TURBO® Refrigerating
HTD and HF Chillers

Manual Part Number 12A4171M15

Service Manual
$50.00 USD
NOTICE

This manual is the property of the owner of this particular Vogt Ice, LLC machine.

Model #____________________ Serial #____________________

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

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

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

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

Please return to: Vogt Ice, LLC
1000 W. Ormsby Ave.
Suite 19
Louisville, KY 40210
Warranty Registration / Start-Up Form - HTD and HF Series Chillers

Model Number:  Serial Number:

This form must be filled out completely and signed by the customer in order to assure acceptance by Vogt.

Date of Start-Up:  Form Completed By:

Distributor

Company Name:  Phone:

Address:  City:  State:  Zip:

Service Company

Company Name:  Phone:

Address:  City:  State:  Zip:

Customer (Location of Equipment)

Company Name:  Phone:

Address:  City:  State:  Zip:

PRE-OPERATION CHECK

- Machine room suitable 40°F min., 100°F max.
- Chiller securely mounted to reservoir (if supplied)
- Chiller (or reservoir) securely mounted to floor or base
- Water supply and drains connected properly
- All accessory components (oil traps, surge drums, valve packages, etc.) are properly installed
- Field connections to chiller per data sheet
- Field piping weld joints cleaned, passivated and leak free
- Evaporator plates properly evacuated and charged with refrigerant
- Relief devices properly installed and vented to safe location
- Instruction manual and warranty certificate left on-site
- Name of person left with: _________________________

OPERATION CHECK

- Evaporator plates clean
- Frame, panel interior, water distribution pan, and headers clean
- Water flow across all plates providing complete wetting of plate surfaces
- Suction pressure at suction header on chiller per data sheet
- Entering water temperature at chiller per data sheet
- Leaving water temperature at chiller per data sheet
- Inlet water pressure between 5 PSIG and 100 PSIG
- Ambient temperature _________ °F

Comments:


Technician Signature:  End User Signature:

I certify that I have performed all of the above procedures
Vogt Ice, LLC

Manufacturers of Quality Ice Machines

Located in Louisville, Kentucky since 1880

Sales – 1-800-959-8468
Service – 1-502-635-3000
Parts – Your Local Distributor

Call your local distributor first for all of your parts and service needs
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Chapter 1: Introduction

A Brief History of Our Company

The Henry Vogt Machine Co. was founded as a small machine shop in Louisville, Kentucky in 1880. In 1938, Vogt built the first Tube-Ice® machine and revolutionized the ice-making industry. Our first “sized-ice” machine quickly replaced the old can-ice plants, which required much hard labor and large amounts of floor space for freezing, cutting, and crushing ice by hand.

The Henry Vogt Machine Co. eventually sold its Tube-Ice® division to Vogt Ice, LLC. Since that time, Vogt Ice, LLC acquired Turbo Refrigeration® in 1989, a company which has become a market leader of plate ice equipment.

With the strong history of these two brands, Vogt Ice, LLC carries on the tradition as one of the world’s leading producers of ice-making equipment.

TURBO® Refrigeration

In 1989, Vogt acquired TURBO® which had been producing a line of fluid chillers since 1984, as well as icemakers and ice generators for the ice industry since 1960. Today, Vogt continues the tradition of building TURBO® equipment under the Vogt name. 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-404A, 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 Series

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 plate. Ammonia, R-404A 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 and Refrigerant Feeds

Chillers are available in R-404A, ammonia, and glycol with direct expansion (DX), flooded, and recirculated refrigerant feed.

Associated Equipment

Modular C-Line Ice Makers (MCL)

Packaged ice applications require a dry sub-cooled ice to avoid the formation of large blocks of ice in the product bags. To meet this need, Vogt produces the MCL icemaker, which uses a water defrost to produce 15 tons per day of ½” thick ice per unit using ammonia. Multiple units can be purchased and installed side-by-side to achieve the desired ice capacity for the system installation.

Modular Hot Gas Ice Generators (MHG)

In industrial applications where ice with a dry surface is not required, Vogt offers the MHG icemaker, which uses a hot gas defrost to produce 26 tons per day of ½” thick ice per unit using ammonia. As with the MCL, multiple units can be installed side-by-side to achieve the desired ice capacity for the installation.

Typical Applications:

- Produce and food processing
- Concrete icing
- Ingredient icing (bakeries)
- Fish and poultry icing
- Chemical and dye processes
- Emergency cooling loads
- Ice slurries
- Catering trucks
- Salad bars or display ice
**Ice Storage Systems**

TURBO® rakes and storage bins were introduced in 1967. Today, Vogt offers four sizes ranging in capacity from 49 tons up to 87 tons of ice storage. These rakes have been used in USDA inspected installations.

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.

**USDA Design**

All Vogt 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.

**Block Press**

Vogt 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 BP360 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 up to 360 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

**Special Applications**

Vogt Ice, LLC 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:

Vogt Ice, LLC  
1000 W. Ormsby Ave.  
Louisville, KY 40210  
Phone: (502) 635-3235  
Fax: #502-635-3024  
Web Site: [www.vogtice.com](http://www.vogtice.com)
Vogt SuperCare Customer Service

The SuperCare group at Vogt provides assistance for all customer service needs, including parts sales and warranty support. SuperCare also conducts training schools at the factory and can offer on-site training if needed.

Note: The model and serial number of your Vogt equipment is located on the nameplate attached to the electrical control panel. If an electrical control panel was not furnished with your machine, the nameplate will be located on the equipment frame or paneling. Please refer to the model and serial number when making inquiries to SuperCare about your machine. This will enable us to handle your questions quickly and accurately.

Important Safety Notice

This information is intended for use by individuals possessing adequate backgrounds of electrical, refrigeration and mechanical expertise. Any attempt to repair major equipment may result in personal injury, property damage, or loss of life. The manufacturer or seller cannot be responsible for the interpretation of this information, nor can it assume any liability in connection with its use.

Safety Symbols and What They Mean

Prior to installation or operation of your machine, please read this manual and be familiar with its contents. Before you operate, adjust or service this machine, you should read this manual, understand the operation of this machine, and be aware of possible dangers.

These Safety Symbols will alert you when special care is needed. Please heed.

<table>
<thead>
<tr>
<th>! DANGER !</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indicates an immediate hazard and that special precautions are necessary to avoid severe personal injury or death</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>! WARNING !</th>
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<tbody>
<tr>
<td>Indicates a strong possibility of a hazard and that an unsafe practice could result in severe personal injury</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>! CAUTION !</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indicates that hazards or unsafe practices could result in personal injury or product or property damage</td>
</tr>
</tbody>
</table>
Chapter 2 : Receipt of Your Chiller

<table>
<thead>
<tr>
<th>! CAUTION !</th>
</tr>
</thead>
<tbody>
<tr>
<td>Only service personnel experienced in ammonia refrigeration should be allowed to install or to work on this machine.</td>
</tr>
<tr>
<td>Eye protection should be worn by all personnel working on or around the chiller.</td>
</tr>
<tr>
<td>It is very important that you are familiar with and adhere to all local, state, and federal, etc. ordinances and laws regarding the handling, storing, and use of anhydrous ammonia.</td>
</tr>
<tr>
<td>An approved ammonia mask should be readily available for use in an emergency and all personnel should be aware of its location and proper use.</td>
</tr>
</tbody>
</table>

| ! CAUTION ! |

Inspection

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

Delivery Inspection Checklist

- Inspect panels
- Open and inspect loose equipment and crate(s)
- Inspect evaporator plates
- Inspect piping and valves (if supplied)

<table>
<thead>
<tr>
<th>! CAUTION !</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use only the appropriate equipment with adequate loading capacity to move and install the machine.</td>
</tr>
</tbody>
</table>

| ! CAUTION ! |

Storage (Prior to Installation and Start-Up)

Chillers should be stored in a protected area to prevent the panels from damage.
Chapter 3 : Installation of HTD and HF Series Chillers

<table>
<thead>
<tr>
<th>! WARNING !</th>
</tr>
</thead>
<tbody>
<tr>
<td>Only service personnel experienced in ammonia refrigeration should be allowed to install or to work on this machine.</td>
</tr>
<tr>
<td>! WARNING !</td>
</tr>
</tbody>
</table>

Important Notice

The Warranty Registration / Start-Up Form must be completed and returned to Vogt Ice, LLC to initiate and to ensure a full warranty. A postage paid envelope is provided or you may fax the report to 1-800-770-8648.

Installation of HTD and HF series chillers requires field fabrication of refrigeration and water piping. Chillers should be installed in areas where the ambient temperature does not fall below 40°F or rise above 100°F to maintain proper operation. All HTD and HF chillers are insulated from the factory to protect against higher ambient temperatures. Sumps offered for HTD chillers are also insulated. uHTD chillers cabinets are not insulated.

Adequate working space should be provided on all sides, including the top, for easy access for service and cleaning operations. The data sheet provided with the chiller will indicate the recommended working space.

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.
**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: Connections can be located on the opposite side of the unit by rotating the upper chiller section 180° before placing it on the 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!!!

**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](image1)

![Chiller Sump Lifting Orientation](image2)

**Figure 3-2 – Typical Chiller Lifting Orientation**
Hoisting or Moving

If a chiller is installed in a location that requires the unit to be lifted by means of a crane, Vogt 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.

<table>
<thead>
<tr>
<th align="left">! CAUTION !</th>
</tr>
</thead>
<tbody>
<tr>
<td align="left">Never lift or sling the chiller with devices fastened to the top frame structure.</td>
</tr>
<tr>
<td align="left">Lift the chiller only from the bottom of the plate bank.</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th align="left">! WARNING !</th>
</tr>
</thead>
<tbody>
<tr>
<td align="left">Hoisting or moving heavy equipment should only be done by competent rigging and hoisting contractors.</td>
</tr>
<tr>
<td align="left">Never allow personnel to go under the unit while it is in the air.</td>
</tr>
<tr>
<td align="left">Failure to carefully follow these instructions could result in permanent injury or loss of life.</td>
</tr>
</tbody>
</table>

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>
<thead>
<tr>
<th>Model</th>
<th>Shipping Weight (lbs)</th>
<th>Operating Weight (lbs)</th>
<th>Dimensions (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Length</td>
</tr>
<tr>
<td>HTDx 480601</td>
<td>1,482</td>
<td>2,466</td>
<td></td>
</tr>
<tr>
<td>HTDx 480602</td>
<td>1,587</td>
<td>2,637</td>
<td></td>
</tr>
<tr>
<td>HTDx 480603</td>
<td>1,692</td>
<td>2,809</td>
<td></td>
</tr>
<tr>
<td>HTDx 480604</td>
<td>1,797</td>
<td>2,981</td>
<td></td>
</tr>
<tr>
<td>HTDx 480605</td>
<td>1,902</td>
<td>3,153</td>
<td></td>
</tr>
<tr>
<td>HTDx 480606</td>
<td>2,001</td>
<td>3,324</td>
<td>68</td>
</tr>
<tr>
<td>HTDx 480607</td>
<td>2,112</td>
<td>3,496</td>
<td></td>
</tr>
<tr>
<td>HTDx 481207</td>
<td>2,540</td>
<td>4,634</td>
<td></td>
</tr>
<tr>
<td>HTDx 481208</td>
<td>2,645</td>
<td>4,805</td>
<td></td>
</tr>
<tr>
<td>HTDx 481209</td>
<td>2,750</td>
<td>4,977</td>
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</tr>
<tr>
<td>HTDx 481210</td>
<td>2,855</td>
<td>5,149</td>
<td></td>
</tr>
<tr>
<td>HTDx 481211</td>
<td>2,960</td>
<td>5,320</td>
<td></td>
</tr>
<tr>
<td>HTDx 481212</td>
<td>3,065</td>
<td>5,492</td>
<td></td>
</tr>
<tr>
<td>HTDx 481213</td>
<td>3,170</td>
<td>5,664</td>
<td></td>
</tr>
</tbody>
</table>

Table 3-1 – Shipping and Operating Weights for 48” HTD Series Chillers
<table>
<thead>
<tr>
<th>Model</th>
<th>Shipping Weight (lbs)</th>
<th>Operating Weight (lbs)</th>
<th>Dimensions (in)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>HTDx 721207</td>
<td>3,347</td>
<td>6,296</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HTDx 721208</td>
<td>3,505</td>
<td>6,557</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HTDx 721209</td>
<td>3,663</td>
<td>6,818</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HTDx 721210</td>
<td>3,821</td>
<td>7,079</td>
<td>92</td>
<td>60</td>
</tr>
<tr>
<td>HTDx 721211</td>
<td>3,979</td>
<td>7,340</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HTDx 721212</td>
<td>4,137</td>
<td>7,601</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HTDx 721213</td>
<td>4,295</td>
<td>7,862</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3-2 – Shipping and Operating Weights for 72” HTD Series Chillers
<table>
<thead>
<tr>
<th>Model</th>
<th>Shipping Weight (lbs)</th>
<th>Operating Weight (lbs)</th>
<th>Dimensions (in)</th>
<th></th>
</tr>
</thead>
<tbody>
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Table 3-3 – Shipping and Operating Weights for 96” HTD Chiller Models
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<th>Dimensions (in)</th>
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Table 3-4 – Shipping and Operating Weights for uHTD Series Chiller Models

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Table 3-5 – Shipping and Operating Weights for 144” HF Series Chiller Models
### Reservoir Specifications

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<th>No. of Plates</th>
<th>Chiller Model</th>
<th>Overall Tank Dimension (in)</th>
<th>Water Level (in)</th>
<th>Gallons per Inch</th>
<th>Sump Weight (lbs)</th>
<th>No. of Legs</th>
<th>Capacity (gal)</th>
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**Table 3-6 – Chiller Reservoir Specifications**

**Outdoor Installation**

Insulated chillers are suitable for outdoor installation, although a cover over the roof panels is recommended at minimum to keep debris and snow from collection on the roof, preventing the top panels from opening. Chiller performance is adversely affected when ambient temperatures exceed 100°F, and risk freezing up at ambient temperatures below 40°F.

