Wallace & Tiernan®

an evoqua brand

VACUUM REGULATOR - CHECK UNIT
3,000 LB/24 HR CAPACITY

BOOK NO. WT.050.177.002.UA.IM.0714

W3T109627

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W3T109627

VACUUM REGULATOR-CHECK UNIT

EQUIPMENT SERIAL NO. _____

DATE OF START-UP _____

START-UP BY _____

Prompt service available from nationwide authorized service contractors.

ORDERING INFORMATION

In order for us to fill your order immediately and correctly, please order material by description and part number, as shown in this book. Also, please specify the serial number of the equipment on which the parts will be installed.

WARRANTY

Seller warrants for a period of one year after shipment that the equipment or material of its manufacture is free from defects in workmanship and materials. Corrosion or other decomposition by chemical action is specifically excluded as a defect covered hereunder, except this exclusion shall not apply to chlorination equipment. Seller does not warrant (a) damage caused by use of the items for purposes other than those for which they were designed, (b) damage caused by unauthorized attachments or modifications, (c) products subject to any abuse, misuse, negligence or accident, (d) products where parts not made, supplied, or approved by Seller are used and in the sole judgment of the Seller such use affects the products' performance, stability or reliability, and (e) products that have been altered or repaired in a manner in which, in the sole judgment of Seller, affects the products' performance, stability or reliability. **SELLER MAKES NO OTHER WARRANTY OF ANY KIND, AND THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR OF FITNESS OF THE MATERIAL OR EQUIPMENT FOR ANY PARTICULAR PURPOSE EVEN IF THAT PURPOSE IS KNOWN TO SELLER.** If Buyer discovers a defect in material or workmanship, it must promptly notify Seller in writing; Seller reserves the right to require the return of such defective parts to Seller, transportation charges prepaid, to verify such defect before this warranty is applicable. In no event shall such notification be received by Seller later than 13 months after the date of shipment. No action for breach of warranty shall be brought more than 15 months after the date of shipment of the equipment or material.

LIMITATION OF BUYER'S REMEDIES. The **EXCLUSIVE REMEDY** for any breach of warranty is the replacement f.o.b. shipping point of the defective part or parts of the material or equipment. Any equipment or material repaired or replaced under warranty shall carry the balance of the original warranty period, or a minimum of three months. Seller shall not be liable for any liquidated, special, incidental or consequential damages, including without limitation, loss of profits, loss of savings or revenue, loss of use of the material or equipment or any associated material or equipment, the cost of substitute material or equipment, claims of third parties, damage to property, or goodwill, whether based upon breach of warranty, breach of contract, negligence, strict tort, or any other legal theory; provided, however, that such limitation shall not apply to claims for personal injury.

Statements and instructions set forth herein are based upon the best information and practices known to Evoqua Water Technologies, but it should not be assumed that every acceptable safety procedure is contained herein. Of necessity this company cannot guarantee that actions in accordance with such statements and instructions will result in the complete elimination of hazards and it assumes no liability for accidents that may occur.

EVOQUA
WATER TECHNOLOGIES

725 Wooten Road
Colorado Springs, Co 80915

VACUUM REGULATOR-CHECK UNIT

INTRODUCTION

This instruction book provides installation, operation, and maintenance instructions for the Evoqua Water Technologies 3,000 lb/24 hr Capacity Vacuum Regulator-Check Unit. The unit consists of a gas pressure reducing valve (two gas pressure reducing valves for the automatic switchover arrangement), pressure check valve, and a pressure relief valve assembled together.

This instruction book covers two arrangements of this vacuum regulator-check unit. One arrangement for chlorine, sulfur dioxide, or carbon dioxide and another arrangement for ammonia only.

The evaporator arrangement also includes a low temperature alarm switch to provide an indication of any liquid carry-over from the evaporator and an electric operator for automatic shut-off of the supply in the event of liquid carry-over or power failure.

WARNING: WHEN THE EQUIPMENT DESCRIBED IN THIS BOOK IS USED WITH CARBON DIOXIDE, REGULATORS, REDUCING VALVES, PRESSURE RELIEF VALVES, AND ALL RELATED LINES AND FITTINGS BETWEEN THE GAS SUPPLY AND THE VACUUM REGULATOR-CHECK UNIT MUST BE OBTAINED FROM THE GAS SUPPLIER AND INSTALLED IN ACCORDANCE WITH THOSE RECOMMENDATIONS (DRAWINGS AND TEXT IN THIS BOOK RELATING TO CHLORINE SUPPLY ARE NOT APPLICABLE). GAS SUPPLY PRESSURE MUST BE REDUCED TO 15 TO 120 PSI TO PREVENT OVER-PRESSURIZATION OF THE VACUUM REGULATOR-CHECK UNIT; A PRESSURE RELIEF DEVICE SET AT 200 PSI MAXIMUM MUST BE INSTALLED BETWEEN THE PRESSURE REDUCING VALVE AND THE VACUUM REGULATOR-CHECK UNIT.

WARNING: HAZARDOUS GAS IS PRESENT IN THIS EQUIPMENT DURING NORMAL OPERATION. TO AVOID POSSIBLE SEVERE PERSONAL INJURY OR DAMAGE TO THE EQUIPMENT, READ THIS INSTRUCTION BOOK AND THE APPROPRIATE GAS MANUAL BEFORE CONNECTING THIS EQUIPMENT TO A SUPPLY OF GAS. OPERATION AND MAINTENANCE OF THIS EQUIPMENT MUST BE RESTRICTED TO TRAINED QUALIFIED PERSONNEL WHO ARE COMPLETELY FAMILIAR WITH THESE INSTRUCTIONS. INCLUDED IN THIS INSTRUCTION BOOK IS THE CHLORINE HANDLING MANUAL. IF THIS VALUE IS BEING USED WITH SULFUR DIOXIDE, CARBON DIOXIDE, OR AMMONIA THE APPROPRIATE GAS MANUAL SHOULD BE OBTAINED FROM YOUR CHEMICAL SUPPLIER OR YOUR LOCAL EVOQUA WATER TECHNOLOGIES REPRESENTATIVE.

NOTE: When ordering material, always specify model and serial number of apparatus.

VACUUM REGULATOR-CHECK UNIT

Table Of Contents

VACUUM REGULATOR-CHECK UNIT

VERY IMPORTANT SAFETY PRECAUTIONS

This page provides very important safety information related to safety in installation, operation, and maintenance of this equipment.

WARNING

TO AVOID POSSIBLE SEVERE PERSONAL INJURY OR EQUIPMENT DAMAGE, OBSERVE THE FOLLOWING:

THIS EQUIPMENT SHOULD BE INSTALLED, OPERATED, AND SERVICED ONLY BY TRAINED, QUALIFIED PERSONNEL WHO ARE THOROUGHLY FAMILIAR WITH THE ENTIRE CONTENTS OF THIS INSTRUCTION BOOK.

USE ONLY EVOQUA WATER TECHNOLOGIES LISTED PARTS EXCEPT FOR COMMERCIALLY AVAILABLE PARTS IDENTIFIED BY COMPLETE DESCRIPTION ON PARTS LIST. THE USE OF UNLISTED PARTS CAN RESULT IN EQUIPMENT MALFUNCTIONS HAVING HAZARDOUS CONSEQUENCES.

DO NOT DISCARD THIS INSTRUCTION BOOK UPON COMPLETION OF INSTALLATION. INFORMATION PROVIDED IS ESSENTIAL TO PROPER AND SAFE OPERATION AND MAINTENANCE.

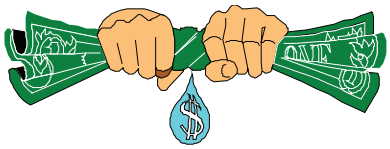
ADDITIONAL OR REPLACEMENT COPIES OF THIS INSTRUCTION BOOK ARE AVAILABLE FROM:

Evoqua Water Technologies
725 Wooten Road
Colorado Springs, CO 80915
Phone: (800) 524-6324

NOTE

Minor part number changes may be incorporated into Evoqua Water Technologies products from time to time that are not immediately reflected in the instruction book. If such a change apparently has been made in your equipment and does not appear to be reflected in your instruction book, contact your local Evoqua Water Technologies sales office for information.

Please include the equipment serial number in all correspondence. It is essential for effective communication and proper equipment identification.



PROTECT YOUR EQUIPMENT INVESTMENT

MINIMIZE DOWNTIME

ORDER A PREVENTIVE MAINTENANCE KIT NOW ...
KEEP ONE ON HAND

Quality Equipment	**+**	**Preventive Maintenance**	**=**	**Dependable Operation Minimum Downtime**

There's no question about it.
Equipment that is properly maintained is dependable equipment.
It will give optimum performance with minimum unscheduled downtime.

Evoqua Water Technologies manufactures quality equipment designed for performance and reliability. Each product is carefully tested and inspected before shipment to ensure that it meets our high standards.

Our equipment is engineered for easy maintenance. To ensure maximum service life and minimize unscheduled repairs, we recommend a program of regular preventive maintenance, as described in the Service section of this book. To support this program, we developed. standard parts kits. These kits can also be used for minor emergency repairs to minimize downtime.

We recommend that these kits be available in your stock at all times. When the complete kit or any of its parts are used, the kit should be replaced immediately.

Preventive maintenance kits may be ordered directly from the company that supplied your equipment, or they may be ordered directly from Evoqua Water Technologies. For ordering numbers, refer to the parts list at the rear of this book.

PREVENTIVE MAINTENANCE SCHEDULE AND RECORD OF PERFORMANCE

This equipment should receive preventive maintenance on a one (1) year cycle.* It is recommended that the following table be used to plan, schedule, and record this important work.

Date of Installation	

Preventive Maintenance Log	
Schedule Date	**Date Performed**

***NOTE:** **This is the recommended cycle. Your local operating conditions may call for more frequent preventive maintenance.**

PROTECT YOUR EQUIPMENT INVESTMENT

MINIMIZE DOWNTIME

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KEEP ONE ON HAND

FLEXIBLE CONNECTION REPLACEMENT

VERY IMPORTANT MAINTENANCE AND SAFETY INFORMATION

YOUR ATTENTION IS DIRECTED TO THE CHLORINE INSTITUTE'S RECOMMENDATION* THAT ---

FLEXIBLE METAL TUBING CONNECTIONS USED TO CONNECT CHLORINE SUPPLY CYLINDERS TO PIPING SYSTEMS "SHOULD BE REPLACED WHENEVER THERE IS SIGN OF DETERIORATION BUT, IN ANY EVENT, AT INTERVALS NO LESS THAN ANNUALLY."

