same as the SCA but are furnished without the air-cooled condenser. A receiver is furnished with the SCAR model but must be installed and connected

to a remote air-cooled condenser. The condenser is also available as an option.

SCE/SCER Models

The SCE unit has a receiver instead of a combination condenser/receiver and includes an *evaporative-cooled* condenser piped into the refrigerant circuit on the discharge side of the compressor. The hot gas is condensed into a liquid in the air-cooled condenser and then flows to the storage receiver.

The SCER units operate the same as the SCE but are furnished without the evaporative-cooled condenser. A receiver is furnished with the SCER model but must be installed and connected to a remote evaporative-cooled condenser by others. The condenser is also available 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.

RECIRCULATED OPERATION

Recirculated chiller for ammonia and R-22 require a refrigerant pumping system to supply refrigerant to the chiller. The refrigerant recirculator systems typically consists of a pressure vessel (surge drum) with a wet suction connection, a dry suction connection, a liquid valve connection, a liquid feed assembly with hand expansion valve to reduce the high pressure line supply to evaporator pressure, relief valve assembly, a primary refrigerant and stand-by refrigerant (if specified, and a refrigerant level control system for the surge drum. The surge drum separates the liquid and gas returned from the chiller in the wet suction line and return dry gas to the compressor via the dry suction line. Refrigerant feed to the surge drum is controlled by the refrigerant level controls. As the chilling process evaporates a portion of the liquid flowing through the chiller and it is returned to the compressor, liquid to replace this refrigerant is metered in to the surge drum through a hand expansion valve.

Typically operating conditions and sequence of operation are described below. The operating sequence is typical for ammonia and R-22 chillers.

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.

If the unit fails to start, refer to section 5 – Trouble-Shooting.

Operation continues in this mode until the unit is turned off or a safety failure occurs.

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.

As the refrigerant leaves the plates, the liquid-vapor mixture is collected in the wet suction header. The wet suction branch line is connected to 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.

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

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

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

Never leave the oil accumulator isolated for extended periods of time. Excessive pressure will develop in the isolated drum.

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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.

Control Devices

Compressor/NH₃ Pump/Liquid Solenoid Control Relay

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 Control Relay is energized via an output of the PLC. When the relay is energized, a normally open (N.O.) dry contact of the Control Relay (-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 chiller operation). For evaporators connected to a central system, the dry contacts can be used to indicate the status of the chiller (ON/OFF) at a remote control panel such as the central equipment room.

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 Control Relay (-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 chiller 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.

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.

Note:

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

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 chiller will not operate without this input present. Refer to the wiring diagram provided with the Chiller 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.

Operating Instructions

Field wiring by others is required for all installations. A jumper is not installed between the terminal strip connections when the evaporator is shipped.

Refrigerant Level Float Switches (FSHL) - Electronic Level Probe

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.

Pump and Water Distributor Circuit

The water is drawn from the reservoir and pumped to the process or to the water distribution header in the Chiller.

Overflow Drain Circuit

An overflow drain box is provided in the reservoir to allow for overflow incase of surges in the water flow.

The overflow drain box is piped to the outside of the unit for field connection to a drain line.

Shutting Equipment Off For an Extended Period of Time

An extended period of time is more than forty-eight (48) hours.

Close the isolation “king” valve on the outlet of the optional

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

receiver or optional combination condenser/receiver.

Turn off the three phase electrical power to the compressor, NH3 pumps, water pump(s), and other 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.

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.

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

Specifications

Specifications

Refrigerant

Refrigerant grade NH₃ (ammonia) – do not use agricultural grade NH₃.

Evaporator Temperature

26°F (40 PSIG for ammonia; 50 PSIG for R-22) Minimum for water; consult factory for other fluids including glycols.

Design Conditions

Water Cooled

Condensing 105°F
(214 PSIG for R-22; 214 PSIG for ammonia)
Water in 85°F
Water out 95°F
Design wet bulb: 78°F

Evaporative Cooled

Condensing 95°F
(181 PSIG for R-22; 181 PSIG for ammonia)
Design wet bulb: 78°F

Air Cooled

Condensing 120°F
(260 PSIG for R-22; 272 PSIG for ammonia)
Design dry bulb 100°F

Note:

SET (saturated evaporator temperature) for the chilling mode is noted above. For condenser selection use a SET 10°F above Chilling mode SET for calculating the Total Heat of Rejection (THR) used for selecting the condenser. This ensures adequate sizing for start-up and pull down loads.

THR (total heat rejection) is evaporator load plus compressor input for open compressor at selected SET. For example:

Chiller SET is 26°F, therefore select condenser based on 26°F + 10°F = 36°F
THR = Evaporator load (BTU/HR) @ 36°F +

compressor BHP @ 36°F x 2,545

Refrigerant Feed

Pumped liquid at a recirculation rate of 4:1.