Indoor installation is the preferred method for ease of cleaning, maintenance, and service access in all weather conditions.

uHTD Series chillers are not suitable for installation outdoors.

**Raised Curbing**

A raised curbing around the outside of the chiller is recommended to contain any condensate, leakage, or cleaning fluid during maintenance operations. A curbing height of two (2) to three (3) inches is typically sufficient.
**Elevated Installation**

Some installations may require mounting a portion of the chiller cabinet above grade, shown in Figure 3-3. A structural steel platform capable of supporting static and dynamic loads must be provided in these cases.

Consult a local firm that specializes in the design and construction of structural steel supports to guarantee compliance with local codes and ordinances.

![Figure 3-3 – Elevated Installation](image)

**Mounting and Leveling**

Set the chiller on a solid and level base, floor, or slab. If the mounting surface is not level, the chiller must be shimmed to level to ensure proper water flow over the evaporator plates. Level must be considered for both the length and width of the machine. A level with a minimum length of 48 inches is recommend to ensure a good installation.

All chiller reservoirs are provided with levelling legs, shown on the data sheet provided with the unit.

**Note:** Failure to follow these guidelines will result in poor water distribution across the evaporator plates, leading to reduced chilling capacity and/or freeze ups.

**Access, Service, Air Space**

When laying out the unit installation, adequate space must be provided around the unit for service and general access.
Water System

General Requirements

Water temperature and flow are used to determine the number of evaporator plates required for the application. All capacities are based on the entering and leaving water temperatures, specific heat of the fluid, and the flow rate over the chiller plates. This determines the heat load for the system. The number of plates used in the chiller is determined by considering the heat load against the saturated suction temperature at which the system will be running. When water is the fluid being chilled, the minimum evaporator temperature is 26°F to prevent ice formations on the plates.

Each water distribution pan contains many small holes that direct flow across the surface of the evaporator plates. In operation, these holes may become plugged with debris or scale, requiring periodic cleaning to maintain the desired chilling capacity.

Water Supply and Drain Connections

Properly size the supply and drain piping to the chiller to deliver the specified flow and pressure on the data sheet. The data sheet will also contain information about the size and location of each.

Water connection points on the chiller are designed for a minimum inlet pressure of 5 PSIG and a maximum of 100 PSIG. When utility water pressure exceeds 100 PSIG, a pressure reducing valve must be installed on the supply line to the chiller cabinet. An expansion tank or other device may need to be installed in high water pressure systems to prevent water hammer at the chiller.

Pump connections are provided at the bottom of the reservoir to be used in recirculation or distribution systems.

The reservoir also contains connection points for an overflow connection to handle surge volumes and a drain connection to aid in cleaning operations. These connections should be piped to a drain location.

Water Quality and Treatment

When the fluid to be cooled is water, its quality can adversely affect the performance and corrosion resistance of the system if proper corrective action is not taken. A water analysis performed by a water treatment company is recommended.

All city water sources contain dissolved solids (minerals), gasses, and other organics. The degree of concentration of each of these depends on location, the type of treatment at the utility source (i.e. – water treatment plant), and the local geology.

At high enough concentrations, minerals in the water can cause scale build up on the evaporator plates. This most frequently is in the form lime and calcium build-up, which can be treated with conventional scale cleaning agents. Some water sources contain higher amounts of silica, which forms a clear, glass-like scale. Mechanical cleaning is the only removal method for silica scale. If the plates are not cleaned of fouling, the leaving water temperature cannot be obtained. Details on cleaning procedures are provided in the maintenance section.

Free chlorine is common in utility water sources. As it is discharged from the water distribution header and falls over the evaporator plates, it is released from the water in gaseous form. High concentrations of chlorine in the source water will lead to high concentrations of chlorine gas inside of the chiller cabinet, causing corrosion of
stainless steel surfaces that are not wetted during operation. This includes the water distribution pans, chiller frame, exterior panel surfaces and refrigerant headers. Additionally, it can be a hazard to service technicians, who may become nauseous or develop headaches during prolonged exposure. The standard chiller offering contains a vent hood that is designed to allow chlorine gas to escape from the machine. If this standard offering is declined, an alternate venting method must be installed. Chlorine can be vented during cleaning routines when the chiller cabinet doors are opened for this operation. When this is performed weekly, the chlorine gas concentration is often not high enough to be a cause for concern.

Due to the low water temperatures experienced in a chilling system, organic matter in the source water can lead to mold, slime, and fungal growth in the chiller. Left unchecked, fungal and slime growth can affect the water flow across the plates, leading to freeze ups and poor chiller performance. The application will determine the extent to which bio-growth affects the water supply itself, but it can pose a hazard to service technicians. Consult a local water treatment firm about any bio-growth in your chiller.

All of these can be prevented with the use of an appropriate water pre-treatment system. If minerals, gasses, and organics are removed from the water supply before reaching the chiller, it will extend the life of the chiller and reduce cleaning intervals by keeping the evaporator plates and water distribution system clean. Consult a local water treatment firm about pre-treatment options for your installation.

At minimum, Vogt recommends that a strainer be installed in the make-up water line to prevent larger debris from plugging the holes in the water distribution pan(s). Strainers are offered as an option for all chillers.

**Water Temperature**

The temperature of the water being fed to the chiller is critical to achieving the designed capacity of the unit. Typical incoming water temperatures are between 35°F and 90°F. Leaving water temperatures can be within 0.5°F of the freezing point of the fluid. For water chilling applications, the recommended minimum incoming water temperature is 35°F to avoid freeze up conditions.

**Water Distribution Header**

A PVC water distribution header is located inside the unit. 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 pipe ID from both ends.

Holes in the water 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.

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 allow uniform distribution of the fluid across the plates. The size and number of holes in the pans are selected to match the flow requirements specified by the customer. This design point considers the water pan(s) being half full. 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 it. For USDA applications, a perforated PVC sheet is used instead as a filter element, which requires more frequent cleaning to ensure proper distribution at all times.

**Insulation**

Fluid lines connected to the chiller should be insulated by others to reduce heat infiltration and condensation.

**Electrical Connections**

Chillers are not provided with electrical components and do not require field wiring to the cabinet. Methods of refrigerant and water control to the chiller cabinet are by others.

**Refrigerant Connections**

All piping in the chiller is provided standard as 304 stainless steel. Optional 304L piping is available. Typically, refrigerant connections are stubbed out on the right side of the unit. 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.

When connecting refrigeration piping, you must follow and adhere to all piping codes required in the jurisdiction of installation. Vogt recommends ASHRAE 15 “Safety Standard for Refrigeration Systems,” and ASME B31.5 “Refrigeration Piping and Heat Transfer Components,” which are required in many locations throughout the world. Make sure all piping is kept clean, dry, and contaminate free. All piping should be supported properly.
If carbon steel piping is connected to the chiller, special care must be taken to shield the cabinet and evaporator plates from carbon dust. If left unprotected, carbon dust can settle on the stainless steel surfaces, causing pitting and corrosion.

Refrigerant piping connection sizes and locations are listed on the data sheet provided with each chiller.

Chillers are vacuum leak checked and shipped with a small nitrogen holding charge to prevent contamination during shipping and storage. To keep the system clean, avoid making field connections that may remain open for extended periods prior to start-up of the system.

**Leak Test of Field Installed Refrigeration Piping**

Testing for leaks ensure a tight system that operates without loss of refrigerant. Field piping leak tests must be performed according to piping codes required in the jurisdiction of installation. Vogt recommends following the guidelines in ASHRAE 15 “Safety Standard for Refrigeration Systems,” and ASME B31.5 “Refrigeration Piping and Heat Transfer Components.” The maximum recommended test pressure for the evaporator plates is 150 PSIG.

When the appropriate test pressure has been obtained, leak checks can be performed easily with a soap solution. This can be purchased from a local refrigeration supply store or mixed on site with four (4) parts water and one (1) part liquid soap. A few drops of glycerin can be added to the mixture to improve capillary action.

Apply the soap solution to all weld joints and flanges with a narrow brush or spray bottle. Bubbles will form if a leak is present. Mark any leak joints that are discovered and relieve the pressure from the system before repairing.

Weld joints should be repaired by grinding out the defective area and re-welding.

<table>
<thead>
<tr>
<th>! DANGER !</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never attempt to repair weld joints while a piping system is still under pressure.</td>
</tr>
<tr>
<td>Performing welding or grinding operations under pressure can result in a sudden release of pressure and result in serious injury or loss of life.</td>
</tr>
</tbody>
</table>

| ! DANGER ! |
Evacuating the System

Refrigeration systems operate best when only refrigerant is present in them. Steps must be taken to remove all air, water vapor, and other non-condensables from the chiller unit before charging it with refrigerant. If these are left in the system, various operating difficulties will be encountered. 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. Air and non-condensables will lodge in the condenser, causing a rise in system head pressure that will result in decreased capacity at the chiller.

A properly evacuated system is dry and free of air, water, and non-condensable gasses. Evacuation operations should be performed when the ambient temperature is in excess of 60°F to allow for proper moisture boil off.

Use a high vacuum pump and a gauge rated for vacuum service. The pump used should be capable of obtaining a blanked-off pressure of 10 microns or less. Connect it the system and allow it to operate until the system pressure is below 500 microns as indicated by the vacuum gauge.

If the chiller is installed in a system containing a large volume of new piping, the system may need to be evacuated multiple times. This can be done with the following method:

1. Seal off the system and allow the vacuum pump to reduce the pressure as low as possible.
2. Continue to operate the pump for five (5) or six (6) hours.
3. Shut off the pump and let the system stand for five (5) or six (6) hours.
4. Break the vacuum and increase the system pressure with oil free dry nitrogen to zero (0) PSIG.
5. Seal off the system and allow the pump to reduce the pressure below 500 microns.
6. Continue to operate the pump for two (2) or three (3) hours.
7. Shut off the pump and let the system stand for no less than three (3) hours.
8. Break the vacuum and increase the system pressure with oil free dry nitrogen to zero (0) PSIG.
9. Seal the system for a third time and allow the pump to reduce the system pressure below 500 microns.
10. Continue to operate the pump for six (6) hours.
11. Shut off the pump and let the system stand for 12 hours.
12. Break the vacuum and increase system pressure with oil free dry nitrogen to just above zero (0) PSIG.
13. Evacuate the system to below 500 microns and charge with refrigerant.
Charging the System with Refrigerant

<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
</table>

Only service personnel experienced in ammonia refrigeration and qualified to work on such equipment should be allowed to charge the system with refrigerant.

It is very important that you are familiar with and adhere to all local, state, and federal regulations and ordinances regarding the handling, storage, and use of anhydrous ammonia.

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

| CAUTION |

All chiller models are furnished without a refrigerant charge. The unit must be evacuated and then charged with the appropriate refrigerant for the application.

Whenever refrigerant is added to any chiller system, extreme care should be taken during the charging process. Avoid overcharging the system as it will create high discharge pressures.

Table 3-7 lists the operating charge for each individual evaporator plate. To determine the operating charge of your chiller, simply multiply the number of plates in the chiller by the weight shown in the table.

<table>
<thead>
<tr>
<th>Evaporator Feed Type</th>
<th>Plate Size</th>
<th>R-717</th>
<th>R-404A</th>
<th>R-22</th>
<th>20% Propylene Glycol</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>48”</td>
<td>7</td>
<td>12</td>
<td>13</td>
<td>20</td>
</tr>
<tr>
<td>Liquid Recirculating</td>
<td>60”</td>
<td>10</td>
<td>18</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>72”</td>
<td>14</td>
<td>25</td>
<td>27</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>144”</td>
<td>8</td>
<td>13</td>
<td>15</td>
<td>22</td>
</tr>
<tr>
<td>Flooded</td>
<td>48”</td>
<td>11</td>
<td>19</td>
<td>21</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>60”</td>
<td>16</td>
<td>29</td>
<td>32</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>72”</td>
<td>22</td>
<td>39</td>
<td>43</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>144”</td>
<td>12</td>
<td>21</td>
<td>24</td>
<td>-</td>
</tr>
<tr>
<td>Direct Expansion</td>
<td>48”</td>
<td>6</td>
<td>11</td>
<td>12</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>60”</td>
<td>9</td>
<td>16</td>
<td>18</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>72”</td>
<td>13</td>
<td>22</td>
<td>25</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>144”</td>
<td>7</td>
<td>12</td>
<td>13</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 3-7 – Evaporator Plate Operating Charges
Relief Devices

Relief valves must be installed on all pressure vessels to prevent excessive pressure build-up in the system. They must be vented to a safe discharge point. Consult local, state, and federal regulations, codes, and ordinances regarding the safe discharge of refrigerants, particularly ammonia. Industrial Codes such as ASHARE 15 and ASME B31.5 provide guidelines for the safe design and installation of pressure relief valve discharge piping.