SIMILAR RECOMMENDATIONS APPLY FOR OTHER GASES.

This recommendation recognizes the potential for mechanical damage to these connections in normal use, as well as the possibility of reduced mechanical strength resulting from the corrosive effects of damp air entering the tubing during the process of changing cylinders. Either of these conditions can be difficult to detect and carries the potential for breakage and resultant chlorine (or other gas) leakage. A timely replacement program can minimize this potential.

Deterioration exists if a salmon-pink color develops on the end fittings (de-zincification due to a minute leak), if dents or kinks are present (which weaken the tubing), or if the tubing "squeaks" when it is handled (a sure sign of internal stress corrosion).

FOR YOUR CONVENIENCE, EVOQUA WATER TECHNOLOGIES MAINTAINS A COMPLETE STOCK OF STANDARD FLEXIBLE CONNECTIONS (TYPICAL UNITS ARE ILLUSTRATED ON DRAWING 50.150.007.021) AND IS PREPARED TO RESPOND TO YOUR PURCHASE ORDER WITH PROMPT SHIPMENT.

*Refer to paragraph titled CONNECTIONS in the Chlorine Handling Manual attached to the rear of this instruction book — "Connections should be replaced whenever there is sign of deterioration but, in any event, at intervals no less than annually."

REGIONAL OFFICES

INSTALLATION, OPERATION, MAINTENANCE, AND SERVICE INFORMATION

Direct any questions concerning this equipment that are not answered in the instruction book to the Reseller from whom the equipment was purchased. If the equipment was purchased directly from Evoqua Water Technologies, Colorado Springs, CO contact the office indicated below.

UNITED STATES

725 Wooten Road
Colorado Springs, CO 80915
TEL: (800) 524-6324

CANADA

If the equipment was purchased directly from Evoqua Water Technologies, Canada, contact the nearest office indicated below.

ONTARIO

Evoqua Water Technologies Ltd.
2045 Drew Road
Mississauga, Ontario
L5S 1S4
(905) 944-2800

QUEBEC

Evoqua Technologies des Eaux Itee
505 Levy Street
St. Laurent, Quebec
H4R 2N9
(450) 582-4266

VACUUM REGULATOR-CHECK UNIT

VACUUM REGULATOR-CHECK UNIT

1 TECHNICAL DATA

Capacity	
Chlorine	3000 lb/24 hr
Ammonia	1450 lb/24 hr
Sulfur Dioxide	2800 lb/24 hr
Carbon Dioxide	2250 lb/24 hr
Electrical Requirements	115 Vac, 60 Hz, single phase
Gas Supply Pressure	18 to 120 psi
Operating Vacuum	13 to 35 inches of water

WARNING: THIS EQUIPMENT IS SUITABLE FOR USE ONLY WITH THE GASES SPECIFIED. DO NOT USE WITH OTHER GASES. SUCH USE CAN RESULT IN MALFUNCTION OR FAILURE OF VARIOUS COMPONENTS RESULTING IN POSSIBLE SEVERE PERSONAL INJURY.

2 INSTALLATION

To prevent damage in transit, the vacuum regulator and upper body of the check unit are shipped as two separate units. To assemble, proceed as follows:

a. Remove vacuum regulator-check unit from boxes.

b. Remove bolts, washers, and lead gasket from bag.

c. Inspect gasket groove in lower block to ensure surface is not damaged. Install a new lead gasket into groove in lower block (see Figure 1).

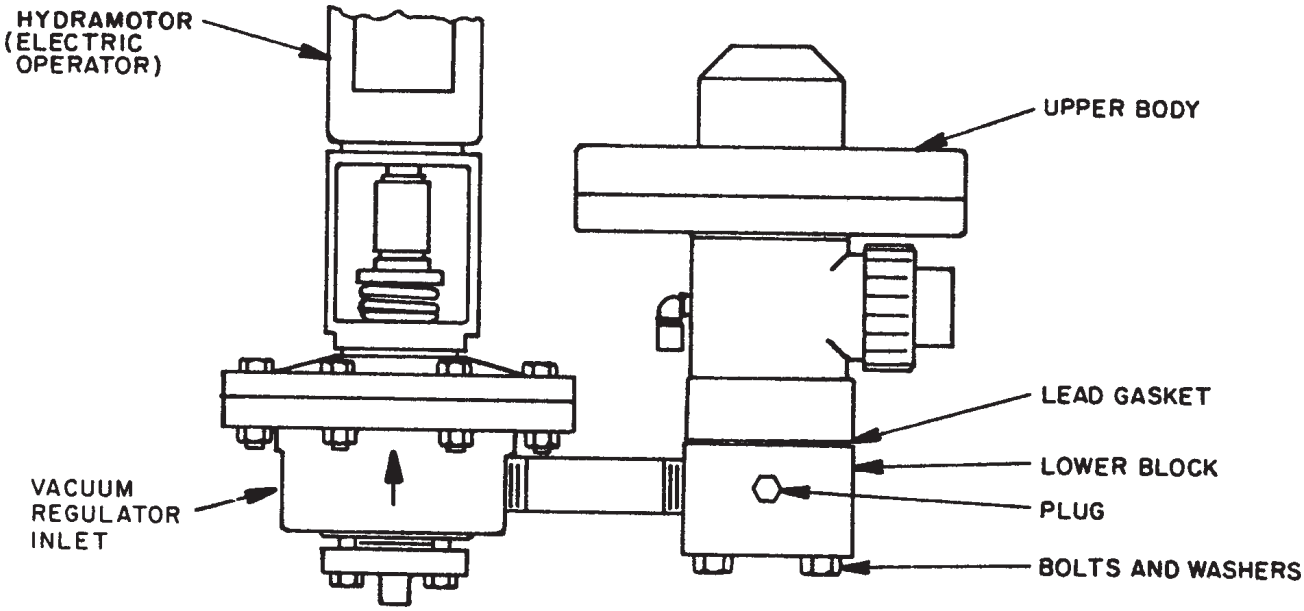


Figure 1

d. Place upper body onto lower block. Insert bolts and washers and tighten securely.

e. Remove plug and apply 60 psi air pressure at this point and at vacuum regulator inlet. Check for leaks around gasket joints. If joint leaks, tighten bolts and retest.

The general physical requirements of the installation are shown on the TYPICAL INSTALLATION and INSTALLATION PIPING drawings. Locate the equipment so that the vent is run as described below and the necessary gas supply can be properly connected. Ready access to the equipment for operation, routine maintenance, and service is required.

Use litharge and glycerin cement on all threaded joints. Piping for chlorine (or sulfur dioxide) supply, where the chlorine (or sulfur dioxide) is under pressure, should conform to Chlorine Institute recommendations. Piping for ammonia or carbon dioxide supply, where the ammonia or carbon dioxide is under pressure,

should conform to the recommendations of the Compressed Gas Association. Plastic tubing and pipe are not recommended and should not be used.

Before connecting the unit to the piping, check the piping for scale or trash left after threading and assembling pipe. Clean out as necessary. Wire the electric operator to the low temperature alarm switch and an alarm unit as shown on Dwg. 50.177.130.010.

CAUTION: The low temperature alarm switch (supplied with the evaporator arrangement) must be wired to actuate the electric operator and an appropriate alarm device as shown in the INSTALLATION WIRING drawing(s). The vacuum regulator-check unit is installed with the shut-off knob uppermost (electric operator uppermost on evaporator arrangement). The connecting line from the unit to the gas supply must be on a continuous down gradient to permit drainage back to the container in the event of reliquefaction between the container and the unit. When a unit is connected to a manifold, ensure that the manifold does not run above the unit and allow reliquefied gas to settle in the unit. Gas residue, if allowed to accumulate, may gum up and obstruct proper operation of the unit. If necessary (manifold is above unit), install a trap or drip leg at the lowest point to collect liquid and residue.

Gas at the pressure of the supply container will reliquefy at a temperature slightly lower than the temperature of the supply container, whereas at the regulated vacuum (slightly less than atmospheric pressure), reliquefaction will not occur until the temperature drops below -29°F. Locate the vacuum regulator-check unit close to the gas supply to afford maximum protection of the gas feed equipment. Select a location at an elevation higher than the outlet of the container. If a low temperature alarm switch is supplied, set the low temperature alarm switch to actuate at a temperature as close as possible to (but lower than) the minimum expected ambient temperature. Use litharge and glycerin cement on all threaded joints.

CAUTION: For installation using ton containers without an evaporator, the unit must be connected to the upper (gas discharge) container connection not to the lower (liquid discharge) container connection.

2.1 Gas Supply from a Cylinder

NOTE: The maximum rate of withdrawal from one 150-pound gas cylinder is about one pound per day per °F. If the rate to be fed exceeds the room temperature in °F, it will be necessary to have more than one cylinder connected. See the INSTALLATION PIPING drawing for manifolding of cylinders for this condition.

Supply cylinders are heavy. Arrange storage so that they are handled as little as possible. Refer to CHLORINE MANUAL (or equivalent for other gases) for further discussion of handling and storage.

WARNING: TO AVOID POSSIBLE SEVERE PERSONAL INJURY OR DAMAGE TO EQUIPMENT, SUPPLY CYLINDERS MUST BE SUPPORTED IN SUCH A MANNER (E.G., WITH CHAIN) AS TO PREVENT THEIR BEING KNOCKED OVER.

Make provisions for the installation of a Evoqua Water Technologies Two-Cylinder Scale for weighing the supply cylinders. If periodic readings are recorded, the amount of gas used in any given period may be determined. Using a Evoqua Water Technologies Loss-Of-Weight Recorder on the scale, a graphical record of gas use may be obtained.

2.2 Gas Supply from a Ton Container

If the source of gas supply is to be a ton container, install a trap or drip leg at the lowest point in piping between vacuum regulator-check unit and ton container to collect liquid and residue.

WARNING: THIS UNIT MAY CONTAIN LIQUID OR GAS UNDER HIGH PRESSURE. TO AVOID POSSIBLE SEVERE PERSONAL INJURY OR EQUIPMENT DAMAGE, CLOSE CONTAINER VALVE AND EVACUATE COMPLETE SYSTEM BEFORE DISCONNECTING GAS CONTAINER SUPPLY OR DISASSEMBLING UNIT. ON TON CONTAINERS WITHOUT AN EVAPORATOR, THE UNIT MUST BE CONNECTED TO THE UPPER VALVE THAT DISCHARGES GAS, NOT TO THE LOWER VALVE THAT DISCHARGES LIQUID. TON CONTAINERS MUST BE SECURED IN SUCH A MANNER (E.G., WITH CHOCKS) TO PREVENT THEIR ROLLING OUT OF PLACE.