Make-Up Water Temperature

- Entering water temperature specified by customer. Above 90°F consult factory
- Leaving water temperature minimum 32.5°F for water; consult factory for other fluids.

Make-Up Water Pressure

At inlet to water distribution header 8 PSIG

Make-Up Water Flow

Flow rates for standard chiller plates are shown in the table below.

Table 4-1 Plate Specifications (Per Plate)

	Plate Overall Length, inches			
	48"	72"	96"	144"
Plate Overall Wetted Length, inches	44	68	92	140
Plate Overall Depth, inches	60	60	60	24
Maximum water flow, Gallons per minute	44	68	92	140
Maximum water flow, Gallons per minute	5.5	8.5	11.5	17.5
Internal volume, cubic feet	0.31	0.47	0.64	0.35
Weight, pounds	105	158	210	126

Note: 1. All plate sizes and data are standard for R-22 and ammonia applications.

2. Consult factory for other materials or flow conditions.

3. All data is per plate. To determine total flow for a plate bank multiply the data above by the number of plates in the system. For example a HTDA960606 chiller is a flooded chiller with six (6) 96" by 60" plates. The maximum water flow for this system is:

$$\text{Maximum Flow} = 6 \text{ plates} \times 92 \text{ GPM per plate} = 552 \text{ GPM}$$

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

Make-Up Water Feed

Control

Reference TURBO option kit
#1 for “Water Level Controls”

Evaporator Plates

304 Stainless Steel
Hydraulically blown to inflate
to proper rise.
304L available as option.

Design Operating Pressure

200 PSIG

Burst Pressure

1,500 PSIG

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

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.

Reservoir Water Level Controls

Refer to the chiller manual Options Section for the operation of the water level controls (Option #1) for the chillers. The operation of the water level controls is the same for both the DX and flooded chillers.

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

GLYCOL SYSTEM OPERATION

Glycol chillers use propylene or ethylene glycol as a secondary refrigerant that is pumped through the plates to chill the fluid flowing over the exterior of the plates. A glycol pumping system to supply the glycol is required (by others). The system typically consists of a pump, and a glycol chiller.

Typical operating conditions and sequence of operation are described below.

Typical Start-Up

The master control switch (MCS) is turned to the ON position.

Through the PLC, a signal energizes the remote optional glycol system, glycol pump(s) and the external water system.

If all other safety switches in the glycol system and pumping systems are in a “non-trip” status, the water pump(s) for the external flow over the plates, compressor motor and controls for the glycol system, and the glycol pump start to supply glycol to the chiller. .

With the glycol system on, refrigerant (glycol) is pumped to the evaporator plates and water flows over both sides of each evaporator plate.

If the unit fails to start, refer to section 5 – Trouble-Shooting.

Operation continues in this mode until the unit is turned off or a safety failure occurs.

Typical Refrigerant Sequence

Glycol is pumped to the top of each plate bank. Liquid enters the evaporator plates through glycol supply headers. Water is circulated over the outside of the vertical evaporator plates. The water is ON anytime the unit is running.

As the refrigerant leaves the plates, the glycol is collected in the suction header or glycol return. The suction/glycol return branch line is connected to main glycol return line (by others).

Pump and Water Distributor Circuit

The water is drawn from the reservoir and pumped to the process or to the water distribution header in the Chiller.

Overflow Drain Circuit

An overflow drain box is provided in the reservoir to allow for overflow in case of surges in the water flow.

The overflow drain box is piped to the outside of the unit for field connection to a drain line.

Shutting Equipment Off For an Extended Period of Time

Glycol chillers should be drained and cleaned both internally and external if they are being stored or taken out of service for extended time periods. Extended period of time is more than 30 days. Refer to the cleaning and maintenance sections of the manual for additional information on cleaning.

The refrigeration system (by others) for the glycol chiller may require a pump down to isolate the refrigerant charge into the receiver or combination water-cooled condenser/receiver. This is typically done by closing 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, glycol pumps, water pump(s), and other 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.

Specification

Glycol Temperature

The temperature of the glycol pumped through the evaporator plates is determined by the application to obtain the desired fluid temperature of the external flow over the plates. If the external flow is water, the glycol temperatures would never be lower than 25°F. The flow rate through the plate(s) as well as the glycol temperature and concentration can be adjusted to obtain the desired leaving temperature of the external fluid.

The glycol entering and leaving temperatures are calculated for each application to meet the refrigeration load and external fluid temperature requirements.

Glycol Flow

The flow for the internal glycol flow is calculated for each application to provide the maximum performance without minimal pressure drop through the plates. Flow rates are typically selected for a pressure drop through the glycol circuit

of 10 PSIG or less (16 PSIG Maximum). The number of plates used can be adjusted to ensure the flow rates meet the pressure drop criteria.