Vogt provides pressure relief valves on vessels purchased as options with your chiller. These valves are sized according to the guidelines in ASHRAE 15, with consideration given to the size of the vessel.

ASHRAE 15 permits a maximum back pressure of 15% through the discharge piping of conventional relief valves. Table 3-8 contains maximum equivalent pipe lengths for common relief valve sizes at different relief pressures.

<table>
<thead>
<tr>
<th>Relief Pressure (PSIG)</th>
<th>Relief Valve Size (in)</th>
<th>Relief Valve Capacity (lbs air/min)</th>
<th>3/4</th>
<th>1</th>
<th>1-1/4</th>
<th>1-1/2</th>
<th>2</th>
<th>2-1/2</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>1/2 x 3/4</td>
<td>10.6</td>
<td>30</td>
<td>119</td>
<td>524</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1/2 x 3/4</td>
<td>31.3</td>
<td>7</td>
<td>51</td>
<td>125</td>
<td>456</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1/2 x 1</td>
<td>35.8</td>
<td>4</td>
<td>37</td>
<td>92</td>
<td>344</td>
<td></td>
<td></td>
</tr>
<tr>
<td>250</td>
<td>1/2 x 3/4</td>
<td>17.2</td>
<td>22</td>
<td>93</td>
<td>422</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1/2 x 3/4</td>
<td>50.5</td>
<td>25</td>
<td>70</td>
<td>298</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3/4 x 1</td>
<td>17.2</td>
<td>93</td>
<td>422</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3/4 x 1</td>
<td>57.7</td>
<td>25</td>
<td>70</td>
<td>298</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 x 1-1/4</td>
<td>85.4</td>
<td>4</td>
<td>23</td>
<td>124</td>
<td>344</td>
<td></td>
<td></td>
</tr>
<tr>
<td>300</td>
<td>1/2 x 3/4</td>
<td>20.5</td>
<td>19</td>
<td>86</td>
<td>394</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1/2 x 3/4</td>
<td>60.1</td>
<td>32</td>
<td>88</td>
<td>370</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1/2 x 1</td>
<td>68.6</td>
<td>21</td>
<td>63</td>
<td>278</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3/4 x 1</td>
<td>20.5</td>
<td>86</td>
<td>394</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3/4 x 1</td>
<td>68.6</td>
<td>21</td>
<td>63</td>
<td>278</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 x 1-1/4</td>
<td>101.6</td>
<td>19</td>
<td>113</td>
<td>319</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>350</td>
<td>1/2 x 3/4</td>
<td>24.1</td>
<td>27</td>
<td>113</td>
<td>510</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1/2 x 3/4</td>
<td>70.1</td>
<td>46</td>
<td>118</td>
<td>480</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1/2 x 1</td>
<td>80.0</td>
<td>32</td>
<td>86</td>
<td>364</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3/4 x 1</td>
<td>24.1</td>
<td>27</td>
<td>113</td>
<td>512</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3/4 x 1</td>
<td>80.0</td>
<td>32</td>
<td>86</td>
<td>364</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 x 1-1/4</td>
<td>118.5</td>
<td>29</td>
<td>152</td>
<td>419</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3-8 – Maximum Equivalent Length for Relief Valve Discharge Piping
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:

1. Ship it clean
2. Install it clean
3. Keep it clean

Rule #1. Ship it Clean

Vogt passivates all chillers prior to shipment in a nitric acid solution to ensure that contaminates from the manufacturing process are completely removed from the stainless steel surfaces. This process also provides a protective barrier against corrosion. After passivation, the exterior panels are installed, and all areas of the chiller are cleaned.

Prior to shipment, the chiller and reservoir (if supplied) are stretch wrapped for protection 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. Upon completion of the installation process, clean all surfaces using a citric acid cleaner followed by a fresh water rinse.

Rule #3. Keep it Clean

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

Vogt recommends that the chiller should be opened on a weekly basis and the entire interior and exterior surfaces flushed with fresh water at a minimum. 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, resulting in pitting of the stainless steel.

The key to a long corrosion free life for your investment is to keep it clean.

Chiller Protection during Installation

Once set and leveled, a tarp or canvas cover should be used to cover the chiller during all piping and installation. The cover will protect the stainless surfaces from carbon contamination. Reinstall exterior panels after mounting the chiller to protect the reservoir (if supplied) and the interior of the cabinet.
Weld Zone Clean Up

Installation of the chiller includes welding the refrigerant connections. After the welding has been completed, it is recommended that these areas cleaned. Use a wire brush to remove loose scale and passivate the stainless steel section of all carbon-to-stainless weld joints. Follow the instructions on the passivating agent or contact Vogt for additional information. After passivating, the weld area should be rinsed with fresh water.

<table>
<thead>
<tr>
<th>! CAUTION !</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passivation processes must be performed according to the instructions provided by the product manufacture.</td>
</tr>
<tr>
<td>Only specially trained personnel should perform this type of treatment.</td>
</tr>
</tbody>
</table>

| ! CAUTION ! |

When using the passivating gel, proper safety equipment, including eye protection and gloves must 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. If necessary, passivate these areas.

The lifting process can introduce carbon contaminants to the chiller plates, particularly the ones at each end where the straps were in the most contact. It may be necessary to passivate these areas prior to operation.

Final Cleaning

Clean the entire chiller once the installation process has been completed. 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-BriteTM Light Duty Cleaning Pad No. 66 (white in color), or equivalent, to clean difficult areas. These pads are designed specifically for cleaning stainless steel.

Avoid using abrasive pads on the stainless steel surfaces as they can strip off the passive layer, leading to pitting.

After application of the citric acid cleaning agent, rinse with fresh, low chlorine content water.

Note: Citric acid cleaning agents are environmental friendly and can be safely disposed in 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.

Reference the Refrigerant Connections section for additional requirements for securing idle or inactive systems.
Installation Review: A Checklist

☐ Chiller securely mounted to reservoir (if supplied)
☐ Chiller (or reservoir) securely mounted to floor or suitable structural base frame
☐ All accessory components (oil pots, surge drums, valve packages, etc.) are properly installed
☐ Field piping connections are per the supplied data sheet
☐ Field piping weld joints cleaned, passivated (as needed) and leak free
☐ Evaporator plates and associated piping properly evacuated and charged with refrigerant
☐ Water supply and drain piping installed and leak free
☐ Relief devices properly installed and vented to safe location
Chapter 4 : Operation

General Information

HTD and HF series chillers consist of a bank of stainless steel plates mounted in a stainless steel frame. The cabinet is enclosed by two (2) 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. Stainless steel refrigerant inlet and outlet headers are provided on the same side as the water inlet connection.

Additional vessels and valve kits for liquid feed and suction lines may have been purchased as optional equipment.

A stainless steel water distribution pan and a PVC distribution header are installed on top of the plates to evenly distribute flow across the plates and the plate bank. Water depth in the pan should be no less than one (1) inch and no more than four (4) inches to maintain good system operation. Running too little or too much water in the pan can result in a freeze-up condition.

An overflow connection is provided on all reservoirs to allow for surge volumes in the event of a system interruption or significant changes in the incoming water supply. During a shutdown, water that drains down into the sump from the distribution pan(s) above may cause an overflow condition. Field piping must be supplied from this connection point to a drain line.

Liquid recirculating, flooded, and direct expansion chillers can be turned off without pumping down the unit during daily operation. If the system is to be shut down for more than 48 hours, a pump down of the evaporator section is recommended.
**Flooded System**

**Principle of Operation**

Liquid refrigerant is gravity fed from a surge drum into the liquid line(s) at the bottom of the chiller cabinet. This causes the evaporator plates to be filled internally from the bottom to top. Water is fed into the water make-up header(s) at the top of the cabinet. The water floods the distribution pan and cascades over the outside surface of the evaporator plates. With the central refrigeration plant running and relatively warm water falling across the evaporator plates, the liquid refrigerant boils into a saturated vapor at the top suction headers, where it is drawn back into the surge drum, to be carried to the central system compressor. As the water falls across the plates, it is cooled by the boiling refrigerant. The degree of heat removal from the water is dependent upon the evaporator suction temperature, make-up water temperature, and make-up water flow rate.

Water should be flowing over the plates prior to starting up the refrigeration system. If the refrigeration system is started first, a layer of ice could begin to form on the plates, which may temporarily reduce chilling capacity or cause freeze-up issues.

**Surge Drum**

For flooded operation, refrigerant feed to the chiller is dependent upon the use of a surge drum. The drum is installed at an elevation higher than the top of the chiller cabinet and is based on a gravity feed principle. Refrigerant supply to the surge drum must come from the central system High Pressure Liquid Line. This liquid is fed into the surge drum through a valve group, filling it until the level has been satisfied by a level probe or a float switch. The wet suction gas returning back to the surge drum from the chiller is separated in the drum and exits via the dry suction line, passing through a suction valve regulator, and on to the central system compressor.

**Oil Accumulator Drum (Oil Pot)**

To prevent oil from accumulating in the evaporator of an ammonia system, an oil accumulator drum is needed in the bottom of the liquid leg coming out of the surge drum. The oil pot must be installed at an elevation lower than the bottom of the evaporator in order for the oil to drain properly from the system to prevent loss of chilling capacity.
**Liquid Recirculated System**

*Principle of Operation*

Liquid refrigerant is pumped from a recirculator into the liquid line(s) at the top of the chiller cabinet. As the liquid enters the inlet tubes at the top of the evaporator plates, it hits an orifice within the tubes and begins circulating within the plate. Water is fed into the water make-up header(s) at the top of the cabinet. The water floods the distribution pan and cascades over the outside surface of the evaporator plates. With the liquid recirculator running and relatively warm water falling across the evaporator plates, the liquid refrigerant boils into a two-phase liquid/vapor mixture at the top suction headers, where it is drawn back into the main recirculator vessel. In the vessel, the two-phase mixture is separated, with the vapor being carried to the central system compressor. As the water falls across the plates, it is cooled by the boiling refrigerant. The degree of heat removal from the water is dependent upon the evaporator suction temperature, make-up water temperature, and make-up water flow rate.

*Liquid Recirculator*

For liquid recirculation operation, refrigerant feed is dependent upon the use of a liquid recirculator system. A typical recirculator consists of a primary pressure vessel with wet and dry suction connections, liquid feed connections, refrigerant level controls, a refrigerant pump, a hand expansion valve to control the liquid flow rate going to the chiller cabinet, and a hand expansion valve to control the make-up liquid flow rate coming from the central system high side to the recirculator. The primary pressure vessel acts as a liquid/vapor separator for the suction coming back from the evaporator. Wet suction leaves the chiller cabinet and enters the liquid recirculator, where the liquid droplets fall out of the flow, sending dry vapor to the central system compressor.

*Oil Accumulator Drum (Oil Pot)*

To prevent oil from accumulating in the evaporator of an ammonia system, an oil accumulator drum is needed in the bottom of the liquid leg coming out of the surge drum. The oil pot must be installed at an elevation lower than the bottom of the evaporator in order for the oil to drain properly from the system to prevent loss of chilling capacity.
Direct Expansion (DX) System

Principle of Operation

Liquid refrigerant is fed to a thermal expansion valve (TXV) at the bottom of the chiller cabinet from the high pressure liquid line. As the liquid refrigerant passes through the valve, it expands into a two-phase liquid/vapor mixture, passes through the refrigerant distributor, and partially fills the evaporator plates. Water is fed into the water make-up header(s) at the top of the cabinet. The water floods the distribution pan and cascades over the outside surface of the evaporator plates. With the central refrigeration plant running and relatively warm water falling across the evaporator plates, the liquid/vapor mixture boils into a superheated vapor at the top suction headers, where it is drawn back into the suction line of the central system compressor. The central system compressor is protected by a suction accumulator (typically with a boil out coil) to remove any residual liquid refrigerant resulting in a momentary overfeed of the TXV or an improper TXV setting. As the water falls across the plates, it is cooled by the boiling refrigerant. The degree of heat removal from the water is dependent upon the evaporator suction temperature, make-up water temperature, and make-up water flow rate.

Water should be flowing over the plates prior to starting up the refrigeration system. If the refrigeration system is started first, a layer of ice could begin to form on the plates, which may temporarily reduce chilling capacity or cause freeze-up issues.