2.3 Vent

The pressure check-pressure relief valve is shipped with a red diaphragm support in place of the vent elbow and reducing bushing on top of unit. Remove the shipping support and install reducing bushing and vent elbow. Save this diaphragm support to center the diaphragm during reassembly after preventive maintenance.

As shown on the TYPICAL INSTALLATION drawings, a vent line is required from the pressure relief port on the unit to a point outside the building where a leakage of gas will not be objectionable. The proper installation of this line is extremely important. For gases other than ammonia, the gradient of the line must be continuous (down, if possible) without traps and the atmospheric end should point down and be screened against the entrance of foreign materials. For ammonia, the gradient of the line must be continuous (up, if possible) without traps and the atmospheric end should point up and be provided with a suitable raincap to prevent the entrance of water and foreign materials. Allow for free discharge of vapor. Where traps are unavoidable, provisions for condensate removal must be installed at all low points. Suitable support for the vent is required throughout its entire length. The vent lines from two or more vacuum regulator-check units may be manifolded together.

WARNING: TO AVOID POSSIBLE SEVERE PERSONAL INJURY OR DAMAGE TO EQUIPMENT, DO NOT CONNECT THE VENT LINE FROM A VACUUM REGULATOR-CHECK UNIT TO A VENT LINE FROM ANY EQUIPMENT OTHER THAN ANOTHER VACUUM REGULATOR-CHECK UNIT. THE VACUUM REGULATOR-CHECK UNIT MUST BE VENTED TO OUTSIDE ATMOSPHERE. THE VENT LINE MUST TERMINATE IN AN AREA WHERE GAS FUMES CANNOT CAUSE INJURY TO PERSONNEL OR DAMAGE. DO NOT TERMINATE THE VENT LINE AT A LOCATION ROUTINELY USED BY PERSONNEL, SUCH AS WORK AREAS OR PATHWAYS, NOR NEAR WINDOWS OR VENTILATION SYSTEM INTAKES.

CAUTION: If any individual vent line is disconnected from a manifolded system, plug the resultant opening in the manifold immediately.

2.4 Leak Check

WARNING: TO AVOID POSSIBLE SEVERE PERSONAL INJURY, WHEN MAKING LEAK CHECKS IT IS RECOMMENDED PRACTICE TO HAVE AN APPROVED GAS MASK AVAILABLE THAT YOU HAVE BEEN TRAINED TO USE.

After the unit is in place and before the gas piping to the control module is connected to the unit, check for gas leaks as follows:

a. Turn the knob(s) to the OFF position (de-energize the electric operator on evaporator arrangement) (counterclockwise as seen from the top as far as it will go).

b. Open the gas supply valve.

c. For chlorine or sulfur dioxide, wet a dauber with aqueous ammonia. Pass the dauber close to all gasketed joints, all pipe threaded joints (including any plugs), and the opening of the plastic discharge fitting (of the pressure check-pressure relief valve). A gas leak will be indicated by a white cloud. Refer to SERVICE for gases other than chlorine and sulfur dioxide.

WARNING: DO NOT TOLERATE GAS LEAKS OF ANY KIND. THEY DO NOT SELF-SEAL AND ALWAYS GET WORSE WITH TIME. EVEN SMALL AMOUNTS OF GAS, WHEN MIXED WITH DAMP AIR, ARE VERY CORROSIVE TO ADJACENT METAL PARTS, ELECTRICAL APPARATUS, AND CONTROL EQUIPMENT.

d. If leaks are detected, close the gas supply valve and take corrective steps immediately. Correct leaks as indicated by the nature of the leak (tightening of gasketed joints or screws, new gaskets, pipe thread sealant, etc.).

e. Repeat the leak check procedure until there are no gas leaks.

3 OPERATION

Refer to the gas feeder instruction book for operating instructions, which may vary depending upon the installation configuration.

WARNING: TO AVOID POSSIBLE SEVERE PERSONAL INJURY OR EQUIPMENT DAMAGE, FOR LONG TERM SHUT-DOWN, ENSURE COMPLETE SHUT-OFF OF THE GAS SUPPLY AT THE GAS CONTAINER VALVES IN ADDITION TO THE VACUUM REGULATOR-CHECK UNIT.

3.1 Theory of Operation

Gas under pressure enters the vacuum regulator-check unit. The gas pressure is reduced to less than atmospheric pressure as the gas passes through two valves, which will not open unless a vacuum is produced. If the first valve passes gas when a vacuum is not present, the second valve will remain closed and contain the gas pressure in the unit, which is designed to contain full container pressure. In the extremely unlikely event that the second valve also passes gas, the built-in pressure relief valve will permit this gas to pass out the vent. For this reason, the vent line must be run to outside atmosphere.

WARNING: THE VACUUM REGULATOR-CHECK UNIT MUST BE VENTED TO OUTSIDE ATMOSPHERE. THE VENT LINE MUST TERMINATE IN AN AREA WHERE GAS FUMES CANNOT CAUSE INJURY TO PERSONNEL OR DAMAGE. DO NOT TERMINATE THE VENT LINE AT A LOCATION ROUTINELY USED BY PERSONNEL SUCH AS WORK AREAS OR PATHWAYS NOR NEAR WINDOWS OR VENTILATION SYSTEM INTAKES.

Automatic switchover capability is provided (when ordered) by having two vacuum regulators fitted with mechanical detents. One regulator feeds gas until the container to which it is connected is nearly exhausted. The resulting rise of vacuum to higher than normal provides sufficient force to unlatch the detents in the second regulator, which then takes over the gas supply function. The original supply continues to feed with the new supply, ensuring exhaustion of gas from the original supply container. In the evaporator arrangement, the low temperature alarm switch in the base of the pressure check valve will indicate liquid carry-over from the evaporator. This switch is actuated only if liquid is present in the unit. Actuation is caused by the intense chilling that occurs as the liquid vaporizes (due to the pressure reduction in the regulator). The low temperature switch will de-energize the electric operator, closing the regulator unit, stopping the flow of the liquid.

4 SERVICE

WARNING: TO AVOID POSSIBLE SEVERE PERSONAL INJURY OR EQUIPMENT DAMAGE, SHUT OFF THE GAS AT THE SUPPLY CONTAINER AND EXHAUST ALL GAS IN THE SYSTEM BEFORE SERVICING THE EQUIPMENT.

4.1 Maintenance

Maintenance of vacuum regulator-check unit consists of two periodically performed operations:

- Periodic Cleaning to remove contaminants and deposits brought to the units by the gas flow.
- Periodic Preventive Maintenance to disassemble, inspect, clean, and accomplish recommended parts replacement. Kits of replacement parts required for this periodic maintenance are available and are listed in PREVENTIVE MAINTENANCE KITS.

PROTECT YOUR EQUIPMENT INVESTMENT
MINIMIZE DOWNTIME
REORDER A PREVENTIVE MAINTENANCE KIT NOW
KEEP ONE ON HAND

4.2 Cleaning Vacuum Regulator (See Dwg. 25.052.001.026 or 25.052.001.032)

The standard regulator or the automatic switchover regulator are both cleaned in the same manner. Where two key numbers are given, the first refers to Dwg. 25.052.001.026, the second to Dwg. 25.052.001.032. To clean the regulator, proceed as follows:

a. Shut off the gas container valve. Operate the gas feeder a few minutes to exhaust remaining gas from the regulator.

WARNING: THE HEATER MAY BE HOT ENOUGH TO CAUSE BURNS. DISCONNECT AND ALLOW TO COOL BEFORE SERVICING.

CAUTION: When any connection is broken even for a short time, immediately plug the resultant opening with a rubber stopper or equivalent to prevent the entrance of moisture. Moisture must be excluded from any part of the equipment that is normally exposed to dry gas only. Non-corrosive when dry, moist chlorine or sulfur dioxide is extremely corrosive to common metals such as brass or steel.

b. Loosen and remove four bolts (24, 21) and washers (4, 10).

c. Remove cap (25, 22), lead gasket (22, 20), main spring (27, 18), stem unit (20, 17), seat and retainer unit (23, 32), O-ring (19, 16), and strainer (21, 31).

d. Discard the lead gasket (22, 20).

e. Inspect the O-ring (19, 16). Replace if necessary.

f. Rinse remaining part thoroughly with warm water.

g. Reassemble the parts in reverse order using a new lead gasket (22, 20).

4.3 Cleaning Vacuum Regulator (See Dwg. 50.177.001.012) (Evaporator Arrangement)

To clean the regulator, proceed as follows:

a. Shut off the gas container valve. Operate the gas feeder a few minutes to exhaust remaining gas from the regulator.

WARNING: THE HEATER MAY BE HOT ENOUGH TO CAUSE BURNS. DISCONNECT AND ALLOW TO COOL BEFORE SERVICING.

CAUTION: When any connection is broken even for a short time, immediately plug the resultant opening with a rubber stopper or equivalent to prevent the entrance of moisture. Moisture must be excluded from any part of the equipment that is normally exposed to dry gas only. Non-corrosive when dry, moist chlorine or sulfur dioxide is extremely corrosive to common metals such as brass or steel.

b. Loosen and remove four bolts (30) and washers (16).

c. Remove cap (31), lead gasket (32), main spring (26), stem unit (25), seat and retainer unit (28), O-ring (24), and strainer (27).

d. Discard the lead gasket (32).

e. Inspect the O-ring (24). Replace if necessary.

f. Rinse remaining parts thoroughly with warm water.

g. Reassemble the parts in reverse order using a new lead gasket.

4.4 Cleaning Gas Line Strainer (See Dwg. 50.150.005.033)

To clean filter screen in the gas line strainer, remove bolts (4) and cover (3). Screen is welded to cover and will come out for cleaning when cover is removed. After cleaning, replace screen and cover using new gasket (2). If screen cannot

be adequately cleaned, replace with new screen and cover unit. To replace the screen portion only, order kit U27148 (3/4-inch) or U27149 (1.0-inch).

4.5 Adjusting Vacuum Regulator (See Dwg. 25.052.001.026 or 25.052.001.032)

The operating vacuum level for the standard regulator or automatic switchover regulator is adjusted in the same manner. Where two key numbers are given, the first refer to Dwg. 25.052.001.026, the second Dwg. 25.052.001.032. To adjust operating vacuum level, proceed as follows:

a. With the regulator inlet open to room air, connect a water manometer or vacuum gauge at the 1/4-inch pipe tap in the bottom section of the pressure check valve.