Glycol Pressure

As indicated above the glycol circuit is designed for 10 PSIG or less pressure drop through the plates. The maximum design pressure drop is 16 PSIG. Glycol pumps should be sized for the pressure drop specified above plus all piping losses, elevation losses, and valves losses. For example, select a glycol pump for the following conditions;

- Glycol flow rate: 138 gallons per minute (GPM).
- Refrigerant: 42 % propylene glycol
- Pressure drop – evaporator: 11 PSIG
- Pressure drop –system (piping, elevation, and valves): 15 PSIG

Solution:

- Total pressure drop = 11 +15 = 26 PSI

or

- For 42% propylene glycol at 65.4 pounds per cubic foot = 57.2 foot of head.

Pump selection:

- 138 GPM at a 57.2 foot head (26 PSI).

The maximum glycol pressure at the inlet to the glycol circuit is 85 PSIG. Above 85 PSIG, the plates deflect enough to cause water distribution

problems in chiller with longer plates (96” and 144” plates).

Consult factory if inlet pressures higher than 85 PSIG are to be provided to the chiller.

Note: The pressure limit on the glycol circuit is not to prevent plate failures or leaks. The plate burst pressures are well beyond these pressures. However, plate bowing that causes erratic flow over the plate exterior can result. Erratic flow can affect the chiller performance including high leaving fluid temperatures and freeze up in areas starved for adequate fluid flow.

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



Chiller Operation & Maintenance Manual

Section 5: TROUBLE-SHOOTING

This section lists common problems and suggests solutions with various chillers and chiller systems. Some of the problems and solutions apply to optional equipment or equipment supplied by others and may vary. 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 or pump(s) "off" or "tripped".</i></p> <p><i>Improper signal at the programmable controller.</i></p> <p><i>Chiller 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>Emergency stop button depressed.</i></p> <p><i>Overload relay on magnetic starter tripped.</i></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>
<p>Unit drawing high amps (compressor or water pump motors).</p>	<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>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>

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>Chiller evaporator temperature too high; leaving water temperature too high</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>Ammonia Recirculated Models:</i> <i>NH3 pump off or flow restricted (recirculated system).</i></p> <p><i>Low on NH3.</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>

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>Balance all hand expansion valves to maintain adequate refrigerant to all sections. Open the valve(s) if necessary until proper evaporator temperature is obtained. Note: It may be necessary to close the hand TXV to other sections/chillers to increase flow to chiller that is not operating properly. Adjust hand expansion valve to maintain 40-45 PSIG in each chiller. Reference chiller specifications for evaporator temperature.</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><i>Insufficient water flow to condenser (water cooled):</i></p> <ul style="list-style-type: none"> - <i>Strainer plugged.</i> - <i>Float valve defective (make-up water line to cooling tower).</i> - <i>Pump impeller worn</i> <p><i>Condenser pump prime lost – low water level in sump.</i></p> <p><i>Condenser water make-up valve closed or restricted.</i></p> <p><i>Recirculating water pump off:</i></p> <ul style="list-style-type: none"> - <i>Motor overloads tripped.</i> - <i>Water recirculating pump prime lost.</i> <p><i>Low water level in reservoir.</i></p> <ul style="list-style-type: none"> - <i>Strainer plugged.</i> - <i>Check valve stuck closed.</i> <ul style="list-style-type: none"> - <i>water connection broken or water supply lost</i> - <i>water level sensor switch defective</i> 	<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.</p> <ul style="list-style-type: none"> - leak in sump or piping - water line broken - isolation valve in water line closed <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. Remove and clean. Remove and clean. 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>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>

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 solenoid coil failed</i></p> <p><i>Evaporator plates oil logged.</i></p> <p><i>Orifice in liquid header to evaporator plate plugged.</i></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>Consult factory.</p>
High suction pressure.	<p><i>Water temperature too high.</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>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 supplied by others or separately, consult supplier's data for additional information.	<p><i>Refrigerant system overcharged.</i></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>Verify actual charge. Reduce charge as required.</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>

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
	<i>Check position of all isolation valves and pressure controls.</i>	Open all valves fully open or to correct position. Make sure all pressure controls are properly adjusted and in automatic position.
<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>Excessive motor temperature. 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><i>Defective or worn bearing.</i></p> <p><i>Structural support under unit insufficient.</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 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>

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



Chiller Operation & Maintenance Manual

Section 6: MAINTENANCE

To help you get the best performance from your Chiller 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 chiller daily to determine that the unit is operating properly. Observe the fluid flow over the plates to ensure the water distribution system is free of debris. Check as required.

When starting, observe that the discharge and suction pressures are correct on the gauges and are stable to ensure the proper refrigerant feed to the chiller.

Weekly Inspections (Includes accessory equipment used with the Chiller System)

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

Clean the chiller weekly:

- Clean the water distribution pan and header. The distribution header can be easily disassembled to remove debris inside the header or clear plugged holes.
- If necessary remove the water distribution header from the water distribution pan and wipe out all loose debris in the pans. Unplug holes in the pans as required to ensure complete flow over the entire plate.
- Check for indications of discoloration on the frame, water, pans, panels, and headers. If necessary use citric acid to clean the areas using a non-abrasive cleaning pad. Follow the cleaning with a fresh water rinse.