TXV and Refrigerant Distributors

Critical to the proper operation of a DX chiller is the TXV and the refrigerant distributor and distribution tubes. The TXV must be properly adjusted to a superheat setting that is favorable to the operation of the refrigeration plant. The TXV is installed in the liquid feed line at the bottom of the chiller cabinet and the sensing bulb is installed on the suction header at the top of the machine.

The refrigerant distributor splits the flow coming out of the TXV to each individual plate within the chiller. The coiled tubes coming out of the distributor must be free of kinks and other deformations in order to ensure proper operation of the chiller. Routine inspection of the distribution tubes is recommended, especially following installation and service operations.
**Glycol System**

*Principle of Operation*

Glycol (typically ethylene or propylene glycol) is pumped directly through the top of the evaporator plates in the chiller cabinet. The glycol acts as a secondary refrigeration circuit, the glycol itself being cooled by the primary refrigerant, typically ammonia. Water is fed into the water make-up header(s) at the top of the cabinet. The water floods the distribution pan and cascades over the outside surface of the evaporator plates. As the water falls across the plates, it is cooled by the recirculated glycol. The degree of heat removal from the water is dependent upon the glycol temperature, make-up water temperature, and make-up water flow rate.

Water should be flowing over the plates prior to starting up the refrigeration system. If the refrigeration system is started first, a layer of ice could begin to form on the plates, which may temporarily reduce chilling capacity or cause freeze-up issues.

*Glycol Chiller Shutdown*

Glycol chillers should be drained and cleaned internally and externally if they are being stored or taken out of service for a period in excess of 30 days. Additional information is available in the maintenance section of this manual.

*Glycol Temperature*

The temperature of the pumped glycol through the evaporator plates is determined by the application to obtain the desired temperature of the fluid being chilled on the external surfaces of the plates. If the external flow is water, then the glycol temperature should not be lower than 25°F to avoid freeze up problems. The flow rate of glycol through the plates, along with glycol concentration and temperature, can be adjusted to achieve the desired leaving temperature of the external fluid.

*Glycol Flow*

The flow rate for the glycol system is calculated for the specific application to provide maximum performance with minimum pressure drop through the plates. Flow rates are typically selected for a pressure drop of 10 PSIG or less (16 PSIG maximum). The number of plates used in the chiller can be adjusted to ensure the flow rates meet the pressure drop criteria.

*Glycol Pressure*

Glycol pumps should be sized for a pressure drop not exceeding 16 PSIG, with a drop of 10 PSIG or less being ideal. Other piping losses must be considered as well for a properly designed system.

The maximum glycol pressure at the inlet to the chiller cabinet must not exceed 85 PSIG. Above this pressure, the plates deflect enough to cause water distribution problems resulting in erratic flow that can reduce the chilling capacity of the machine and cause freeze up conditions. Consult the factory if inlet pressure higher than 85 PSIG are to be provided to the chiller.
Chapter 5: Troubleshooting

This section lists common problems and suggests solutions with various chillers and chiller systems. Some of the problems and solutions apply to optional 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, call the factory direct at 502-635-3000 or 1-800-853-8648.

The following describes problems you might encounter, and provides diagnostic instructions and solutions.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Causes</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge pressure too high – Defective water regulating valve (water cooled).</td>
<td>Check pressure sensing connection to regulator. Replace if necessary.</td>
<td></td>
</tr>
<tr>
<td>Discharge pressure too high – Fouling at condenser (water cooled).</td>
<td>Clean condenser by brushing and/or acid treatment. Consult manufacturer for water treatment recommendations.</td>
<td></td>
</tr>
<tr>
<td>Discharge pressure too high – Faulty water pump (water or evaporative cooled).</td>
<td>Replace pump. Check pump suction and discharge for obstructions.</td>
<td></td>
</tr>
<tr>
<td>Discharge pressure too high – Fouling at condenser (air cooled).</td>
<td>Clean with air, water hose, or brushing. Remove debris from condenser inlet.</td>
<td></td>
</tr>
<tr>
<td>Discharge pressure too high – Flood back valves out of adjustment (air or evaporative cooled).</td>
<td>Adjust to maintain 180 PSIG.</td>
<td></td>
</tr>
<tr>
<td>Discharge pressure too high – Belt worn or loose causing belts to slip (air or evaporative cooled).</td>
<td>Adjust, replace belts.</td>
<td></td>
</tr>
<tr>
<td>Discharge pressure too high – Fan turning too slow (air cooled)</td>
<td>Change sheave to increase speed up to FLA of motor. Consult factory before restarting. Check for restrictions.</td>
<td></td>
</tr>
<tr>
<td>NH3 pump off or flow restricted (recirculated system).</td>
<td>Check pump overload. Check pump suction and discharge for obstructions. Check bypass pressure regulator. Rebuild pump.</td>
<td></td>
</tr>
<tr>
<td>Low on NH3.</td>
<td>Search for leak and repair. Add refrigerant to maintain proper level in recirculator or surge drum (flooded) and high pressure receiver.</td>
<td></td>
</tr>
<tr>
<td>Problem</td>
<td>Causes</td>
<td>Solution</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Chiller evaporator temperature too high;</td>
<td>Hand expansion valve improperly adjusted.</td>
<td>Balance all hand expansion valves to maintain adequate refrigerant to all sections. Open the valve(s) if necessary until proper evaporator temperature is obtained.</td>
</tr>
<tr>
<td>Leaving water temperature too high (con’t)</td>
<td>Plugged or restricted strainer on liquid or recirculation unit (by others).</td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td>Plugged or restricted liquid line strainer.</td>
<td>Clean strainer. Restrictions can be observed by temperature drop across the strainer resulting in lower temperature at outlet. If temperature cannot be measured isolate the strainer and remove it for visual inspection.</td>
</tr>
<tr>
<td></td>
<td>Air or other non-condensable in refrigerant system.</td>
<td>Bleed air from condenser. Replace refrigerant charge if contamination cannot be removed.</td>
</tr>
<tr>
<td></td>
<td>Restriction in piping.</td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td>Power off to condensing unit.</td>
<td>Check power, circuit breaker, and disconnects to all motors, starters, and control switches.</td>
</tr>
<tr>
<td></td>
<td>Insufficient water flow to condenser (water cooled).</td>
<td>Clean or replace.</td>
</tr>
<tr>
<td></td>
<td>Insufficient water flow to condenser (water cooled) – Strainer plugged.</td>
<td>Clean strainer. Replace if damaged.</td>
</tr>
<tr>
<td>Problem</td>
<td>Causes</td>
<td>Solution</td>
</tr>
<tr>
<td>---------</td>
<td>--------</td>
<td>----------</td>
</tr>
<tr>
<td>Insufficient water flow to condenser (water cooled) – Float valve defective in make-up water line to cooling tower.</td>
<td>Check adjustment of float valve. Replace if required.</td>
<td></td>
</tr>
<tr>
<td>Insufficient water flow to condenser (water cooled) – Pump impeller worn.</td>
<td>Check water pump impeller for wear. Replace impeller or pump if required.</td>
<td></td>
</tr>
<tr>
<td>Condenser pump prime lost – low water level in sump.</td>
<td>Add water to cooling tower. Determine cause of water loss. - Leak in sump or piping. - Water line broken. - Isolation valve in water line closed.</td>
<td></td>
</tr>
<tr>
<td>Condenser water make-up valve closed or restricted.</td>
<td>Clean, repair, open, or replace valve.</td>
<td></td>
</tr>
<tr>
<td>Recirculating water pump off – Motor overloads tripped.</td>
<td>Check pump for restrictions. Reset starter overload relay.</td>
<td></td>
</tr>
<tr>
<td>Recirculating water pump off – Pump prime lost, low water level in reservoir.</td>
<td>Locate water feed restriction. Add water to tank.</td>
<td></td>
</tr>
<tr>
<td>Recirculating water pump off – Strainer plugged.</td>
<td>Remove and clean. Replace if damaged.</td>
<td></td>
</tr>
<tr>
<td>Recirculating water pump off – Check valve stuck closed.</td>
<td>Clean, repair, or replace valve.</td>
<td></td>
</tr>
<tr>
<td>Recirculating water pump off – Water connection broken or water supply lost.</td>
<td>Inspect water lines and repair broken or damaged sections. Check that water supply service valves are open and flowing water to the recirculating system.</td>
<td></td>
</tr>
<tr>
<td>Recirculating water pump off – Water level sensor switch defective.</td>
<td>Check switch operation and replace if required.</td>
<td></td>
</tr>
<tr>
<td>Recirculating water pump off – Water feed solenoid coil failed.</td>
<td>Check solenoid operation and replace if faulty.</td>
<td></td>
</tr>
<tr>
<td>Evaporator plates oil logged.</td>
<td>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).</td>
<td></td>
</tr>
<tr>
<td>Orifice in liquid header to evaporator plate plugged.</td>
<td>Consult factory.</td>
<td></td>
</tr>
<tr>
<td>Water temperature too high.</td>
<td>Water temperature above 60°F (based on incoming city water).</td>
<td></td>
</tr>
<tr>
<td>Improperly adjusted hand expansion valve (overfeed refrigerant).</td>
<td>Check expansion valve adjustment (close the valve to reduce refrigerant flow). Set to maintain 15 PSIG in all sections.</td>
<td></td>
</tr>
</tbody>
</table>
Chapter 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, please contact the factory:

Vogt Ice, LLC
1000 West Ormsby Ave
Suite 19
Louisville, KY, 40210
Phone: 502-635-3235
Toll Free: 1-800-853-8648
Fax: 502-635-3024
Web: www.vogtice.com

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

The high side of any refrigeration system should be checked on a weekly basis. Consult the supplier of your high side regarding any specific inspections, but consider the following as a guideline:

- Check oil level in compressor
- Review the high side for signs of oil leaks
- Check the liquid level in the receiver to ensure that the level is correct and has not changed
- Inspect valve packings and relief valves for indications of refrigerant loss

The chiller unit should be visually inspected once a week. When performing a visual inspection, look for the following:

- Refrigerant leaks
- Water leaks
- Debris in the water distribution pan filter
- Biogrowth (slime, fungus, mold, etc.)
- Even distribution of water across each individual plate
- Even distribution of water across the plate bank
- Pipe vibrations
- Rubbing of capillary tubes on DX machines
- Unusual noises
- Loose bolts, nuts, or screws
Clean the chiller weekly according to the following guidelines:

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

A preventive maintenance form is provided at the end of this section for use at your facility.

**After First Ten and Fifty Hours of Operation**

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

**Water Scale Build-Up**

One of the main concerns with any system using water is scale build-up. The three areas below are the most commonly affected areas of the chiller:

- Evaporator plates
- Water distribution pan and headers
- Water cooled condensers (by others)

To avoid these problems, speak with a local water treatment consultant, and follow the guidelines below.

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

**Scale Formation on Evaporator Plates**

Flush plates with an acceptable ice machine cleaner – typically citric or phosphoric acid. If an unusually high amount of scale is forming on the plates, have the water analyzed to determine the TDS count. Scale is most commonly caused by calcium and lime in the water supply.

In some instances, silica scale may form on the evaporator plates. This type of scale requires a more aggressive treatment than ice machine cleaners. Typically, mechanical removal (i.e. – scrubbing or scraping the plates) is required to clear off silica scale.

**Scale and Solids in Chiller Sump**

Drain and flush the chiller sump at least once a week. Solids from the sump will carry into the water recirculation system and plug the holes in the water distribution pans. The pan can be cleaned by using an air hose, a vacuum cleaner, or a brush. If excessive or frequent cleaning is required, consult the factory.
 Scaling of Condensers and Cooling Towers

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.

 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.

3. A regular de-scaling schedule eliminates the need to use stronger acids such as the nitric acid mixture to remove scale build up. Hydrochloric and sulphuric acid should not be used.
Preventive Maintenance Form

This form can be removed and duplicated for record keeping.

Date: ____________________________ Model No.: ____________________________ Serial No.: ____________________________

The following service was performed and checked:

<table>
<thead>
<tr>
<th>Shift</th>
<th>Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt;</td>
<td>☐ ☐ ☐ Evaporator plates clean</td>
</tr>
<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt;</td>
<td>☐ ☐ ☐ Frame, panel interior, water distribution pan, and headers clean</td>
</tr>
<tr>
<td>3&lt;sup&gt;rd&lt;/sup&gt;</td>
<td>☐ ☐ ☐ Water flow across all plates providing complete wetting of plate surface</td>
</tr>
<tr>
<td></td>
<td>☐ ☐ ☐ Suction pressure at suction header on chiller within normal range (reference data sheet for</td>
</tr>
<tr>
<td></td>
<td>design point)</td>
</tr>
<tr>
<td></td>
<td>☐ ☐ ☐ Entering water temperature within normal limits</td>
</tr>
<tr>
<td></td>
<td>☐ ☐ ☐ Leaving water temperature within normal limits</td>
</tr>
<tr>
<td></td>
<td>☐ ☐ ☐ Inlet water pressure within normal limits</td>
</tr>
<tr>
<td></td>
<td>☐ ☐ ☐ Ambient temperature ______________ °F</td>
</tr>
<tr>
<td></td>
<td>☐ ☐ ☐ High side head pressure within normal range</td>
</tr>
<tr>
<td></td>
<td>☐ ☐ ☐ Compressor net oil pressure (gage reading less suction) _____________ PSIG</td>
</tr>
<tr>
<td></td>
<td>☐ ☐ ☐ Drained oil from oil pot</td>
</tr>
</tbody>
</table>

Comments:

________________________________________________________________________

________________________________________________________________________

First Shift Operator: ________________________________________________

Second Shift Operator: _____________________________________________

Third Shift Operator: _____________________________________________
Chapter 7 : Optional Accessories

All chillers are offered with several optional accessories, detailed below. Each of these are required for the chiller to function, but may already be installed at your location.