<u>WARNING</u>: TO AVOID POSSIBLE SEVERE PERSONAL INJURY OR EQUIPMENT DAMAGE, DO NOT CONNECT THE UNIT TO A GAS SUPPLY FOR THIS ADJUSTMENT.

b. Set the control module to draw air through the unit at an approximate 10-lb/24 hr feed rate or the lowest feed rate detectable on the rotameter. The black knob should be rotated to ON and air should be free to enter the unit through the inlet. For automatic switchover units, turn off the regulator not being adjusted.

<u>CAUTION</u>: If a water manometer is used, be careful to avoid drawing water into the unit. A pinch clamp on the tube permits the tester to open slowly and reclose quickly if the water column rises too high. If water does enter the unit, it must be disassembled and thoroughly dried before reconnecting to the gas supply.

c. For automatic switchover units, remove two set screws (36) from the holes in black knob (2).

d. Insert adjusting tool U24218 through the clearance holes in knob (13, 2) and engage the spanner holes in adjuster (10, 4). Rotate the adjuster with the tool as required to obtain an operating vacuum of 8 to 12 inches of water.

<u>NOTE</u>: Clockwise rotation will lower the vacuum while counterclockwise rotation increases the vacuum.

<u>CAUTION</u>: Do not continue to draw air through the unit once the adjustment is made.

e. For automatic switchover units, replace two set screws (36).

4.6 Adjusting Vacuum Regulator (See Dwg. 50.177.001.012) (Evaporator Arrangement)

WARNING: TO AVOID POSSIBLE SEVERE PERSONAL INJURY, DO NOT USE FINGERS TO MAKE ADJUSTMENTS.

a. Use an 1-1/8-inch open-end wrench and loosen locknut (6) on adjuster (8) and position adjuster 1/2-inch from adapter (4).

b. Energize electric operator (hydramotor, 2) and wait until return spring is fully compressed.

c. Drain air through the unit at a slow rate (approximately equivalent to a 10-lb/24 hr feed rate or lowest feed rate detectable on the rotameter). Air should be free to enter the unit through the inlet.

d. Check the vacuum level. The operating limits for the 3000 lbs/24 hr vacuum regulator are 8 to 12 inches of water.

e. De-energize the electric operator.

f. Turn adjuster with an 1-1/8-inch open end wrench. Lowering the adjuster will have the effect of INCREASING the vacuum. Raising the adjuster will have the effect of DECREASING the vacuum.

g. Energize the electric operator and re-check vacuum level. If the level is within limits, tighten adjuster lock nut. Use 1-1/8-inch open end wrench. If level is out of limits, repeat adjustment procedures above.

NOTE: Do not continue to draw air through the unit once the adjustment is made.

4.7 Adjusting Switchover Detent Level (See Dwg. 25.052.001.032)

To adjust the detent vacuum level, proceed as follows:

a. Turn black knob (2) on the regulator not being adjusted to the OFF position.

b. With the inlet of the regulator being adjusted open to room air, connect a water manometer or vacuum gauge at the 1/4-inch pipe tap in the bottom section of the pressure check valve. A vacuum gauge, rather than a water manometer, is preferred.

WARNING: TO AVOID POSSIBLE SEVERE PERSONAL INJURY OR EQUIPMENT DAMAGE, DO NOT CONNECT THE UNIT TO A GAS CONTAINER FOR THIS ADJUSTMENT.

CAUTION: If a water manometer is used, be careful to avoid drawing water into the unit. A pinch clamp on the tube permits the tester to open slowly and reclose quickly if the water column rises too high. If water does enter the unit, it must be disassembled and thoroughly dried before reconnecting to the gas supply.

c. Set the control module to draw air through the unit at an approximate 10-lb/24 hr feed rate or lowest feed rate detectable on the rotameter.

d. Latch the regulator into STANDBY by rotating black knob (2) to the OFF position, and then to the ON position.

e. Observe the vacuum at which the regulator switches over. This level should be between 32 and 42 inches of water.

f. To adjust the level, loosen two locking screws (24) that hold detent plate (8), turn adjusting screw (26) 1/8 turn (clockwise if level was too high, counterclockwise if level was too low) and retighten the two locking screws.

g. Recheck the detent level.

h. Continue this procedure to reach the proper detent level.

CAUTION: Do not continue to draw air through the unit once the adjustment is made.

4.8 Adjustment of Pressure Check-Pressure Relief Valve (See Dwg. 50.177.000.075)

a. Connect one end of a piece of tubing to elbow (6) in the top of the unit. Submerge the free end approximately 1/4-inch under water.

b. Apply pressure gradually to discharge adapter (26). Observe the point at which bubbles begin to flow rapidly from the end of the tubing. This level must be 13 to 17 inches of water (0.47-0.61 psi). If necessary, remove reducing bushing (14) from the top of the valve and adjust hex nut (17) to obtain the proper relief level.

NOTE: Remove the tubing from the water before turning off pressure to the valve. No water is allowed inside the valve.

4.9 Replacement of Low Temperature Alarm Switch (Evaporator Arrangement Only)

The cavity in the pressure check body is filled with silicone oil at the factory before the low temperature alarm switch is installed. If any oil is spilled during replacement of the switch, it is recommended that the amount of oil be maintained at three mL total.

CAUTION: Do not add more than this, to prevent possible damage to the switch upon installation.

4.10 Chlorine or Sulfur Dioxide Leaks

WARNING: TO AVOID POSSIBLE SEVERE PERSONAL INJURY OR EQUIPMENT DAMAGE, DO NOT TOLERATE ANY LEAKS. THEY ALWAYS GET PROGRESSIVELY WORSE AND MUST BE CORRECTED PROMPTLY.

NOTE: For leak testing, use Evoqua Water Technologies U409 or Commercial 26° Baume' aqueous ammonia. Household ammonia is not strong enough.

A bottle of aqueous ammonia U409 is furnished for checking leakage of chlorine (or sulfur dioxide) gas at joints, valves, etc. Hold the moistened dauber close to the joint or suspected leakage area. If leakage exists, a white cloud will form. When a leak is found, immediately shut off gas supply and remove the escaped gas by ventilation. Continue injector operation for a few minutes to remove all gas from the system.

WARNING: ESCAPED GAS MUST BE EXHAUSTED TO OUTSIDE ATMOSPHERE. THE EXHAUST SYSTEM MUST TERMINATE TO AN AREA WHERE GAS FUMES CANNOT CAUSE INJURY TO PERSONNEL OR DAMAGE TO EQUIPMENT. DO NOT TERMINATE THE EXHAUST SYSTEM AT A LOCATION ROUTINELY USED BY PERSONNEL, SUCH AS WORK AREAS OR PATHWAYS, NOR NEAR WINDOWS OR VENTILATION SYSTEM INTAKES.

Eliminate the leak before proceeding.

As a routine practice, check gas connections for leaks once a day. Green or reddish deposits on metal parts indicate possible leaks.

CAUTION: WHEN ANY CONNECTION IS BROKEN EVEN FOR A SHORT TIME, THE OPENINGS MUST BE PLUGGED TO PREVENT THE ENTRANCE OF MOISTURE, WHICH, WHEN MIXED WITH GAS, CORRODES METAL PARTS.

No odor should be in evidence around equipment except when a joint is temporarily opened.

4.11 Ammonia Leaks

The existence of an ammonia leak is readily detectable by odor. The location may be determined with moist phenolphthalein or red litmus paper, which changes color in ammonia vapor.

4.12 Carbon Dioxide Leaks

Carbon dioxide is colorless and odorless. Leaks may be detected by the application of soapy water to suspected areas or by means of commercially available detectors. Consult your gas supplier for additional information.

4.13 Auxiliary Cylinder Valve (Chlorine/Sulfur Dioxide)

This valve operates under full cylinder pressure and its construction must be understood. See Dwg. 50.150.001.012 for the physical details of the valve.

<u>WARNING</u>: TO AVOID POSSIBLE SEVERE PERSONAL INJURY OR EQUIPMENT DAMAGE, DO NOT REMOVE THE PACKING NUT WHILE THE VALVE IS UNDER PRESSURE.

If a new packing is required, proceed as follows:

a. Close the main cylinder valve and relieve gas pressure in the line connected to the auxiliary cylinder valve by operating injector until the gas pressure gauge reads zero.

b. Remove valve handle (9) from valve stem (5) and valve body (4) by rotating counterclockwise.

c. Turn packing nut clockwise to remove.

<u>NOTE</u>: The packing nut has a left-hand thread. Turning clockwise loosens while turning counterclockwise tightens the packing nut.

d. Remove plastic washer (7) and packing (6).

e. Reassemble in reverse order. Check to ensure that valve handle is engaged on both valve stem (5) and valve body (4) as follows:

   (1) Seat valve stem (5) before the handle covers all the threads on valve body (4).

   (2) If the handle travels too far, remove it. Push the valve stem in slightly, re-engage the handle and close the valve.

   (3) Readjust the valve stem as required so that about one thread on the valve body is exposed when the valve closes.

f. Check for leaks

To tighten the packing while the valve is pressurized, remove valve handle (9) from valve stem (5) and valve body (4) by rotating counterclockwise. Using a

small wrench (to avoid damaging threads by over tightening), tighten packing nut (8) by turning counterclockwise. Replace valve handle.

4.14 Auxiliary Cylinder Valve (Ammonia)

The ammonia version is serviced in the same manner as the chlorine/sulfur dioxide valve. See Dwg. 910.200.003.010 for comparable part and key numbers.

4.15 Changing Cylinders

WARNING: TO AVOID POSSIBLE SEVERE PERSONAL INJURY OR EQUIPMENT DAMAGE, PRIOR TO PERFORMING THIS OPERATION YOU MUST BE COMPLETELY FAMILIAR WITH THE APPROPRIATE GAS MANUAL RECOMMENDED PROCEDURES AND YOUR LOCAL PLANT OPERATING AND EMERGENCY PROCEDURES.

When changing a gas cylinder, air must not be allowed to enter gas lines due to the corrosion problem when ambient air is mixed with dry gas.

CAUTION: When any connection is broken for even a short time, immediately plug the resultant opening with a rubber stopper or equivalent to prevent the entrance of moisture. Moisture must be excluded from any part of the equipment that is normally exposed to dry gas only. Non-corrosive when dry, moist chlorine and sulfur dioxide is extremely corrosive to common metals such as brass or steel.

WARNING: TO AVOID POSSIBLE SEVERE PERSONAL INJURY OR EQUIPMENT DAMAGE, GAS CYLINDERS MUST BE SECURED IN SUCH A MANNER (E.G., WITH CHAIN) AS TO PREVENT THEIR BEING KNOCKED OVER.