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

After Initial Ten Hours of Operation

Check for indications of discoloration on the frame, water, pans, panels, and headers. If necessary use citric acid to clean the areas using a non-abrasive cleaning pad. Follow the cleaning with a fresh water rinse.

After Initial Fifty Hours of Operation

Check for indications of discoloration on the frame, water, pans, panels, and headers. If necessary use citric acid to clean the areas using a non-abrasive cleaning pad. Follow the cleaning with a fresh water rinse.

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 any system using water is scale build-up resulting from:

- Solids forming the plates
- Solids build-up in the water distribution pan and headers

- 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.

Goldenrod water treatment systems are also available from Vogt Ice. The Goldenrod can eliminate scaling problems in most cases. Consult the factory for additional information.

Plates Forming Scale

Flush plates with an acceptable icemaker cleaner – typically citric acid. Have water analyzed.

Stainless Steel Surface Cleaning

Scale on the chiller 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 and/or 304L 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.

Citric acid cleaning agents are also recommended for frequent cleaning. Regular

Maintenance

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

use eliminates the need to use stronger acids such as the nitric acid mixture to remove built up scale.

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, consult the factory.

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.

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

Table 6-2 Sample Weekly Maintenance Log Sheet

Date _____

Evaporator plates clean

First Shift Start	_____	First Shift End	_____
Second Shift Start	_____	Second Shift End	_____
Third Shift Start	_____	Third Shift End	_____

Frame, panel interior, water distribution pan and headers clean

First Shift Start	_____	First Shift End	_____
Second Shift Start	_____	Second Shift End	_____
Third Shift Start	_____	Third Shift End	_____

Water flow across all plates providing complete wetting of plate surface

First Shift Start	_____	First Shift End	_____
Second Shift Start	_____	Second Shift End	_____
Third Shift Start	_____	Third Shift End	_____

Chiller High Side Head (discharge) Pressure within normal range (Reference manual for various refrigerants and condensing types)

First Shift Start	_____	First Shift End	_____
Second Shift Start	_____	Second Shift End	_____
Third Shift Start	_____	Third Shift End	_____

Chiller Suction Pressure within normal range (Reference chiller specifications for proper pressure)

First Shift Start	_____	First Shift End	_____
Second Shift Start	_____	Second Shift End	_____
Third Shift Start	_____	Third Shift End	_____

Compressor Oil Pressure

First Shift Start	_____	First Shift End	_____
Second Shift Start	_____	Second Shift End	_____
Third Shift Start	_____	Third Shift End	_____

Chiller Entering Water Temperature within Normal Limits

First Shift Start	_____	First Shift End	_____
Second Shift Start	_____	Second Shift End	_____
Third Shift Start	_____	Third Shift End	_____

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

Chiller Leaving Water Temperature within Normal Limits

First Shift Start	_____	First Shift End	_____
Second Shift Start	_____	Second Shift End	_____
Third Shift Start	_____	Third Shift End	_____

Chiller Inlet Water Pressure within Normal Limits

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	_____

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

TURBO[®]

REFRIGERATING

Chiller Operation & Maintenance Manual

Section 7: OPTIONS AND ACCESSORIES

Option Kits

A number of options are available with HTDA, HF AND UHTD chillers. A few of the options are described below and include the basic

kits for the chiller water and components for the refrigeration systems as well as condensing units, refrigerant recirculation packages, complete skid mounted systems and more.

Figure 1 below shows the basic option kits available for chillers.