Option 1 : Water Level and Flow Control Package

The water level control package includes an electronic float switch, water solenoid valve, and water strainer. Each component is rated for 125 PSIG inlet water pressure, and the operating pressure drop is less than 15 PSIG. The solenoid valve fails open. Figure 2 shows this kit as installed on the chiller cabinet.

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.

The control sequence should be as stated below, starting with the sump empty and the chiller “on”.

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 water solenoid (WS) coil. 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 the chiller is turned “off” or the water level reaches the FS.
4. The refrigerant liquid solenoid valve should be closed when the water supply is shut off. This is done to prevent surging of the low pressure surge drum during no load conditions.
5. Water level controls are intended for use as a high level controller. 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.

A mechanical float valve can be substituted for the electronic float switch detailed above for applications less than 60 GPM. A minimum inlet pressure of 25 PSIG is required for the mechanical float to operate correctly.

Option 2 : Surge Drum for Flooded Machines

Surge drums are the low side pressure vessel that operates at the evaporator pressure, and is used to maintain a liquid seal on the chiller unit. It also provides separation of the liquid from the vapor in the wet suction return line. This option package is for the vessel itself and does not include any valves or level controls, which can be purchased separately with Options 4, 5, and 7.
Each Surge drum is provided with a liquid leg connection at the bottom, a wet suction connection on one end, a dry suction connection to the high side on the opposite end, a high pressure liquid connection, a relief valve connection, and a top connection for a refrigerant float switch assembly (Option 7). The bottom float switch connection is installed in the liquid leg by others.

The normal operating level in the surge drum is three (3) 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 level of seven (7) inches.

Insulation of the surge drum and all field connection points are by others.

**Figure 7-1 – Typical Surge Drum**

**Option 3 : Oil Accumulator Drum or Oil Pot for Flooded Machines**

In flooded ammonia systems, the refrigerant oil contained in the liquid ammonia must be removed from the system before it enters the chiller plates. When the liquid leg from the surge drum 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 accumulator drum with a globe-type isolating valve is provided in this option package. A relief valve is also included.
Option 4 : High Pressure Liquid Line Valve Package for Flooded Machines

For flooded system operation, high pressure liquid refrigerant is supplied to the surge drum through a refrigerant solenoid valve, strainer, and a hand expansion valve. This option package includes these three (3) valves, plus an additional hand expansion valve to be used in a service bypass circuit.

The bypass hand expansion valve would be piped in parallel to the refrigerant solenoid valve, strainer, main expansion valve, and isolating valve. By closing the main hand expansion valve and isolating valve, and opening up the bypass expansion valve, the solenoid valve and strainer may be serviced without shutting the system off. This configuration is intended for service or emergency use only. The bypass expansion valve would be closed during normal operation.

The operation of the refrigerant solenoid can be controlled by the float switches mounted on the surge drum.

Option 5 : Suction Line Valve Package with Pressure Regulator for Flooded Machines

To prevent ice formation on the chiller plates due to variations in system loading, a suction pressure regulator must be installed in the dry suction line from the surge drum to the system high side. Included with the package is a suction pressure regulator and two (2) angle isolation valves.

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.

Suction temperatures should never fall below 26°F in order to prevent icing. See the data sheet provided with the chiller unit to set the regulator to the designed suction temperature.
**Option 7 : Refrigerant Level Control Package for Flooded Machines**

To assist with controlling the liquid level in the surge drum (Option #2), two float switches are offered in this package. One float is to be used to maintain the operating level in the vessel, and the other is to be used as a high-level safety. The design intent is that if the high level safety float switch closed, then the liquid supply to the surge drum would shut off. For serviceability and ease of installation, four (4) globe valves and four (4) unions are included in the kit.

The normal operating level in the surge drum is three (3) inches. The operating level float switch should be set to a level of seven (7) inches.

<table>
<thead>
<tr>
<th>! WARNING !</th>
</tr>
</thead>
<tbody>
<tr>
<td>Only qualified service personnel should perform service work or remove the float switches.</td>
</tr>
<tr>
<td>Caution must be used to remove the refrigerant contained in the float switch chamber and piping from the isolating valves to the float switch.</td>
</tr>
<tr>
<td>NEVER leave both isolating valves closed except when performing service.</td>
</tr>
<tr>
<td>Even exposed to heat, excessive pressure can develop between the two isolating valves when closed.</td>
</tr>
<tr>
<td>Purge the refrigerant as soon as possible after closing the valves.</td>
</tr>
<tr>
<td>Failure to carefully follow these instructions could result in permanent injury or loss of life.</td>
</tr>
</tbody>
</table>

**Option 8 : Liquid Line Valve Package for Liquid Recirculated Machines**

The liquid line valve package for liquid recirculated chillers consists of a refrigerant solenoid valve, strainer, two (2) globe-style isolation valves, and a hand expansion valve to be used as a flow controller. It is intended to control the pumped liquid flow going to the chiller unit and are offered in line sizes from 1” up to 2-1/2”

**Option 9 : Suction Line Valve Package for Liquid Recirculated Machines**

As with flooded refrigeration circuits, a suction pressure regulator is required in a liquid recirculating system to prevent ice formation on the chiller plates due to variations in system loading. The regulating valve in this package is to be installed in the dry suction line from the recirculator vessel to the system high side. Two (2) angle isolation valves are provided for service access.

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.

Suction temperatures should never fall below 26°F in order to prevent icing. See the data sheet provided with the chiller unit to set the regulator to the designed suction temperature.
**Option 10 : Direct Expansion Liquid Feed Group**

This option package completes a direct expansion chiller by installing the thermostatic expansion valve, refrigerant distributor, distributor tubes, and suction line on the unit. The feed group supports refrigeration capacities up to 70TR. Chillers having loads greater than this limit will have multiple feed groups.

All chillers purchased as direct expansion units will have the cost of the liquid feed group(s) added to the base price at the time of sale.

**Option 11 : Dual Refrigerant Feed Circuits**

Some chiller installations may benefit from splitting the plate bank in the chiller into two distinct refrigerant feed circuits. In these cases, chillers can be supplied with two separate liquid and suction connections. Direct expansion systems would include two (2) expansion valves and two (2) distributors.

**Option 12 : Low Carbon Content (304L) Stainless Steel Construction**

All chillers are available for construction in low carbon (304L) stainless steel, should the application demand. When this option is selected, the scope affects the evaporator plates, frame, water distribution pan(s), water reservoir, exterior panels, and all connections.
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Appendix A
Material Safety Data Sheet # 4001

LaRoche Industries Inc.  
2/15/96

SECTION 1: CHEMICAL PRODUCT & COMPANY IDENTIFICATION

CHEMICAL NAME: Anhydrous Ammonia  
TRADE NAMES/SYNONYMS: Ammonia  
PRODUCT CODE: 5B81-83

MANUFACTURER AND/OR DISTRIBUTOR: LaRoche Industries Inc.  
Transportation (CHEMTREC): (800) 424-9300  
Environmental/Health/Safety: (800) 528-4963  
Customer Service: (800) 491-7987

SECTION 2: COMPOSITION/INFORMATION ON INGREDIENTS

CHEMICAL FORMULA % BY WEIGHT CAS OSHA PEL NIOSH REL / ACGIH TLV IDLH  
C-grade P-grade

Ammonia NH₃ 99.5 99.995 7664-41-7 50 ppm (TWA) 25 ppm (TWA) 35 ppm (STEL) 300 ppm

Water H₂O 0.4 33 ppm 7732-18-5 None None None

Oil ----- 0.1 2 ppm None None None

SECTION 3: HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW: 1) Colorless gas or compressed liquid with extremely pungent odor  
2) Liquid ammonia reacts violently with water. Vapor cloud is produced  
3) Avoid contact with liquid and vapor  
4) Stay upwind and use water spray to absorb vapor  
5) Not flammable under conditions likely to be encountered outdoors  
6) Stop discharge if possible

POTENTIAL HEALTH EFFECTS:
- ROUTES OF ENTRY: Inhalation, Skin Contact, Eye Contact, Ingestion  
- TARGET ORGANS: Eyes, skin and respiratory system  
- EYE CONTACT: Exposure to liquid or high concentrations of vapor can cause painful, instant and possibly irreversible damage to tissue such as the conjunctiva, cornea and lens.  
- SKIN CONTACT: Prolonged contact with high concentrations can cause painful tissue damage, frostbite and serious chemical burns.  
- INHALATION: Depending on exposure concentration and duration, effects can vary from none or only mild irritation, to obstruction of breathing from laryngeal and bronchial spasm, to edema and severe damage of the mucous membranes of the respiratory tract with possible fatal results. Latent edema and residual reduction in pulmonary function may occur.  
- INGESTION: Tissue damage, chemical burns, nausea and vomiting can occur. Ammonia is a gas under normal atmospheric conditions and ingestion is unlikely.

CARCINOGENICITY: NTP? No IARC? No OSHA? No

SECTION 4: FIRST AID MEASURES

EYE CONTACT: Flush with large amount of water for at least 15 minutes then immediately seek medical aid.  
SKIN CONTACT: Immediately flush with large quantities of water for at least 15 minutes while removing clothing. Clothing frozen to the skin should be thawed with water before removal. Seek immediate medical aid.  
INHALATION: Remove from exposure. If breathing has stopped or is difficult, administer artificial respiration or oxygen as needed. Seek immediate medical aid.  
INGESTION: Do not induce vomiting. Have the victim drink large quantities of water if conscious. Immediately seek medical aid. Never give anything by mouth to an unconscious person.

SECTION 5: FIRE FIGHTING MEASURES

FLASH POINT(method used): Not Applicable  
FLAMMABLE LIMITS: 16-25% in air  
EXTINGUISHING MEDIA: With a source of ignition, ammonia will burn in the range of 16-25% in air. Stop flow of gas or liquid.

SPECIAL FIRE FIGHTING PROCEDURES: Move containers from fire zone if possible; if not, use water to cool fire exposed containers. Use water spray to control vapors. Do not put water directly on liquid ammonia. Personnel must be equipped with appropriate protective clothing and respiratory protection.

NFPA HAZARD CLASSIFICATION: Health: 3 Flammability: 1 Reactivity: 0 (least-0 ↔ 4-highest)

SECTION 6: ACCIDENTAL RELEASE MEASURES

Release of 100 lbs. or more of ammonia within 24 hours must be immediately (within minutes) reported to the National Response Center at 1-800-424-8802, as well as appropriate local and state agencies. Suggested Local Action: Stop leak if feasible. Avoid breathing ammonia. Evacuate personnel not equipped with protective clothing and equipment. Use copious amounts of water spray or fog to absorb ammonia vapor. DO NOT put water on liquid ammonia. Contain run-off to prevent ammonia from entering a stream, lake, sewer, or ditch. Any release of this material, during the course of loading, transporting, unloading or temporary storage, must be reported to U.S. D.O.T. as required by CFR 171.15 and 171.16.

SECTION 7: HANDLING AND STORAGE

Refer to the ANSI K61.1 standard for storage and handling information. Protect containers from physical damage and temperatures exceeding 120°F. Use only approved storage systems. Zinc, copper, silver, cadmium and their alloys must not be used in ammonia systems since they can be rapidly corroded by it. Avoid hydrostatic pressure, which can cause equipment rupture, by adhering to proper filling procedures and the use of hydrostatic pressure relief valves where appropriate.
SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

RESPIRATORY PROTECTION: Respiratory protection approved by NIOSH/MSHA for ammonia must be used when exposure limits are exceeded. Whether a chemical cartridge respirator or a self-contained breathing apparatus is sufficient for effective respiratory protection depends on the type and magnitude of exposure.

EYE PROTECTION: Chemical splash goggles, approved for use with ammonia, must be worn to prevent eye contact with liquid or vapor. A face shield should be used for increased protection from contact with liquid.

VENTILATION: Local positive pressure and/or exhaust ventilation should be used to reduce vapor concentrations in confined spaces. Ammonia vapor, being lighter than air, can be expected to dissipate to the upper atmosphere. Ammonia concentrations may also be reduced by the use of an appropriate absorbent or reactant material.