When a gas cylinder is exhausted, as shown by a scale showing depletion of contents or by venting from the vacuum relief valve, place a full cylinder ready for service. If the gas feeder is operating, the injector need not be shut off. If the system has two vacuum regulator-check units for automatic switchover, the in-use unit need not be shut off. Proceed as follows:

a. Bring a full cylinder to the point of use.

b. Close the cylinder valve on the exhausted cylinder.

c. Turn the vacuum regulator-check unit knob all the way to OFF. (On evaporator arrangement, de-energize electric operator.)

d. Disconnect the empty cylinder.

e. Release the chain and move the empty cylinder aside.

f. Move the full cylinder into place and secure the restraining chain. Check that the cylinder valve packing nut has not worked loose. Tighten if necessary.

g. Using a new lead gasket, connect the full cylinder.

h. Turn on the gas cylinder valve approximately one-half turn.

i. Check the gasket joint and packing nut for leaks. Correct as indicated.

j. After correcting any leaks, turn the vacuum regulator-check unit knob fully on. (On evaporator arrangement, energize the electric operator.)

k. Replace the empty gas cylinder valve cap and hood, tear tag indicating empty cylinder, and move to storage area for empty cylinders.

4.16 Periodic Preventive Maintenance

Because of aging of elastomeric components and the desirability of checking internal zones for possible accumulations of deposits not seen in routine maintenance, it is recommended that at one-year intervals, each of the principal components be completely disassembled. Before starting the work, ensure that the appropriate preventive maintenance kits are on hand.

Refer to the tabulated listing below and at the end of this book for appropriate kit numbers.

Disassembly and reassembly instructions necessary to install the maintenance kit parts are included in the kit.

Servicing of Evoqua Water Technologies gas feed equipment, including installation of parts from maintenance kits, should be restricted to trained, authorized personnel who are completely familiar with the entire contents of the equipment instruction book. The Evoqua Water Technologies sales office or the dealer from whom you purchased the equipment can provide the preventive maintenance kits or overhaul service.

MAINTENANCE ITEM	WHEN TO PERFORM	MAINTENANCE KIT NO.
Vacuum Regulator-Check Unit	At one-year intervals.	U27807 (Auto. Switchover); U27808 (Standard or Evap.)

WARNING LABELS

The following warning labels and tags are attached to the equipment.

L1965: HAZARDOUS GAS IS PRESENT IN THIS EQUIPMENT DURING NORMAL OPERATION. TO AVOID POSSIBLE SEVERE PERSONAL INJURY OR DAMAGE TO THE EQUIPMENT, READ THE EVOQUA WATER TECHNOLOGIES INSTRUCTION BOOK AND THE APPROPRIATE GAS MANUAL BEFORE CONNECTING THIS EQUIPMENT TO A SUPPLY OF GAS. OPERATION AND MAINTENANCE OF THIS EQUIPMENT MUST BE RESTRICTED TO TRAINED, QUALIFIED PERSONNEL WHO ARE COMPLETELY FAMILIAR WITH THESE INSTRUCTIONS.

L2104: THIS HEATER MAY BE HOT ENOUGH TO CAUSE BURNS. DISCONNECT TO COOL.

L2494: AT FIRST INDICATION OF A GAS LEAK SHUT OFF GAS SUPPLY.

DO NOT REMOVE PACKING NUT B OR USE WRENCH ON HANDLE A.

FOR USE ONLY WITH AMMONIA GAS.

DO NOT REMOVE PACKING NUT B UNLESS GAS SUPPLY IS SHUT OFF.

SEE SKETCH ABOVE FOR INFORMATION ON CORRECT GASKETS. DO NOT SUBSTITUTE.

L2016: TO AVOID POSSIBLE SEVERE PERSONAL INJURY FROM ELECTRICAL SHOCK, TURN POWER OFF BEFORE SERVICING.

L3076: CHECK FOR LEAKS DAILY. AT THE FIRST INDICATION OF A GAS LEAK, SHUT OFF GAS SUPPLY. IF BROWNISH OR GREENISH DEPOSIT IS NOTED, DO NOT ATTEMPT TO USE THIS VALVE, TAKE IT OUT OF SERVICE.

DO NOT USE A WRENCH ON HANDLE A. DO NOT TIGHTEN OR REMOVE PACKING NUT B UNLESS GAS SUPPLY HAS BEEN SHUT OFF AND ALL GAS PRESSURE RELIEVED.

FOR USE WITH CHLORINE AND SULFUR DIOXIDE ONLY.

USE ONLY CORRECT GASKETS. DO NOT SUBSTITUTE.

WARNING LABELS (CONT'D)

L2493:	AT FIRST INDICATION OF A GAS LEAK SHUT OFF GAS SUPPLY. DO NOT REMOVE PACKING NUT B OR USE WRENCH ON HANDLE A. FOR USE ONLY WITH AMMONIA GAS. DO NOT REMOVE PACKING NUT B UNLESS GAS SUPPLY IS SHUT OFF. SEE SKETCH ABOVE FOR INFORMATION ON CORRECT GASKETS. DO NOT SUBSTITUTE.

CAUTION LABELS

The following caution labels have been attached to the equipment.

L2556:	FOR CHLORINE, SULFUR DIOXIDE OR CARBON DIOXIDE USE ONLY.
L2499:	FOR AMMONIA USE ONLY.

VACUUM REGULATOR-CHECK UNIT

PREVENTIVE MAINTENANCE KITS AND SPARE PARTS LIST

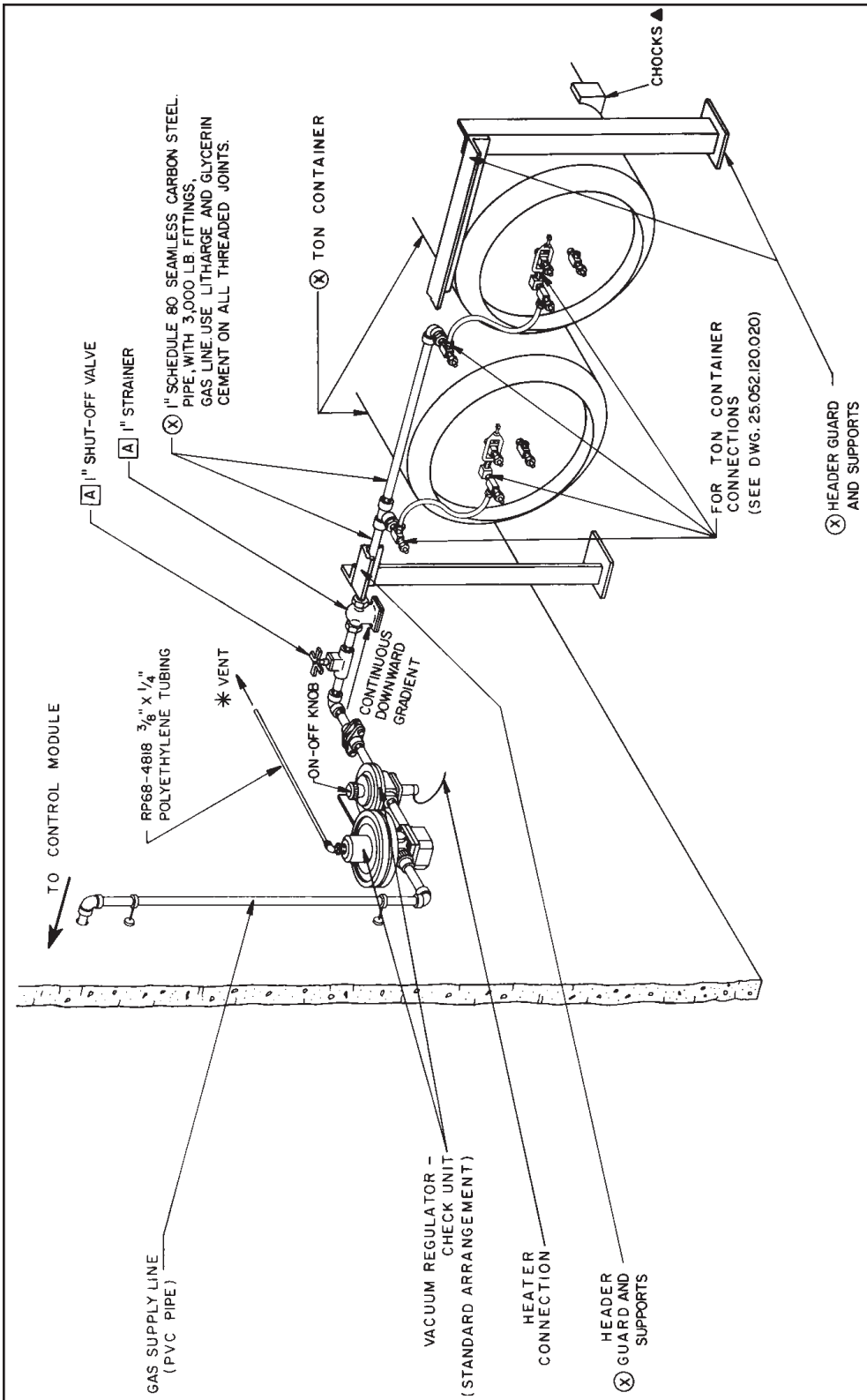
3000 LB/24 HR VACUUM REGULATOR-CHECK UNIT

DESCRIPTION	PART NO.
Preventive Maintenance Kit (Automatic Switchover)	U27807
Preventive Maintenance Kit (Standard or Evaporator)	U27808

ADDITIONAL SPARE PARTS

QTY.	DESCRIPTION	PART NO.
1	Diaphragm (Pressure Check Valve)	P51392
1	Lead Gasket (Pressure Check Valve)	P51386
*1	Diaphragm (Vacuum Regulator) (Chlorine SO_2, CO_2)	P51349
	OR	
*1	Diaphragm (Vacuum Regulator) (Ammonia)	P55203
*1	Diaphragm (Vacuum Regulator) (All Gases)	P51348
*1	O-Ring (Vacuum Regulator)	PXB42310
*1	Lead Gasket (Vacuum Regulator)	P41869
**1 tube	Lubricant	U10242
1 bottle	Ammonia Solution (4 oz.)@	U409
1	Screen Kit (3/4" Strainer)	U27148
1	Screen Kit (1" Strainer)	U27149
1 pkg	Phenolphthalein Test Paper# (100 strips)	U2076
2	Stem (All Gases)	AAC7985
2	Seat and Retainer (All Gases)	U19788

* Quantity two if automatic switchover.
** Commercially available as Dow Corning Silicone Grease DC33.
# For ammonia only.
@ Not For Ammonia.