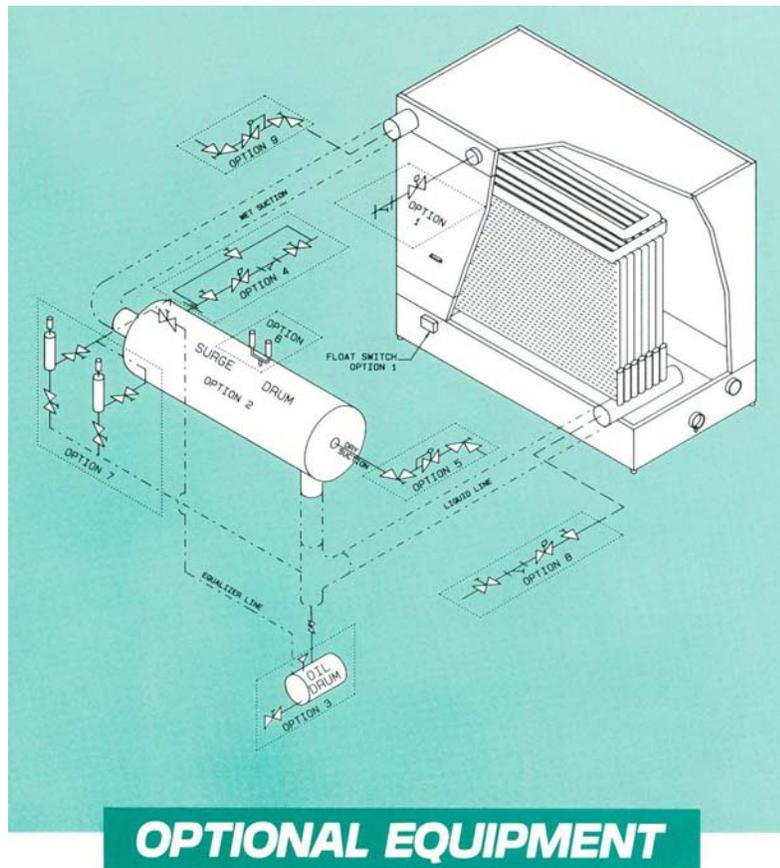


Figure1. Chiller Option Kits – Flooded and Recirculated Models

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

Standard option kit descriptions:

Option #1

Water Level Controls – All Chiller Model

The water level controls consist of a motor actuated water solenoid, water strainer, and a float switch assembly.

The float switch assembly consists of a SPDT switch mounted in a "splash" enclosure on the end of a stainless steel rod. This rod acts as the adjusting arm and wiring conduit for the float switch. A wiring junction box is mounted on top of the rod.

A set of plastic blocks are attached to the fixed lower panel in the upper frame of the chiller. The top block can be removed and the rod assembly installed between the two blocks. Loosen the two (2) bolts holding the plastic blocks together and move the assembly up or down as required to obtain the desired water level in the sump.

The float switch contacts are rated for pilot duty only. A solid state switching relay (LPR) is used with the float switch to activate the motor actuated solenoid. Refer to the wiring diagram for connections.

Starting with the sump empty and MCS "on", the following sequence would occur:

1. The float switch (FS) should be on the bottom of the "splash" enclosure. The normally closed contact of the load-pack relay (LPR) should be open and the LPR relay should be energized.
2. With the LPR energized, the normally open contact should be closed, energizing the WS (open) switch of the water solenoid. The valve should rotate a 1/4 turn and stop, permitting water to enter the sump.
3. Water will continue to enter the sump until either MCS is turned "off" or the water level reaches FS.

— If MCS is turned "off", power to the common terminal on the LPR is disconnected and switched to the WS (closed) switch on the water solenoid valve.

- If the water level reaches FS, the float moves up the stem of the switch causing

the N.C. FS contact to open. When FS opens, the LPR relay de-energizes causing the N.C. contacts to close. The WS (closed) switch on the water solenoid is energized and the water solenoid valve closes.

- If the sump water level drops below FS and MCS is "on", the FS and the LPR relay contacts should reverse. The WS (open) switch in the water solenoid should be energized and the valve should rotate 1/4 turn to the open position. 4. FS and the LPR relay will continue to maintain the desired water level until MCS is turned "off" (see note 3).

Notes: If the sequence of the water solenoid is opposite the sequence described above, it can be reversed by changing the wires on the N.C. and the N.O. contacts of the LPR relay or turning the float on FS.

4. A CR3 control relay is

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

shown in parallel with the water solenoid. Its function is to close the refrigerant liquid solenoid valve when the water supply is shut off. This is done to prevent surging of the low pressure surge drum during no load conditions

If a different method of control is used and the CR3 relay is

WS (open) switch of the omitted, a pilot light, surge suppressor, metal-oxide variator, or some type of load must be wired parallel with WS (open) in order for the LPR relay to function properly.

4. Water level controls are intended for use at a high level control. Water flow to the chiller can be

controlled in the water return connection or make-up water connection. Flow control valves may also be used on the outlet connection of the sump to maintain a steady sump water level.