OTHER EQUIPMENT: Emergency eye wash stations and deluge safety showers must be available in the work area. Post a list of emergency response contacts and telephone numbers.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boiling Point</td>
<td>-28.1°F</td>
</tr>
<tr>
<td>Solubility In Water</td>
<td>High</td>
</tr>
<tr>
<td>Melting Point</td>
<td>-107.9°F</td>
</tr>
<tr>
<td>Vapor Pressure</td>
<td>4802.9 mm Hg @ 60°F</td>
</tr>
<tr>
<td>Percent Volatile By Volume</td>
<td>100%</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>0.62 @ 60°F (water=1)</td>
</tr>
<tr>
<td>Vapor Density</td>
<td>0.60 @ 32°F (Air=1)</td>
</tr>
<tr>
<td>pH</td>
<td>Approx. 11.6 for 1 N Soln. in water</td>
</tr>
<tr>
<td>Appearance</td>
<td>Colorless (pungent) gas</td>
</tr>
</tbody>
</table>

SECTION 10: STABILITY AND REACTIVITY

STABILITY: Material generally considered stable. However, heating above ambient temperatures causes the vapor pressure of ammonia to increase rapidly.

INCOMPATIBILITY (Materials to Avoid): Ammonia can react violently with strong acids. Under certain conditions, ammonia reacts with bromine, chlorine, fluorine or iodine to form compounds which explode spontaneously. Reactions of ammonia with gold, silver or mercury to form explosive fulminate-like compounds have been reported.

HAZARDOUS DECOMPOSITION PRODUCTS: Hydrogen on heating to over 850°F. The decomposition temperature may be lowered to 575°F by contact with certain metals such as nickel.

HAZARDOUS POLYMERIZATION: Will not occur.

CONDITIONS TO AVOID: Not applicable.

SECTION 11: TOXICOLOGICAL INFORMATION

Ammonia is a strong alkali and readily damages all body tissues. Ammonia is not a cumulative metabolic poison.

SECTION 12: ECOLOGICAL INFORMATION

Recover ammonia if feasible. Otherwise, let ammonia evaporate if appropriate. Only personnel experienced in ammonia spills should add water to liquid ammonia. Dispose of diluted ammonia as a fertilizer or in an industrial process. For Hazardous Waste Regulations call 1-800-424-9346, the RCRA Hotline.

SECTION 13: DISPOSAL CONSIDERATIONS

SECTION 14: TRANSPORT INFORMATION

<table>
<thead>
<tr>
<th>Domestic Shipments</th>
<th>International Shipments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identification Number</td>
<td>UN1005</td>
</tr>
<tr>
<td>Packing Group</td>
<td>None</td>
</tr>
<tr>
<td>Proper shipping name</td>
<td>Ammonia, Anhydrous, Liquefied</td>
</tr>
<tr>
<td>DOT Hazard Class</td>
<td>2.2 (nonflammable gas)</td>
</tr>
<tr>
<td>Ammonia, Anhydrous, Liquefied</td>
<td>2.3 (poison gas)</td>
</tr>
</tbody>
</table>

SECTION 15: REGULATORY INFORMATION

NOTICE: This product is subject to the reporting requirements of SARA (1986, Section 313 of Title III) and 40 CFR Part 370.

OSHA HAZARD COMMUNICATION RULE, 29 CFR 1910.1200: Ammonia is considered a hazardous chemical.

OSHA HAZARD COMMUNICATION RULE, 29 CFR 1910.1200: Ammonia is considered a hazardous chemical.

EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW ACT (SARA, TITLE III): Section 302 Extremely Hazardous Substance: Yes; Section 311/312 Hazardous Categories: Immediate (acute) health hazards; Section 313 Toxic Chemical: Yes

CERCLA/SUPERFUND, 40 CFR 117,302: This product contains ammonia which if released to the environment in quantities of 100 lbs. or more requires notification to the National Response Center in Washington, DC at 1-800-424-8802.

WHMIS: One Percent (1%) CALIFORNIA PROPOSITION 65: Reproductive: No Carcinogen: No

OSHA PROCESS SAFETY MANAGEMENT, 29 CFR 1910.119: This product is subject to the Process Safety Management requirements of 29 CFR 1910.119 if maintained on-site in quantities of 10,000 lbs. or greater.

EPA CHEMICAL ACCIDENT RELEASE PREVENTION, 40 CFR PART 68: This product is subject to the Risk Management Plan requirements of 40 CFR Part 68 if maintained on-site in quantities of 10,000 lbs. or greater.

DRINKING WATER: Maximum use dosage in potable water is 5 mg/l.

This information is taken from sources or based upon data believed to be reliable, however, LaRoche Industries Inc. makes no warranty as to the absolute correctness or sufficiency of any of the foregoing or that additional or other measures may not be required under particular conditions.
Anhydrous Ammonia Safety
FOREWORD

Ammonia (frequently called anhydrous ammonia) is one of the most valuable and versatile chemical compounds in today's modern world. For example, it finds wide application in food production and processing, textile and chemical manufacturing, refrigeration, metal treating and pollution abatement.

An ever increasing use of ammonia has been accompanied by a corresponding growth in the need for the dissemination of knowledge regarding ammonia safety among persons working with ammonia under either normal or emergency conditions. Recognizing this need, LaRoche Industries has prepared this booklet which contains a selected collection of helpful information and suggestions for the ammonia user and for safety personnel. The suggestions may be employed as an aid in the preparation of the ammonia user's own comprehensive safety program and should be altered or augmented in accordance with individual requirements.

Anyone working with ammonia, either directly or indirectly, whether at a supervisory or non-supervisory level, has a responsibility not only to be thoroughly familiar with basic ammonia safety principles, but also to observe faithfully all necessary precautions and to react promptly and appropriately should an emergency arise. Readers of this booklet will find answers to questions most often asked regarding general properties, potential hazards, exposure effects, personal protective and safety equipment, first aid procedures and methods of dealing with emergencies involving ammonia. Information as to the manufacture, transportation, storage or application of ammonia is not detailed.

Persons requiring any information regarding ammonia not covered in this booklet are urged to consult with LaRoche Industries or with the Compressed Gas Association, Inc., Arlington, VA or The Fertilizer Institute, Washington, DC for assistance.

PLEASE NOTE

The information and suggestions compiled in this booklet are derived from sources believed to be reputable and reliable. HOWEVER, LA ROCHE INDUSTRIES SUPPLIES THIS BOOKLET MERELY AS A GRATUITOUS SERVICE AND MAKES NO WARRANTY OR GUARANTEE OF RESULTS, EXPRESSED OR IMPLIED, AND ASSUMES NO LIABILITY IN CONNECTION WITH THE INFORMATION AND SUGGESTIONS HEREIN. No assumption shall be made as to the absolute correctness or sufficiency of any representation in the booklet or that certain circumstances may not warrant or require modified or additional precautions or actions.

This booklet should not be confused with federal, state or municipal regulations, insurance requirements or national safety codes, although some statements may be similar or identical.
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ANHYDROUS AMMONIA SAFETY

GENERAL

The term "anhydrous ammonia" appearing in the title of this booklet refers to the compound having the formula NH₃, formed by the chemical combination of nitrogen and hydrogen. Whenever the term "ammonia" appears in this booklet, it should be understood as meaning anhydrous ammonia and not aqua ammonia, aqueous ammonia or ammonium hydroxide which are solutions of ammonia in water. Ammonium hydroxide solutions generally range in concentrations of ammonia from about 30% down to the 2 to 4% found in the well known household ammonia. These solutions are all commonly known as ammonia, but should never be confused with liquid anhydrous ammonia which has a much greater hazard potential. "Anhydrous" means "free from water".

At room temperature and atmospheric pressure, ammonia is a pungent, colorless gas approximately 40% lighter than air. Compressed and cooled, ammonia gas condenses to a colorless liquid about 68% as heavy as water. At atmospheric pressure, the liquid boils at -28F.

In a container, ammonia in the liquid form normally coexists with vapor. Temperature affects both the vapor pressure and volume of liquid ammonia.

As the temperature of the liquid rises, the vapor above the liquid phase exerts increased pressure. It should be noted that the pressure observed within a container is NOT a measure of the quantity of the liquid present.

With increasing temperature, ammonia in the liquid phase expands. For example, in an ammonia cylinder at 65F loaded to its maximum allowable limit in accordance with Federal regulations, the vapor phase occupies about 12% of the total cylinder volume. This vapor space would be completely filled with liquid ammonia if its temperature were permitted to reach 145F. Upon further temperature rise, the cylinder will bulge and could rupture due to the internal hydrostatic pressure caused by the expanding liquid.

Because of these characteristics, ammonia containers should not be exposed to excessive heat. (See THERMAL EXPANSION and FIRE EXPOSURE.)

Under equilibrium conditions, the vapor pressure and volume of liquid ammonia vary with temperature as shown in Table 1.

<table>
<thead>
<tr>
<th>Temperature (F)</th>
<th>Vapor Pressure (psig)</th>
<th>Volume (Gal./CWT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-28</td>
<td>0.0</td>
<td>17.57</td>
</tr>
<tr>
<td>0</td>
<td>15.7</td>
<td>18.10</td>
</tr>
<tr>
<td>30</td>
<td>45.0</td>
<td>18.72</td>
</tr>
<tr>
<td>60</td>
<td>92.9</td>
<td>19.43</td>
</tr>
<tr>
<td>90</td>
<td>165.9</td>
<td>20.25</td>
</tr>
<tr>
<td>115</td>
<td>251.5</td>
<td>21.04</td>
</tr>
<tr>
<td>130</td>
<td>315.6</td>
<td>21.58</td>
</tr>
</tbody>
</table>

(Data derived from U.S. Bureau of Standards Circular No. 142.)
Ammonia is most frequently shipped by highway and rail and stored in pressure containers as a liquefied compressed gas at ambient temperatures. Ammonia in very large quantities is transported in high pressure pipelines at ambient temperatures and is shipped by barge or tanker as refrigerated liquid at -28°F and atmospheric pressure. When stored in large quantities, such as at a terminal, ammonia is generally refrigerated and kept in insulated tanks at -28°F.

**PRIMARY HAZARDS**

Ammonia acts as an irritant to human tissue in varying degrees depending upon concentration and exposure.

The pungent and distinctive odor of the vapor, even at low concentrations, provides adequate warning so that no person will voluntarily remain in concentrations which are hazardous. (See HUMAN PHYSIOLOGICAL EFFECTS.)

At the time of this printing ammonia is classified by the U.S. Department of Transportation as a NONFLAMMABLE GAS. Conditions favorable for ignition are seldom encountered in normal handling due to its narrow range of susceptibility to ignition. In the presence of a flame or spark at about 1200°F, ammonia vapor will ignite, but only within the limited range of 16-25% of ammonia in air by volume. The heat generated by combustion is insufficient to maintain a flame which therefore will extinguish upon ignition source removal.

**OTHER HAZARDS**

**CHEMICAL** - As a chemical compound, ammonia is highly associated and stable at ordinary temperatures. At about 840°F ammonia begins to dissociate with the formation of nitrogen and highly flammable hydrogen.

Ammonia will not corrode most of the common metals, but in the presence of water, ammonia will attack copper, zinc and alloys containing these elements. For this reason, materials of construction used for ammonia containers, fittings, piping and equipment are limited to steel and iron or certain non-ferrous alloys resistant to attack by ammonia.

Ammonia is a highly reactive chemical, forming salts with many inorganic and organic acids, usually with the release of heat. Under certain conditions, ammonia is known to react with bromine, chlorine, fluorine or iodine, to form compounds which explode spontaneously. Ammonia has been reported as reacting with gold, silver or mercury to form fulminate-like compounds which are explosive.

**THERMAL EXPANSION** - Liquid ammonia exhibits a high coefficient of cubical expansion. A given quantity of liquid ammonia therefore expands considerably in volume with a rise in temperature. (See Table 1.) For this reason, appropriate measures must be taken to avoid hydrostatic rupture of containers, piping or other equipment as could be caused by such expansion.

**HUMAN PHYSIOLOGICAL EFFECTS**

Ammonia is NOT a cumulative metabolic poison; ammonium ions are actually important constituents of living systems. Depending upon concentration and time, the effects of exposure to ammonia vapor vary from none or only mild irritation, to obstruction of breathing from laryngeal and bronchial spasm, to edema and severe damage of the mucous membranes of the respiratory tract with possible fatal results.

Ammonia in the presence of water is highly alkaline. Contact of the skin or mucosa with liquid ammonia or a high concentration of vapor can result in a caustic burn. Due to the great attraction of water to ammonia, water may be absorbed simultaneously from the tissue resulting in dehydration of the affected area.
Liquid ammonia boils at -28F under atmospheric conditions, acting as a refrigerant to remove heat from any warmer object it may be contacting. Accordingly, liquid ammonia in contact with the skin can cause frostbite.

Exposure levels of ammonia vapor which are tolerated by some persons may produce adverse reactions in others. Persons having chronic respiratory disease or persons who have shown evidence of undue sensitivity to ammonia should not be exposed to ammonia. Table 2 indicates human physiological response to various concentrations of ammonia in air upon inhalation.