WARNINGS: ✱ THE VENT LINE MUST TERMINATE IN AN AREA WHERE GAS FUMES CANNOT CAUSE INJURY TO PERSONNEL OR DAMAGE TO EQUIPMENT. DO NOT TERMINATE THE VENT LINE AT A LOCATION ROUTINELY USED BY PERSONNEL, SUCH AS WORK AREAS OR PARTHWAYS, NOR NEAR WINDOWS OR VENTILATION SYSTEM INTAKES.

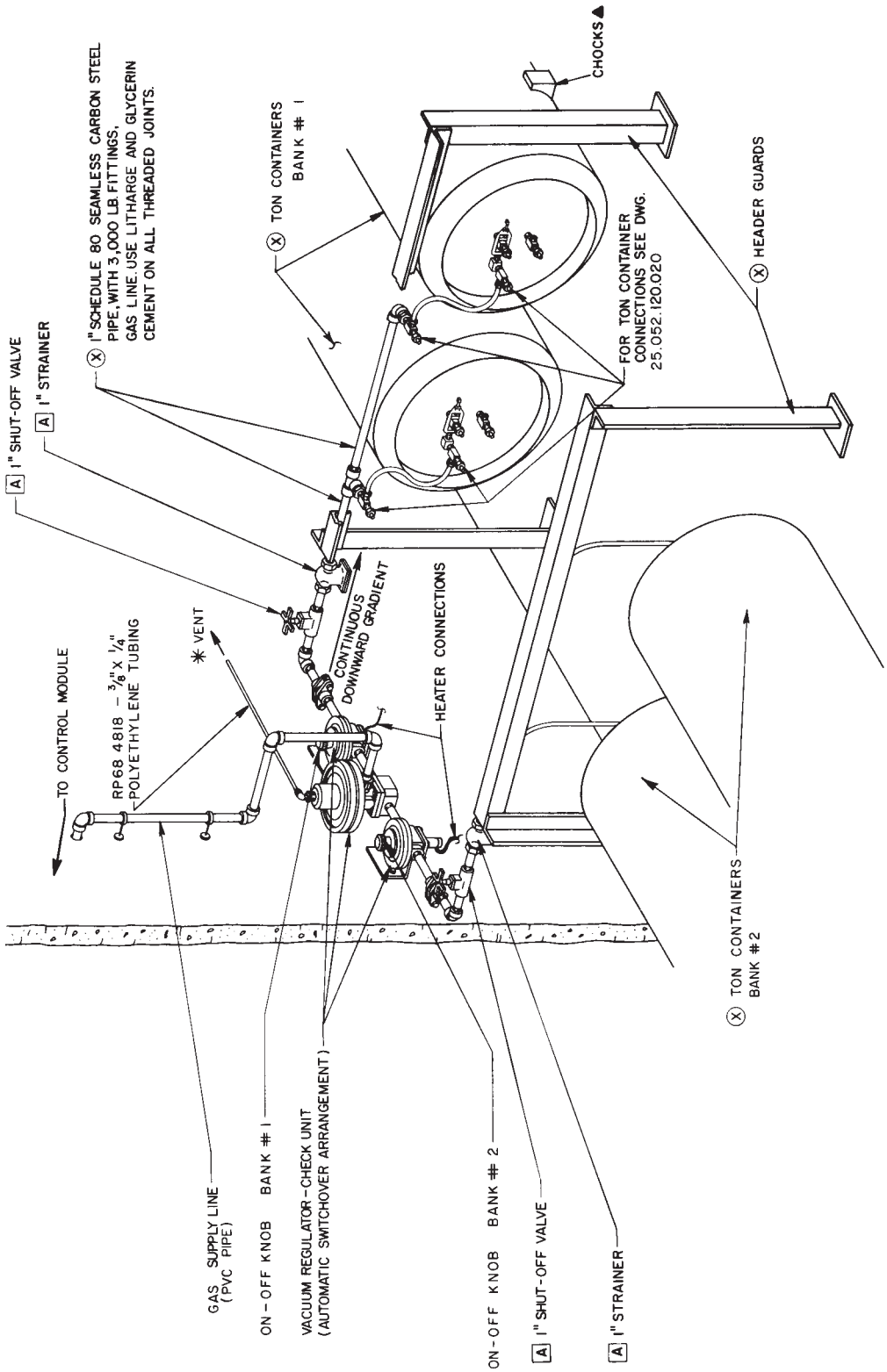
▲ TO AVOID POSSIBLE SEVERE PERSONAL INJEURY OR EQUIPMENT DAMAGE, TON CONTAINERS MUST BE SECURED IN SUCH A MANNER (E.G., CHOCKS) TO PREVENT THEIR ROLLING OUT OF PLACE.

NOTES: Ⓧ NOT FURNISHED BY EVOQUA WATER TECHNOLOGIES.

Ⓐ ACCESSORY ITEM FURNISHED ONLY IF SPECIFICALLY LISTED IN QUOTATION.

3000 LB/24 HR VACUUM REGULATOR-CHECK UNIT - TYPICAL INSTALLATION
With Standard Regulator

25.052.110.010
ISSUE 9 7-14



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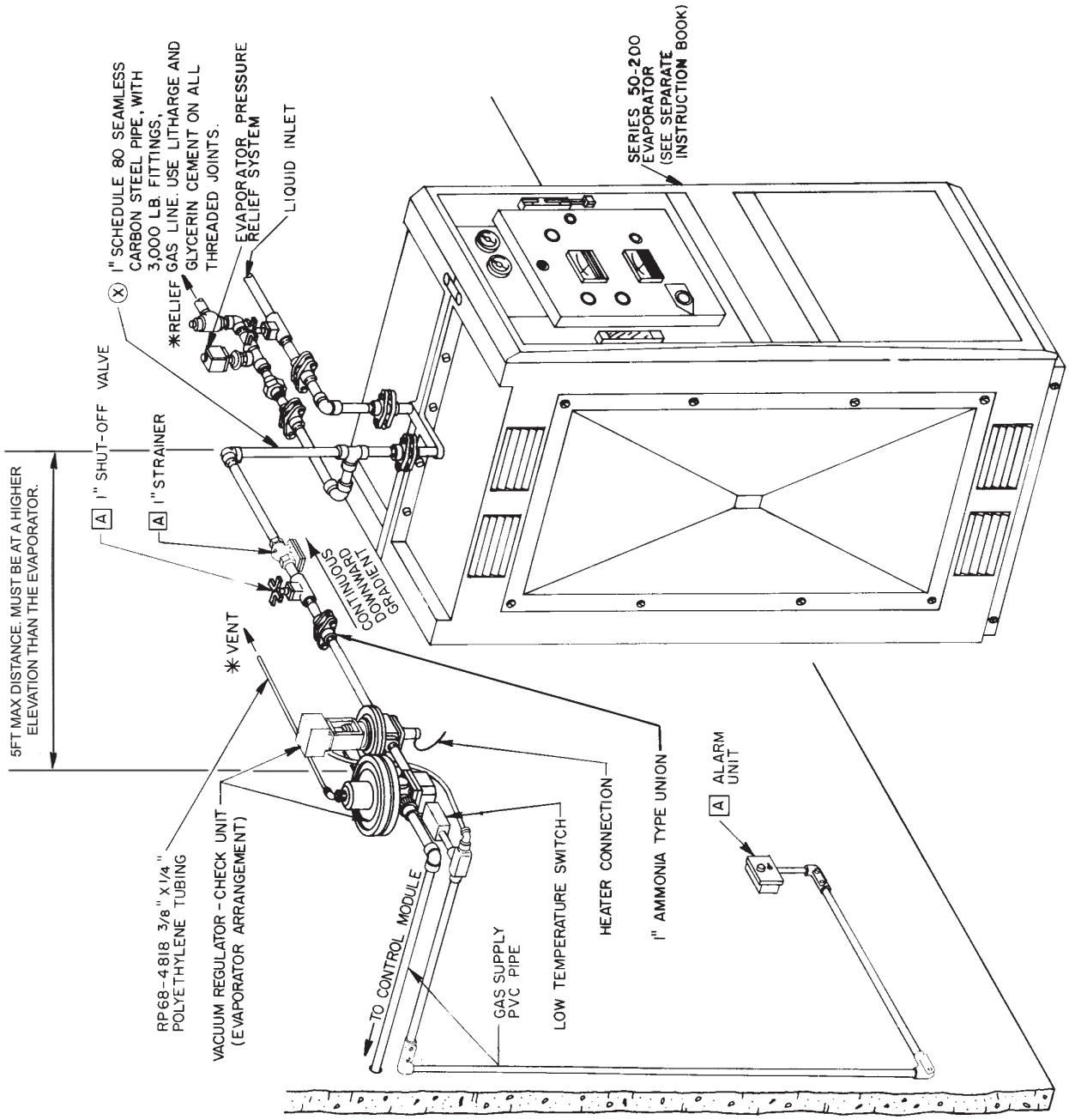
◀ TO AVOID POSSIBLE SEVERE PERSONAL INJEURY OR EQUIPMENT DAMAGE, TON CONTAINERS MUST BE SECURED IN SUCH A MANNER (E.G., CHOCKS) TO PREVENT THEIR ROLLING OUT OF PLACE.

NOTES: Ⓧ NOT FURNISHED BY EVOQUA WATER TECHNOLOGIES.

Ⓐ ACCESSORY ITEM FURNISHED ONLY IF SPECIFICALLY LISTED IN QUOTATION.