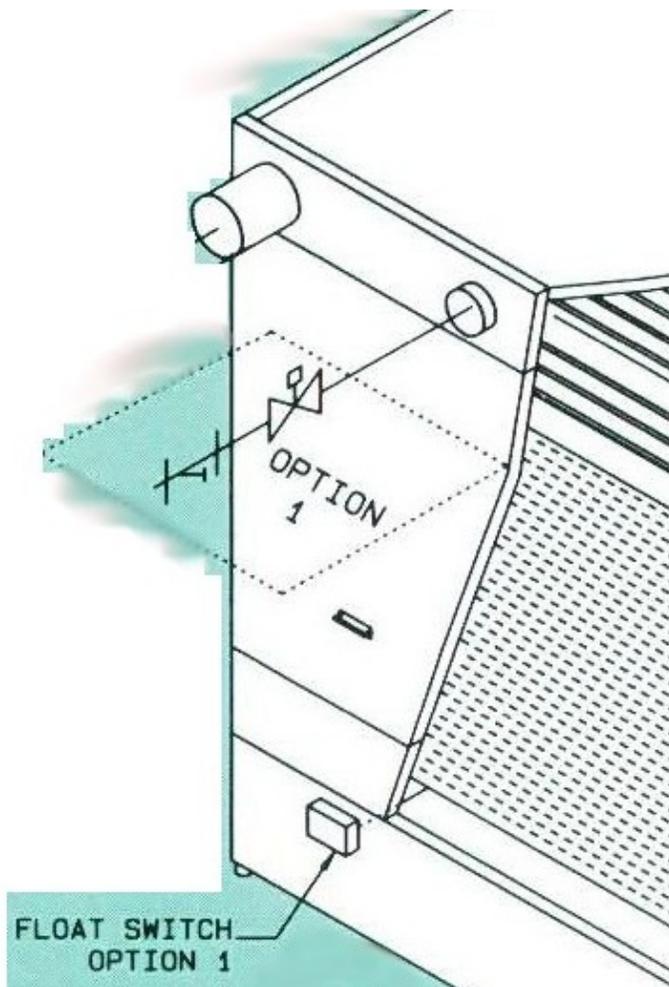


Figure 2. Water Level Controls Option

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

**Option #2
Surge Drum (Flooded Ammonia)**

A low pressure vessel (surge drum) operating at evaporator pressure is used to maintain a liquid seal on the evaporator, and provide separation of the liquid from the vapor in the wet return line.

Each surge drum is provided with a liquid leg connection in the bottom of the drum, a

wet suction connection on the end opposite the liquid leg connection, a dry suction connection to the high side, a high pressure liquid connection, a relief valve connection and a gas (top) connection for the refrigerant float switch assembly. The bottom float switch assembly is installed in the liquid leg by others.

The normal operating level in the surge drum is three inches. Each surge drum is sized to

match the design conditions for the application. Sufficient volume is allowed for pull-down and operation at higher loads for short periods. Float switch assemblies should be set to a seven inch high level setting.

Insulation of the surge drum and all connections is field installed by others.

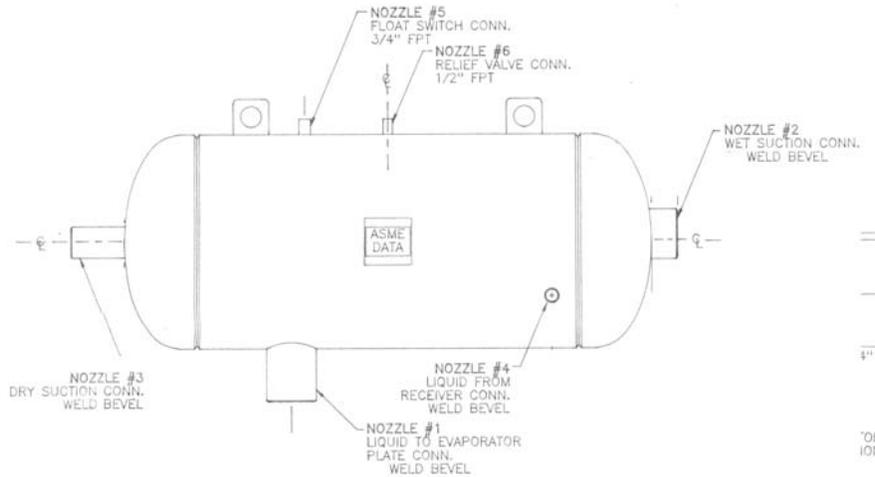


Figure 3. Typical Surge Drum

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

Option #3

Oil Drum (Ammonia)

In flooded ammonia systems, the refrigerant oil contained in the liquid ammonia must be removed from the system before it enters the chiller plates. The liquid leg from the surge drum to the chiller is not provided with any of the option kits. When the liquid leg is field installed, it should be provided with an oil pot lower than the horizontal portion of the liquid leg. This allows the oil to collect in the bottom of the liquid leg before it reaches the chiller refrigerant inlet.

To remove the refrigerant oil, an oil drain drum with an isolating valve is provided. This drum is also provided with a 150 # relief valve.

The isolating valve, located between the oil pot on the liquid leg and the drum inlet, is closed.

A drain valve is located on the bottom of the oil drum to remove the oil.

**exposure
to ammonia in the
event of an accident
Failure to carefully
follow these
instructions
could result in
permanent injury or
loss of life.**

WARNING

Only qualified service personnel should remove oil from the oil drum. Such personnel should have proper knowledge of handling ammonia as well as treatment for

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

**Option #4
Liquid Line Valve
Package**

High pressure refrigerant is supplied to the surge drum through a refrigerant solenoid valve, strainer, and hand expansion valve to drop the pressure to the lower system operating pressure in the surge drum.