**TABLE 2. PHYSIOLOGICAL EFFECTS OF AMMONIA VAPOR**

<table>
<thead>
<tr>
<th>Effect</th>
<th>PPM Ammonia in Air by Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Least perceptible odor</td>
<td>5 ppm</td>
</tr>
<tr>
<td>Readily detectable odor</td>
<td>20-50 ppm</td>
</tr>
<tr>
<td>No discomfort or impairment of health for protracted exposure</td>
<td>50-100 ppm</td>
</tr>
<tr>
<td>General discomfort and eye tearing: no lasting effect on short exposure</td>
<td>150-200 ppm</td>
</tr>
<tr>
<td>Severe irritation of eyes, nose, and throat: no lasting effect on short exposure</td>
<td>400-700 ppm</td>
</tr>
<tr>
<td>Coughing, bronchial spasms: danger, less than 1/2 hour exposure may be fatal</td>
<td>1,700 ppm</td>
</tr>
<tr>
<td>Dangerous, less than 1/2 hour exposure may be fatal</td>
<td>2,000-3,000 ppm</td>
</tr>
<tr>
<td>Serious edema, strangulation, asphyxia, rapidly fatal</td>
<td>5,000-10,000 ppm</td>
</tr>
<tr>
<td>Immediately fatal</td>
<td>over 10,000 ppm</td>
</tr>
</tbody>
</table>


**EXPOSURE LIMITS**

Occupational Safety and Health Administration (OSHA) regulations require that an employee’s short term exposure limit (STEL) for ammonia not exceed a time-weighted average of 35 ppm ammonia in air by volume in any 15 minute period.

The American Conference of Government and Industrial Hygienists (ACGIH) has established an exposure limit of 25 ppm ammonia in air by volume as an 8 hour time weighted average (TWA).

**PERSONAL PROTECTIVE EQUIPMENT**

Persons working with ammonia under routine circumstances of operation and maintenance should wear flexible fitting, hooded ventilation goggles and rubber or plastic gauntlet gloves impervious to ammonia so as to protect critical body areas which are most vulnerable to contact with ammonia should a minor leak occur. A full face shield may be worn over the goggles for additional protection, but not as a substitute for the goggles.

**EMERGENCY PROTECTIVE AND SAFETY EQUIPMENT**

Each location having an ammonia installation should have readily available and freely accessible, emergency protective and safety equipment as may be required by federal, state, and local governmental regulations. The location of such protective and safety equipment should be well identified by appropriate signs.

Depending upon the size and nature of the installation, emergency protective and safety equipment may include one or more of the following:

**SAFETY SHOWER** - Parts of the body injured by contact with ammonia must be flooded immediately with large quantities of water. An emergency safety shower, eye wash fountain, or other source of clean water can be used for this purpose. Such a source should be protected from freezing in cold weather.

**RESPIRATORY DEVICES** -

1. A full-face GAS MASK with an ammonia (green) or a universal (red) industrial size canister approved by MSHA/NIOSH (formerly U.S. Bureau of Mines). OSHA regulations require at least two gas masks to be maintained at a stationary ammonia storage installation.

It should be noted these canisters are limited to brief periods of use not exceeding 15 minutes and in
concentrations of ammonia not exceeding 3% (30,000 ppm) in air by volume. Spare canisters, within usable date limitations as marked, should be kept on hand. Replacement of over-age canisters, even though not used, is recommended.

A person wearing a mask must leave a contaminated area immediately on detecting an odor of ammonia or experiencing difficulty in breathing. These are indications that the mask or canister is not functioning properly, that the ammonia concentration is excessive, or that adequate oxygen is not available.

2. For protection where ammonia concentrations are unknown or may exceed 3%, or in oxygen deficient atmospheres, SELF-CONTAINED AIR BREATHING APPARATUS of an approved pressure demand type should be used. This apparatus, which consists of a full face piece, a pressure and flow control and a high pressure cylinder of air, provides protection for a period of time which varies with the amount of air carried and the extent of exertion by the user.

Any respiratory device must be used and maintained in accordance with the manufacturer’s instructions. Because the device is normally used in an emergency, where there is tension and excitement, a person who uses it should have received thorough training and practice.

**PROTECTIVE CLOTHING** - Emergency or rescue personnel required to work in high ammonia concentrations should wear protective gloves, boots, pants and jacket, or slicker impervious to ammonia. A hard hat should be worn as required by plant practice or dictated by special hazards.

**RESCUE HARNESS** - A safety belt and lifeline should be worn by an individual using respiratory equipment and entering contaminated air in a confined location. Another person also wearing respiratory equipment and protective clothing should be located outside the contaminated area to act in case of emergency.

**WATER SYSTEM** - At a large installation, a high capacity water system should be available not only for fire fighting, but also for controlling ammonia leaks.

**STRETCHER AND BLANKETS** - Inadequate facilities for transporting a seriously injured person from the scene of an accident to a first aid station can add to the seriousness of the injury. A stretcher provides the most acceptable method of hand transportation and it may be used as a temporary cot at the first aid station or during transit in a vehicle.

**FIRST AID PROCEDURES**

Ammonia is one of the most water soluble of all gases. Accordingly, the best means of providing first aid for an injury caused by ammonia contact with the eyes or skin is to flush immediately the injury area with large quantities of clean water. Promptness in initiating treatment, using adequate quantities of water and continuing its application for at least fifteen minutes, or longer if necessary, are all essential in successful first aid management of an eye or skin injury resulting from contact with ammonia. Cool coffee, tea and even a fruit flavored beverage are all reported as having been used with good effect in starting first aid treatment when water was not immediately available. A physician must be called promptly for any person who has been burned severely or overcome by ammonia. The physician should be given a complete account of the cause of injury. Speedy removal of the patient from the contaminated location is important to avoid aggravation of the injury.

**PRIOR TO MEDICAL AID BY THE PHYSICIAN, FIRST AID PROCEDURES SHOULD BE EMPLOYED. THOSE PRESENTED HEREFIN ARE BASED UPON WHAT IS BELIEVED TO BE COMMON PRACTICE IN INDUSTRY. THEIR ADOPTION IN ANY SPECIFIC CASE SHOULD, OF COURSE, BE SUBJECT TO PRIOR ENDORSEMENT BY A COMPETENT MEDICAL ADVISOR.**
As a guide in case of injury caused by ammonia, the following first aid procedures are suggested:

**INHALATION** - Any conscious person who has incurred irritation due to inhalation of ammonia vapor should proceed to a location free of ammonia and breathe fresh air. If exposure has been minimal, usually no other treatment will be necessary.

A person overcome by ammonia must be carried to a location free of ammonia and the services of a physician obtained promptly. Successful resuscitation requires SPEED and EFFICIENCY. DELAY AND INEXPERIENCE MAY RESULT IN A FATALITY.

If there is an obstruction to the patient’s breathing, the airway must be cleared by appropriate methods which may include proper positioning of the patient’s head, pulling the tongue forward and clearing any blockage from the mouth such as dentures or vomitus. If spontaneous breathing does not resume after the airway has been cleared, artificial respiration should be started immediately by mouth-to-mouth resuscitation (expired-air ventilation, rescue breathing), preferably by an individual trained in the procedure.

Oxygen therapy may be indicated once the patient’s breathing has been restored or if it continues to be labored. Such therapy should not replace immediate mouth-to-mouth resuscitation and should only be applied during a sustained resuscitation period or if the patient is to be moved. CAUTION: It may not be advisable to administer oxygen under positive pressure if the patient is in shock or there is impending or existing cardiovascular failure. Oxygen therapy equipment should be used only by qualified and experienced personnel.

Treatment with oxygen may be discontinued if breathing becomes easy, the color is good and there are no signs of lung congestion. During treatment, the patient should be placed in a reclining position, or if he prefers, in a sitting position. He should be kept quiet, at rest and comfortably warm, but not hot. The patient should be examined by a physician and not allowed to return to work until found free of injury.

**EYES** - If contacted by ammonia, the eyes must be flooded immediately with copious quantities of clean water. Speed is essential. If contact lenses are worn, they must be removed, otherwise ammonia may be trapped underneath causing a severe burn. In isolated areas, water in a squeeze bottle which can be carried in the pocket is helpful for emergency irrigation purposes. An eye fountain should be used, but if not available, clean water from any source may be poured over the eyes. In any case, the eyelids MUST BE HELD OPEN and irrigation continued for at least 15 minutes. Repeat this procedures every ten minutes for an hour, each time irrigating for a period of five minutes until medical attention can be obtained. Such attention must be received promptly from a physician, preferably an ophthalmologist. No oils or any medication should be placed in the eyes unless ordered BY A PHYSICIAN. If prescribed BY A PHYSICIAN, 2 to 3 drops of topical anesthetic such as 1/2% tetracaine hydrochloride (Pontocaine) may be instilled to relieve pain and to permit more thorough flushing of the eyes with water.

**SKIN AND MUCOSA** - If contacted by liquid ammonia, the body area affected should be immediately flooded with water. If no safety shower is available, utilize any available water source. Water will have the effect of thawing out clothing which may be frozen to the skin. Such clothing should be removed and flooding of the skin with water continued for at least 15 minutes.

Do not apply salves or ointments to skin or mucous membrane burns during the 24 hour period following injury. Subsequent medical treatment is otherwise the same as for thermal burns.

**INTERNAL** - Swallowing of liquid ammonia is very unlikely. However, if ammonia has been taken internally and if the patient is CONSCIOUS and able, have him drink large quantities of water immediately. NEVER GIVE ANYTHING BY MOUTH TO AN
UNCONSCIOUS PERSON. Should the patient vomit, place his face down with head lower than hips to prevent vomitus from entering lungs. Transport patient to a physician promptly and apply other first aid treatment as he may prescribe.

EMERGENCY MEASURES

Every plant, warehouse, office or other facility is susceptible to emergency situations which can result in property damage and/or bodily harm to employees, visitors or even neighbors. Management bears responsibility within its own organization for the development and implementation of comprehensive and effective plans designed to meet these situations in a manner as will protect the safety of human life, physical assets and the environment to the greatest degree practicable within the constraints of governmental regulations and prudent business practice.

No one plan will serve the needs of all companies and each organization must assess the various potential emergency conditions that might occur and develop a program to suit its own requirements. Where ammonia is stored and used, the following procedures and actions are suggested for incorporation into an emergency response plan.

When an ammonia leak occurs, personnel trained for and authorized to handle such situations should take immediate steps to locate and control the condition. Respiratory equipment and protective clothing as may be necessary and suitable for ammonia must be worn. All other persons must be kept away from the affected area until the leak has been stopped. Keep on the windward side of the leak when possible.

If ammonia vapor is released, the irritating effect of the vapor will generally force personnel to leave the area before they are overcome by harmful concentrations. Sufficient, well marked and readily accessible exits must be provided to facilitate rapid evacuation from a building. Should an individual become trapped in an ammonia contaminated atmosphere, breathing should be held to a minimum and eyes opened only as necessary. Because ammonia vapor is lighter than air, a trapped person should remain close to the floor to take advantage of lower vapor concentrations while seeking an escape route, unless liquid ammonia has been spilled. If respiratory equipment is not available, some temporary protection may be afforded by holding a wet cloth over the nose and mouth.

Should a leak occur which is extensive, such as might be involved with a spill of liquid ammonia, all persons in the path of the vapor should be warned. If necessary, local emergency authorities should be contacted to control evacuation. The evacuation area should be adjusted according to wind changes and observed effects on population. Suggested evacuation distances are given in Table 3, starting with the circle as shown in the accompanying diagram.

With good ventilation or rapidly moving air currents, ammonia vapor, being lighter than air, can be expected to dissipate readily to the upper atmosphere. Further action may not be required other than to stop the leak. If necessary, the concentration of ammonia vapor in the air can be reduced effectively by the use of an adequate volume of water applied through a spray or fog nozzle.

Under some conditions, ammonia in a container may be colder than the available water supply. At such times, water must not be applied to the container walls since heat would be transferred to the ammonia thus causing increased pressure within the container resulting in aggravation of any leakage or relief valve discharge.

Water should not be applied to a liquid spill unless at least 100 parts of water to one part of ammonia are available. Runoff of a liquid spill should be diverted if the direction of flow will create an additional problem. UNDER NO CIRCUMSTANCES
SHOULD AN ATTEMPT BE MADE TO NEUTRALIZE AN AMMONIA SPILL WITH AN ACID.

It is recommended that an up-to-date telephone listing of various emergency, rescue, medical and regulatory agencies be maintained for use by designated personnel should it become necessary to call for sources of outside help to cope with a situation which is beyond the self-sufficiency of local plant employees. Included in the listing should be numbers for fire and police departments, ambulance, rescue or paramedical services, doctors, hospitals, governmental authorities, material and equipment suppliers. Also listed should be the names and numbers for selected company supervisory and management personnel (such as foreman, superintendent, safety and public relations directors, etc.) who are to be notified of an emergency situation. Where appropriate, both day and night or alternate numbers should be shown.

If company or security personnel are not present at a facility during off-hours, the name(s) and telephone number(s) of a responsible individual(s) should be posted at a gate or entrance for purposes of notification by local authorities should an emergency arise.

LEAK DETECTION

An ammonia leak is readily detectable by its characteristically pungent odor.