3000 LB/24 HR VACUUM REGULATOR-CHECK UNIT - TYPICAL INSTALLATION
With Automatic Switchover Regulator

25.052.110.015
ISSUE 10 7-14



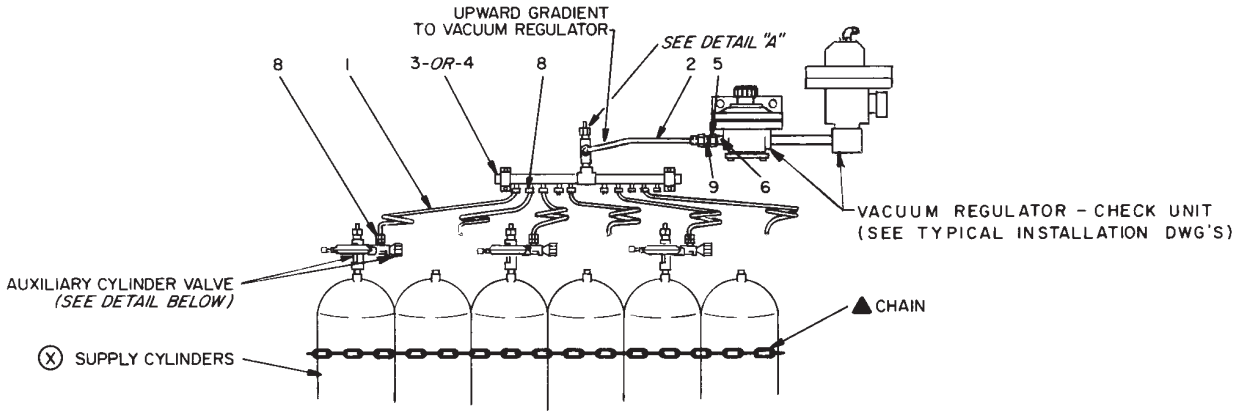
WARNINGS: ✳ THE VENT LINE MUST TERMINATE IN AN AREA WHERE GAS FUMES CANNOT CAUSE INJURY TO PERSONNEL OR DAMAGE TO EQUIPMENT. DO NOT TERMINATE THE VENT LINE AT A LOCATION ROUTINELY USED BY PERSONNEL, SUCH AS WORK AREAS OR PARTHWAYS, NOR NEAR WINDOWS OR VENTILATION SYSTEM INTAKES.

▲ TO AVOID POSSIBLE SEVERE PERSONAL INJEURY OR EQUIPMENT DAMAGE, TON CONTAINERS MUST BE SECURED IN SUCH A MANNER (E.G., CHOCKS) TO PREVENT THEIR ROLLING OUT OF PLACE.

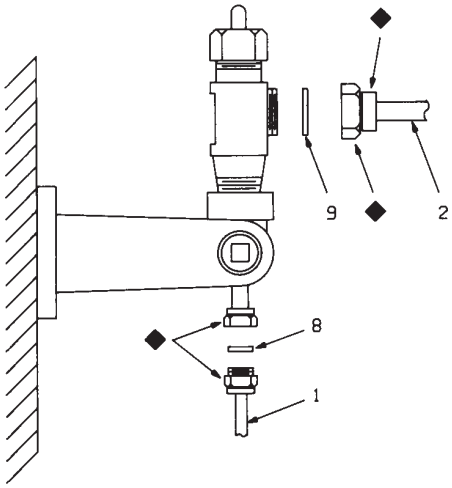
NOTES: (X) NOT FURNISHED BY EVOQUA WATER TECHNOLOGIES.

[A] ACCESSORY ITEM FURNISHED ONLY IF SPECIFICALLY LISTED IN QUOTATION.

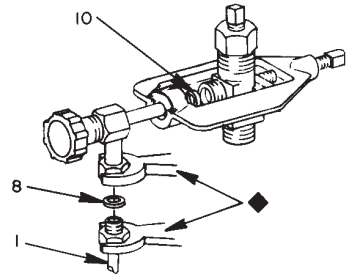
3000 LB/24 HR VACUUM REGULATOR-CHECK UNIT - TYPICAL INSTALLATION
With Evaporator
25.052.110.020
ISSUE 12 7-14



10 TANK MANIFOLD CONNECTION



DETAIL "A" MANIFOLD CONNECTION



U28110 CAPTIVE YOKE TYPE
AUXILIARY CYLINDER VALVE

KEY NO.	PART NO.	DESCRIPTION	KEY NO.	PART NO.	DESCRIPTION
1 ●	UX_493	FLEXIBLE CONN. - 4 FT. LENGTH	6	PC 50282	REDUCING BUSHING (3/4" x 1")
2 ●	UX_1098	FLEXIBLE CONN. - 4 FT. LENGTH	8	P 2519	GASKET 35/64" OD
3	U 28834	5 TANK MANIFOLD	9	P 2476	GASKET 15/16" OD
4	U 28837	10 TANK MANIFOLD	10	P 16191	GASKET 15/16" OD
5	P 7737	3/4" ADAPTER (3/4" NPT x 3/4" N.G.O.ST.PIPE THD.)			

WARNING: ▲ TO AVOID POSSIBLE SEVERE PERSONAL INJURY OR EQUIPMENT DAMAGE, SUPPLY CYLINDERS MUST BE SECURED IN SUCH A MANNER (E.G., CHAIN) AS TO PREVENT THEIR BEING KNOCKED OVER.

CAUTION: ◆ USE TWO WRENCHES ON ALL UNION CONNECTIONS. WRENCH ON TUBING MUST BE HELD STATIONARY WHILE VALVE NUT IS TURNED (TUBING END IS BRAZED TO TUBING).

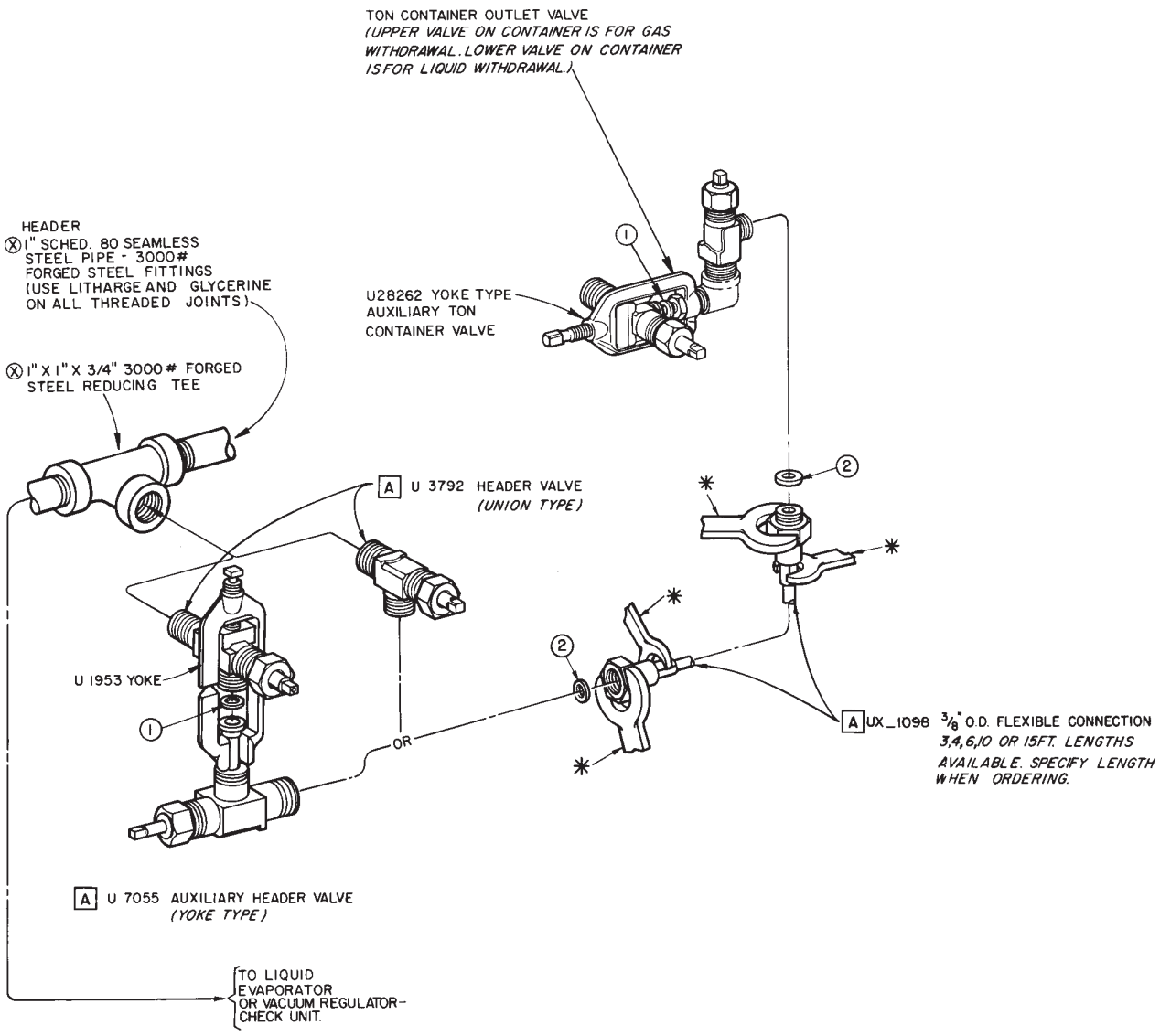
NOTES: ● ALTERNATE LENGTHS AVAILABLE 3, 6, 10, OR 15 FT. SPECIFY LENGTHS WHEN ORDERING. THE CHLORINE INSTITUTE RECOMMENDS THAT FLEXIBLE CONNECTIONS BE REPLACED ANNUALLY OR SOONER IF THERE IS EVIDENCE OF DETERIORATION. SEE CHLORINE HANDLING MANUAL. SIMILAR RECOMMENDATIONS APPLY TO OTHER GASES.

Ⓧ NOT FURNISHED BY EVOQUA WATER TECHNOLOGIES.

WHEN ORDERING MATERIAL, ALWAYS SPECIFY MODEL AND SERIAL NUMBER OF APPARATUS.

GAS CONNECTIONS - CYLINDER TO VACUUM REGULATOR - INSTALLATION PIPING

25.052.120.010
ISSUE 11 7-14



CAUTION: ✳ USE TWO WRENCHES ON ALL UNION CONNECTIONS. WRENCH ON TUBING END MUST BE HELD STATIONARY WHILE NUT IS TURNED (TUBING END IS BRAZED TO TUBING.)

NOTES: Ⓐ ACCESSORY ITEMS FURNISHED ONLY IF SPECIFICALLY LISTED IN QUOTATION.