A by-pass hand expansion valve is piped in parallel to the refrigerant solenoid valve, strainer, and isolating valve. By closing the main hand expansion valve and isolating valve, the solenoid valve and strainer may be serviced without shutting the system off (for service or emergency use only).

The operation of the refrigerant solenoid is controlled by the float switches OLFS and NELS mounted on the surge drum.

between the valves. NEVER leave the isolating valve closed unless service is being performed. When operating the strainer or solenoid valve, the refrigerant between the isolating valve must be bled off slowly. Failure to carefully follow these instructions could result in permanent injury or loss of life.

WARNING

Only qualified service personnel should attempt to service the refrigerant solenoid valve or strainer. When the isolating valves are closed and the line is exposed to heat, excessive pressure can develop

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

**Option #5
Suction Line Package
with Pressure
Regulator**

Isolating valves are provided on both sides of the pressure regulator so that it can be serviced without affecting the rest of the system.

To prevent ice formation on the chiller plates due to variations in system loading, a suction pressure regulator is installed in the dry suction line from the surge drum to the system high side.

During periods of low load on the system, resulting from reduced water flow or lower temperature water entering the chiller, the suction pressure regulator senses the lower upstream pressure (surge drum pressure) and modulates to close the regulator. As the regulator closes, the upstream pressure increases. As the pressure increases, the regulator modulates open to reduce the surge drum pressure. The regulator continues to modulate and control the surge drum pressure to the desired pressure setting.

For a typical chiller system using water as the chilled media, a suction temperature of 26°F can be used without icing the chiller plate(s).

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

**Option #6
Dual Relief Valve
Assembly**

Two pressure relief valves mounted on a three-way valve are needed to protect the surge drum from excessive pressure.

For ammonia systems, a 150 PSIG relief valve is used. Only one relief valve is in use at a time. If the relief valve in use should open, the chiller should be shut off immediately and the cause of the problem determined.

Before restarting the chiller, the three-way valve should be closed to isolate the relief valve in use at the time of the overpressure. When the three-way valve closes the 'A' relief valve, it opens the 'B' relief valve thus providing continuous protection. After the first valve has been isolated, it should be replaced with a new valve.

**and relief valve.
Failure to carefully
follow these
instructions could
result in permanent
injury or loss of life.**

WARNING

Only qualified personnel should attempt to replace the relief valve. Caution must be used in removing the valve to prevent sudden exposure to refrigerant between the three-way valve

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

**Option #7
Refrigerant Level
Control**

Two refrigerant floats are used to control the refrigerant level in the surge drum.

The normal refrigerant operating level in the surge drum is three inches and is controlled by the lower operating level float switch (OLFS). The refrigerant liquid solenoid will remain open and feed refrigerant through the hand expansion valve in the liquid line until the refrigerant level raises the float in the float switch. This causes the switch contacts to reverse and shut off refrigerant flow to the surge drum.

If the OLFS switch should fail to shut off the refrigerant or if the system should surge, a high refrigerant level switch (HLFS) is also provided. The HLFS switch shuts off the refrigerant liquid solenoid, as well as the compressor circuit. Contacts are also provided for connection to a remote alarm circuit.

A typical operating sequence is described below:

1. The refrigerant level

control circuit is energized.

2. At start-up, the refrigerant is below the level of the operating level (OLFS) and high level (HLFS) float switches, therefore, the refrigerant liquid solenoid valve should energize to feed liquid to the surge drum through the hand expansion valve.

The solenoid valve will remain open until the liquid level reaches the operating level of the OLFS and then it closes.

3. As the liquid level in the surge drum drops below the differential (approximately one inch) of the float switch, the liquid solenoid should open and feed refrigerant to the surge drum until OLFS reaches its operating level and shuts the liquid solenoid "off."
4. If the refrigerant level does not reach the operating level, the hand expansion valve should be opened SLOWLY to allow additional refrigerant flow. Adjust the hand expansion valve until there is a steady modulation of the refrigerant solenoid valve through

OLFS.

Each float switch is provided with two (2) isolating valves to allow service of the float switches without purging the entire surge drum.

Only qualified service personnel should perform service work or remove the float switches. Caution must be used to remove the refrigerant contained in the float switch chamber and piping from the isolating valves to the float switch. NEVER leave both isolating valves closed except when performing service (i.e., when exposed to heat, excessive pressure can develop between the two isolating valves when closed. Purge the refrigerant as soon as possible after closing the valves.) Failure to carefully follow these instructions could result in permanent injury or loss of life.

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

Aligning motor and compressor assembly

Chiller models are furnished with direct coupled motors and compressors. The coupling center section is shipped loose for field installation. The compressor and motor are carefully aligned at the factory before testing.

Coupling Center

Check for alignment before inserting the coupling center section.

Compressor Motor

Inspect the compressor motor alignment with a dial indicator to check if it may have been disturbed during shipment or installation. See Table 3-1.