<table>
<thead>
<tr>
<th>TABLE 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table of Initial Isolation and Protective Action Distances</td>
</tr>
</tbody>
</table>

**Small Spill**

- A) Downwind Distance: 0.2mi
- B) Crosswind Distance: 0.2mi
- C) Isolation Zone Diameter: 150 ft.

**Large Spill**

- A) Downwind Distance: 1 mi.
- B) Crosswind Distance: 1 mi.
- C) Isolation Zone Diameter: 300 ft.

(derived from "Guidebook for First Response to Hazardous Materials Incidents" - 1990, U.S. Department of Transportation P5800.5)
The location of a small leak may often be determined by holding a moist strip of phenolphthalein or red litmus paper near the suspected leak source. The rapidity and intensity of the color change in the paper will give some indication of leak proximity or size. In the presence of ammonia, phenolphthalein paper will turn from white to pink or deep red, whereas the red litmus will become blue.

Sulfur dioxide vapor reacts with ammonia to form a dense white cloud and may be used for leak detection. Care must be exercised to avoid breathing sulfur dioxide vapor as it is also highly irritating. It should be noted that a gas mask canister which is specific for ammonia will not offer protection against sulfur dioxide. If there is an appreciable quantity of ammonia in the air, it may be difficult to pinpoint the leak source.

Various types of devices are available to detect and measure the concentration of ammonia vapor in air. One such device employs a colorimetric detector tube through which air to be tested is drawn by a special hand or battery operated pump. A comparison of the length of the color stain produced in the tube is made with a calibrated chart which gives an indication of the concentration.

LEAK CONTROL

EQUIPMENT OR PIPING - If a leak occurs in equipment or piping, shut off the ammonia supply and carefully vent all ammonia from the system before attempting to dismantle any part or make repairs. The appearance of frost on an external surface indicates the presence of liquid ammonia vaporizing in the system. Accordingly, the frost should be allowed to dissipate before breaking any connection. If welding is required, the system should be thoroughly purged until all ammonia and any oil residue has been removed. Welding must conform with applicable codes.

VALVE - A leak at a valve stem can usually be stopped by tightening the packing gland nut. A leak at a valve bonnet may be stopped by tightening the bonnet threads or the bolts holding the bonnet to the valve body. All tightening should be performed slowly and without application of excessive force. Packing gland nut and bonnet threads on some ammonia valves are left-handed. If tightening procedures fail to stop the leak, the valve should be closed. If the valve should fail to close completely, it should be plugged.

PRESSURE RELIEF DEVICE - A leak or discharge through a pressure relief device, such as a pressure relief valve or hydrostatic relief valve, may occur if the pressure within the equipment, piping, tank or container exceeds the rated pressure setting of the device or if the device is faulty. Reducing the pressure within the system by removing ammonia as a vapor to process or cooling the container with a water spray may permit the device to reseat. If reseating does not take place, it most often will be necessary to replace the device with one approved for ammonia service and of the proper pressure rating and capacity.

No attempt should be made to plug, cap or otherwise tamper with a pressure relief device under any circumstances. However, a pressure relief valve may sometimes be provided with a shut-off valve in an arrangement whereby the leaking device can be isolated for removal purposes while another pressure relief valve(s) provides not less than the full rate of discharge capacity required for safety. Unless returned to the manufacturer, a pressure relief device should not be repaired or adjusted in any manner. Pressure relief valves should be replaced at regular intervals as suggested by the manufacturer. Failure to observe these precautions could result in a serious weakening or catastrophic rupture of the equipment, piping, tank or container which was being protected by the device.

STORAGE TANK - A leak at a threaded or flanged storage tank opening may often be stopped by
a careful tightening of threads or bolts. Should such efforts fail, it will be necessary to empty the tank of all ammonia before attempting further repair. If the leak is small, the tank can frequently be emptied by removing the ammonia as a vapor or liquid to process. If necessary to remove the ammonia promptly, or if the tank is equipped with a vaporizer, your supplier should be contacted for advice and assistance.

Occasionally, a storage tank will develop a leak in a plate, weld or coupling. No attempt to peen such a leak should be made. Instead, call your tank or ammonia supplier promptly. Welding on an ammonia storage tank must be performed in accordance with ASME code procedures and on ly after complete purging.

**SHIPPING CONTAINER** - Ammonia is shipped in special containers which are fabricated, transported and maintained in accordance with U.S. Department of Transportation regulations. Shipping containers include cylinders, portable tanks, tank trucks, rail tank cars, barges and tankers. If an ammonia leak occurs in a shipping container while at the user's facility, these actions should be taken to limit and control the escape of ammonia:

1. If liquid is leaking from a cylinder, position it if possible so that vapor instead of liquid escapes. The quantity of ammonia released from a vapor leak is considerably less than from a liquid leak through an opening of the same size.
2. If possible, move the container to an area of reduced hazard.
3. If no risk is entailed, attempt to reduce the pressure in the container by removing the ammonia to process as a vapor.
4. Reduce the quantity of vapor in the atmosphere with a water spray applied to the leak area.
5. Aside from trying to stop a leak from a shipping container by tightening a valve packing nut, closing a valve or possibly tightening a flange bolt, no other repairs should be attempted or authorized by the user.

6. It is a violation of federal regulations to transport an ammonia shipping container which is leaking or damaged. If a shipping container is damaged or is leaking in a manner which cannot be handled by personnel at the site, the nearest office of the producer or supplier should be called for assistance. If the producer or supplier cannot be reached, contact the Chemical Transportation Emergency Center (CHEMTREC) by telephoning the toll free number, 800/424-9300, (add long-distance access number if required) for advice and help day or night.

When calling for assistance, be prepared to provide the following information:

(a) Nature of emergency, when, where and extent.
(b) Type and condition of container.
(c) Name of shipper or supplier.
(d) Extent of injuries or property damage, if any.
(e) Description of surrounding area and prevailing weather conditions.
(f) Corrective measures being applied.
(g) Name of caller and location now and where telephone contact may be re-established with caller or other responsible party at the emergency site.

Environmental protection and/or other regulatory authorities should be notified of an ammonia spill as may be appropriate and required by statute.

**FIRE EXPOSURE**

If possible, an ammonia container should be disconnected and removed immediately from the fire zone. If, for any reason, a container cannot be moved,
it should be kept cool with water spray until well after
the fire is extinguished. Firefighting personnel should
be equipped properly with protective clothing and
respiratory equipment.

EMPLOYEE SAFETY TRAINING

Safety in working with ammonia depends on
more than just the availability of personal or emergency
protective equipment and clothing. Employee training
in safe operation procedures, in first-aid measures and
in the use of suitable operating and protective
equipment, properly maintained, must also be included
as an essential element in any comprehensive safety
program.

Such safety training is the responsibility of
management and should be given to new and old
employees at periodic intervals as needed to maintain
high proficiency levels. Included should be written and
oral instructions followed by drills regarding the
location, purpose and use of personal and emergency
protective clothing, equipment, emergency alarms, fire
fighting equipment, safety showers or other water
sources, first aid supplies and shut-down equipment
such as valves and switches.

Training should also stress the avoidance of
body contact with liquid ammonia or inhalation of gas
and the reporting of equipment failures to appropriate
supervisory authority.

This material has been reviewed by experienced
safety, medical and other technical personnel
competent to evaluate its accuracy and practicability.

Additional copies of this booklet are available by
forwarding a request to LaRoche Industries at any of the
office locations shown below.

Material Safety Data Sheets are also available by
similar request.

REGIONAL OFFICES

Eastern
20 Meta Lane
Lodi, NJ 07644
201/472-8008

Central
1900 Spring Road
OakBrook, IL 60521
708/571-4950

Southern
1990 Lakeside Parkway, Suite 130
Tucker, GA 30084
404/691-0596

Western
15116 Canary Avenue
LaMirada, CA 90638
213/691-0596
SELECTED AMMONIA SAFETY REFERENCES
AND TRAINING AIDS

1. Safety Requirements for the Storage and Handling of Anhydrous Ammonia, ANSI-K61.1
   American National Standards Institute, Inc. (ANSI)
   1430 Broadway
   New York, New York 10018
   212/354-3300

2. Anhydrous Ammonia, Pamphlet G-2
   Compressed Gas Association, Inc. (CGA)
   1235 Jefferson Davis Hwy.
   Arlington, VA 22202
   703/979-0900

3. Agricultural Ammonia Safety, Booklet P15
   The Fertilizer Institute (TFI)
   1015 18th Street, NW
   Washington, DC 20036
   202/861-4900

4. Safe Handling of Anhydrous Ammonia, Rural Accident Protection Bulletin
   National Safety Council
   Farm Department
   444 North Michigan Avenue
   Chicago, Illinois 6061155D
   312/527-4800

5. For the Rest of Your Life, 16mm color sound film
   National Society for the Prevention of Blindness, Inc.
   79 Madison Avenue
   New York, New York 10016
   212/684-3222
VOGT® TUBE-ICE® MACHINE
BASIC PRODUCT WARRANTY

Vogt Tube Ice LLC, hereinafter referred to as SELLER, warrants to the original Purchaser from SELLER or the original end-user, hereinafter referred to as PURCHASER, every Vogt® Tube-Ice® Machine Model P24A, P24F, P24AL, P24ALOF P24FL, P34A, P34F, P34FL, P34AL, P34ALOF and packaged high side Models P24AHS, P24FHS, P34AHS and P34FHS to be free from defects in material and workmanship, if properly installed, maintained and operated, for a period of 12 months from date of original installation or 12 months from date of shipment from SELLER'S plant if SELLER does not have an accepted start-up form on file.

SELLER'S obligation under this warranty shall be strictly limited, at SELLER'S option, to: (i) repairing or furnishing replacement parts on an exchange basis, F.O.B. Louisville, Kentucky, without charge to PURCHASER those parts proven defective upon examination by SELLER; or (ii) issuing written authorization for PURCHASER or its agents to replace or repair, without charge to PURCHASER, those parts proven defective upon examination by SELLER; or (iii) in discharge of SELLER'S maximum liability herewith, refunding all monies paid by PURCHASER to SELLER for the product and, at discretion of SELLER, having the product removed and returned to SELLER at PURCHASER'S expense. All transportation charges relative to corrective work or defective parts or replacement parts shall be borne by PURCHASER. PURCHASER shall give SELLER immediate notice upon discovery of any defect. The undertaking of repairs or replacement by PURCHASER or its agents without SELLER'S written consent shall relieve SELLER of all responsibility herewith.

Any alteration in material or design of SELLER'S product or any component parts thereof by PURCHASER or others without written authorization by SELLER voids all obligations of SELLER regarding the product and any associated warranty herein stated.

SELLER'S sole liability shall be exclusively as set forth herein, and SELLER shall not be liable for any incidental or consequential damages due to its breach of any warranty herein contained, or otherwise. Without limitation to the foregoing, in no event shall SELLER be liable for the loss of use of the product or for the loss of use of any other product, process, plant, equipment, or facilities of the PURCHASER whether partially or wholly due to defects in material and/or workmanship and/or design of SELLER'S product, and in no event shall SELLER be liable for removal of appurtenances or incidentals such as connections, pipework and similar items of obstruction or for any cost brought about by the necessity of removing the product from its point of installation.

SELLER DOES NOT MAKE AND DOES NOT AUTHORIZE ANY OTHER PERSON TO MAKE ANY WARRANTY OF ANY KIND WHATSOEVER, EXPRESS OR IMPLIED, ORALLY OR IN WRITING, OTHER THAN AS SPECIFICALLY STATED HEREIN; AND THERE ARE NO WARRANTIES OF MERCHANTABILITY AND/OR FITNESS FOR A PARTICULAR PURPOSE WHICH EXCEED THE OBLIGATIONS AND WARRANTIES SPECIFICALLY STATED HEREIN.

Parts furnished without charge as replacements for original parts under warranty are warranted only for that period of time during which the original parts warranty is effective. Damage to any component due to water quality is specifically excluded from this warranty.

EXTENDED WARRANTY

At the termination of the Basic Product Warranty period above, SELLER hereby extends this warranty for one additional year to cover the CIRCULATING WATER TANK AND CUTTER ASSEMBLY, EXCLUDING THE CUTTER BEARINGS AND DRIVE TRAINS.

LIFETIME WARRANTY*

This component warranty is further extended for the life of the machine to cover the EVAPORATOR (FREEZER). Damage to evaporator tubes as a result of expansion caused by re-freezing of ice or corrosion damage due to water quality is specifically excluded.

The Extended Warranty applies only to VOGT TUBE-ICE MACHINE MODELS P24A, P24F, P24AL, P24ALOF, P24FL, P34A, P34F, P34FL, P34AL, and P34ALOF for the exclusive benefit of PURCHASER, as defined above. All other obligations, terms, conditions, exclusions and limitations of the Basic Product Warranty apply to the Extended and Lifetime Warranty.

*“Lifetime” is defined as 25 years. Vogt® and Tube-Ice® are registered trademarks of Vogt Tube-Ice, LLC, 1000West Ormsby Ave., Louisville, Kentucky 40210