Motor & Compressor Flanges

Check the alignment of the motor and compressor flanges with a dial indicator on the motor flange. The procedure for checking alignment and alignment tolerances follow. Both angular and parallel must be checked. For the details on the compressor manufacturer alignment procedure, refer to the Installation, Start-Up and Service Instructions located in the Appendix & Notes Section.

Motor/Compressor Assembly

The motor/compressor assembly is doweled to the base after the factory alignment is completed to help maintain alignment and aid in repositioning the motor after servicing.

Compressor Alignment

If, for any reason, the compressor alignment is not within tolerance after reinstallation of the coupling, it must be realigned (refer to Table 3-1).

Doweling Procedure

Since doweling is performed after the motor/compressor alignment has been hot checked (i.e. compressor has been run and brought up to operating temperature after initial alignment), some models are shipped from the factory without doweling.

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

In such cases, doweling is done after the initial start-up of the

equipment. The following procedure is used:

1. With the compressor at operating temperature, verify the compressor alignment.
2. With the compressor still at operating temperature, drill and ream two (2) holes diagonally opposite on both the compressor and motor. Do not ream the holes too deep. Part of the dowel pin should protrude above the compressor or motor foot (see step 4 below). See Figure 3-12.

Tools Required:

- Drill motor
 - 9/32" diameter drill
 - #6 taper reamer
3. Insert the #6 x 2 1/2" hardened taper dowel pins in the holes.
 4. Using a rubber hammer or mallet, tap the dowel lightly into position. Leave 1/8" – 3/16" of the dowel pin above the motor foot (required to tap and loosen the dowel for removal when required).
 5. Coat the dowels with white lead or lubricant to prevent rusting.

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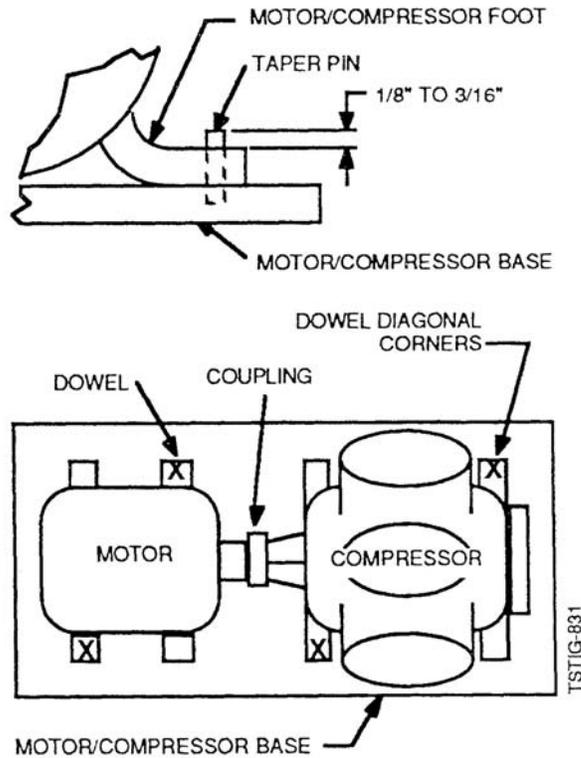


Figure 3-12 Doweling

Reference

Refer to the compressor manufacturer alignment procedure in the Installation, Start-Up and Service Instructions in the Appendix & Notes Section

Table 3-1 Compressor Alignment Tolerances

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

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

TSTIG-833

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

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

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

Optional Condensing Units

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 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 for all models except SC, SCA and SCE. Models without the refrigerant are supplied with either a nitrogen holding charge only. SC, SCA and SCE models are factory charged prior to shipment except for international shipments. International shipments for all models are shipped with a nitrogen holding charge only.

NOTE:

The nitrogen holding charge is approximately 15PSIG and must be relieved before beginning the

evacuation and charging process.

Structural Base Frame

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

Field Piping

SC, SCA and SCE models are factory piped including the refrigerant piping between the evaporator section and the condensing unit – no refrigerant field piping is required. Field piping between the condensing unit and all other components is required for SCAR and SCER models with remote air-cooled (SCAR) or evaporative -cooled (SCER) condensers. Field piping is by others.

Electrical Service

SC, SCA and SCE models are factory wired including the wiring between the evaporator section and the condensing unit – no field wiring is required. Field wiring between the condensing unit and all other components is required for SCAR and SCER models with remote air-cooled (SCAR) or evaporative -

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cooled (SCER) condensers. Field wiring is by others.

Single-phase and three-phase electrical service to the evaporator section and all other components is field installed by others.
Terminal block

connections are provided in the control panel. Main circuit breakers and branch circuits breakers and/or disconnects are not provided. Main and branch protection must be provided by others in accordance with all

local, state and federal codes.

Cooling Tower and Cooling Tower Pump(s)

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

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

Optional Flooded Unit

TIG evaporators are available for flooded operation with refrigerant R-22. For flooded models the evaporator is 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.

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.