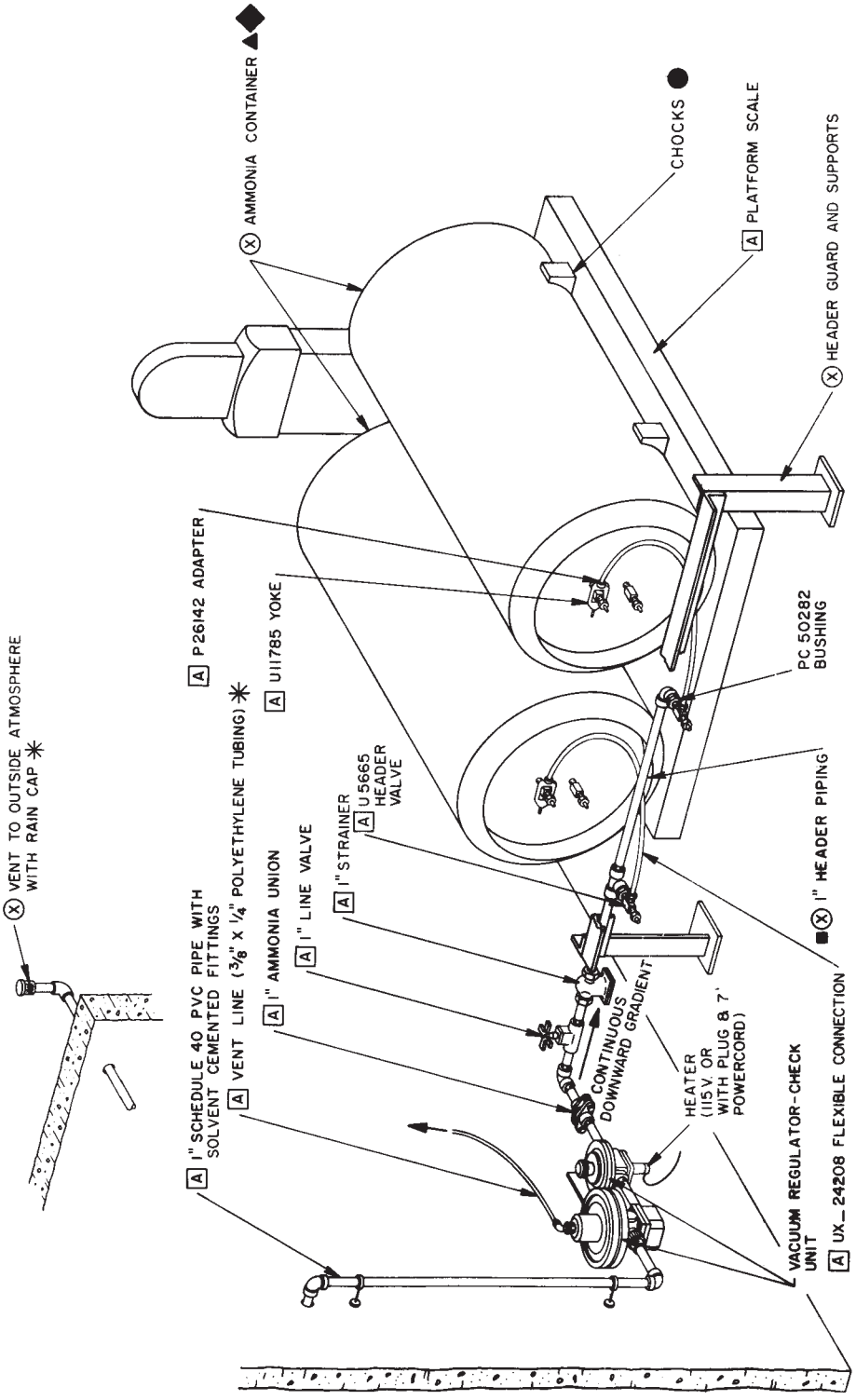
X NOT FURNISHED BY EVOQUA WATER TECHNOLOGIES.

THE CHLORINE INSTITUTE RECOMMENDS THAT FLEXIBLE CONNECTIONS BE REPLACED ANNUALLY OR SOONER IF THERE IS EVIDENCE OF DETERIORATION. SEE THE CHLORINE HANDLING MANUAL. SIMILAR RECOMMENDATIONS APPLY TO OTHER GASES.

WHEN ORDERING MATERIAL, ALWAYS SPECIFY MODEL AND SERIAL NUMBER OF APPARATUS.

TON CONTAINER TO HEADER CONNECTIONS - INSTALLATION PIPING

25.052.120.020
ISSUE 10 7-14



WARNINGS:

- ◆ TO AVOID POSSIBLE SEVERE PERSONAL INJURY OR EQUIPMENT DAMAGE, AMMONIA GAS SHOULD NOT BE STORED IN OR FED FROM THE SAME ROOM WITH CHLORINE. CONTACT OF THE GASES MAY RESULT IN AN EXPLOSIVE MIXTURE.
- ✳ THE VENT LINE MUST TERMINATE IN AN AREA WHERE GAS FUMES CANNOT CAUSE INJURY TO PERSONNEL OR DAMAGE. DO NOT TERMINATE THE VENT LINE AT A LOCATION ROUTINELY USED BY PERSONNEL SUCH AS WORK AREAS OR PATHWAYS NOR NEAR WINDOWS OR VENTILATION SYSTEM INTAKES.
- ● TO AVOID POSSIBLE SEVERE PERSONAL INJURY OR EQUIPMENT DAMAGE, TON CONTAINERS MUST BE SECURED IN SUCH A MANNER (e.g. CHOCKS) TO PREVENT THEIR ROLLING OUT OF PLACE.

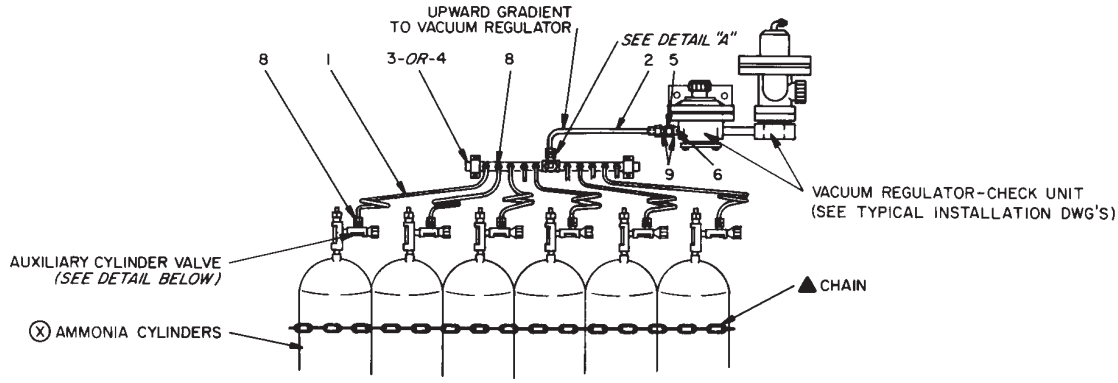
NOTES:

- Ⓧ NOT FURNISHED BY EVOQUA WATER TECHNOLOGIES.
- A ACCESSORY ITEM FURNISHED ONLY IF SPECIFICALLY LISTED IN QUOTATION.
- ◀ GAS WITHDRAWAL CONNECTION MUST BE MADE TO UPPER VALVE AS ILLUSTRATED.
- ■ SCHEDULE 80 SEAMLESS STEEL PIPE WITH FORGED STEEL FITTINGS. USE LITHARGE AND GLYCERINE CEMENT OR WHITE LEAD ON ALL THREADED JOINTS.

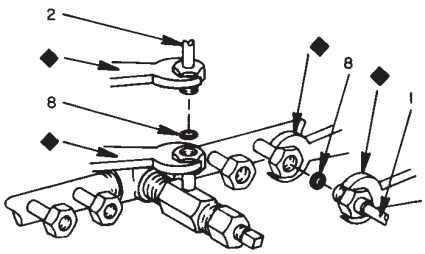
1450 LB/24 HR AMMONIA VACUUM REGULATOR-CHECK UNIT
- TYPICAL INSTALLATION

60.221.110.085

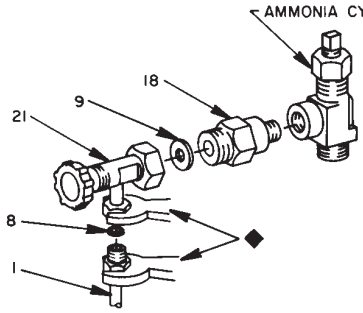
ISSUE 8 7-14



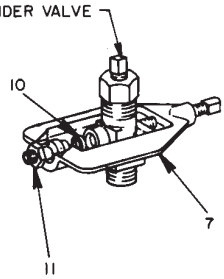
10 TANK MANIFOLD CONNECTION



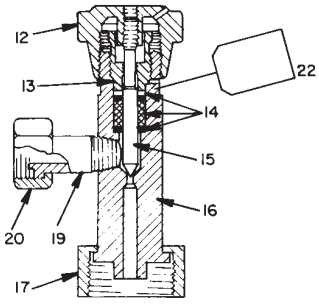
DETAIL "A" MANIFOLD CONNECTION



UNION TYPE
AUXILIARY CYLINDER VALVE CONNECTION



YOKE FOR AMMONIA CYLINDER VALVE OR AUXILIARY CYLINDER VALVE-YOKE TYPE U26595



DETAIL "B"
U 2065

KEY NO.	PART NO.	DESCRIPTION	KEY NO.	PART NO.	DESCRIPTION
1	UX_2066	FLEXIBLE CONN. - 6 FT. OR 10 FT. LGTHS.	12	P 6729	CAP
2	UX_24208	FLEXIBLE CONN. - 4 FT. OR 10 FT. LGTHS.	13	P 6730	PACKING NUT
3	U 28401	5-TANK MANIFOLD	14	U 21412	PACKING
4	U 28402	10-TANK MANIFOLD	15	P 6731	STEM
5	PXA7737	3/4" ADAPTER (3/4" THRD. x 3/4" ST. PIPE THRD.)	16	P 18433	BODY
6	PC 50282	REDUCING BUSHING (3/4" x 1")	17	P 6735	UNION NUT
7	U 11785	YOKE	18	P 13900	ADAPTER
8	P 2519	GASKET 35/64"OD	19	PS 6714	UNION NIPPLE
9	P 2476	GASKET 15/16"OD	20	PS 6749	UNION NUT
10	P 16191	GASKET 15/16"OD	21	U 2065	AUXILIARY CYLINDER VALVE (SEE DETAIL B")
11	P 26142	ADAPTER	22	L 2494	INSTRUCTION CARD

WARNING: ▲ TO AVOID POSSIBLE SEVERE PERSONAL INJURY OR EQUIPMENT DAMAGE, SUPPLY CYLINDERS MUST BE SECURED IN SUCH A MANNER (E.G., CHAIN) AS TO PREVENT THEIR BEING KNOCKED OVER.

CAUTION: ◆ USE TWO WRENCHES ON ALL UNION CONNECTIONS. WRENCH ON TUBING MUST BE HELD STATIONARY WHILE VALVE NUT IS TURNED (TUBING END IS BRAZED TO TUBING).

NOTES: Ⓧ NOT FURNISHED BY EVOQUA WATER TECHNOLOGIES.
USE LITHARGE AND GLYCERINE CEMENT ON ALL PIPE THREADED JOINTS.

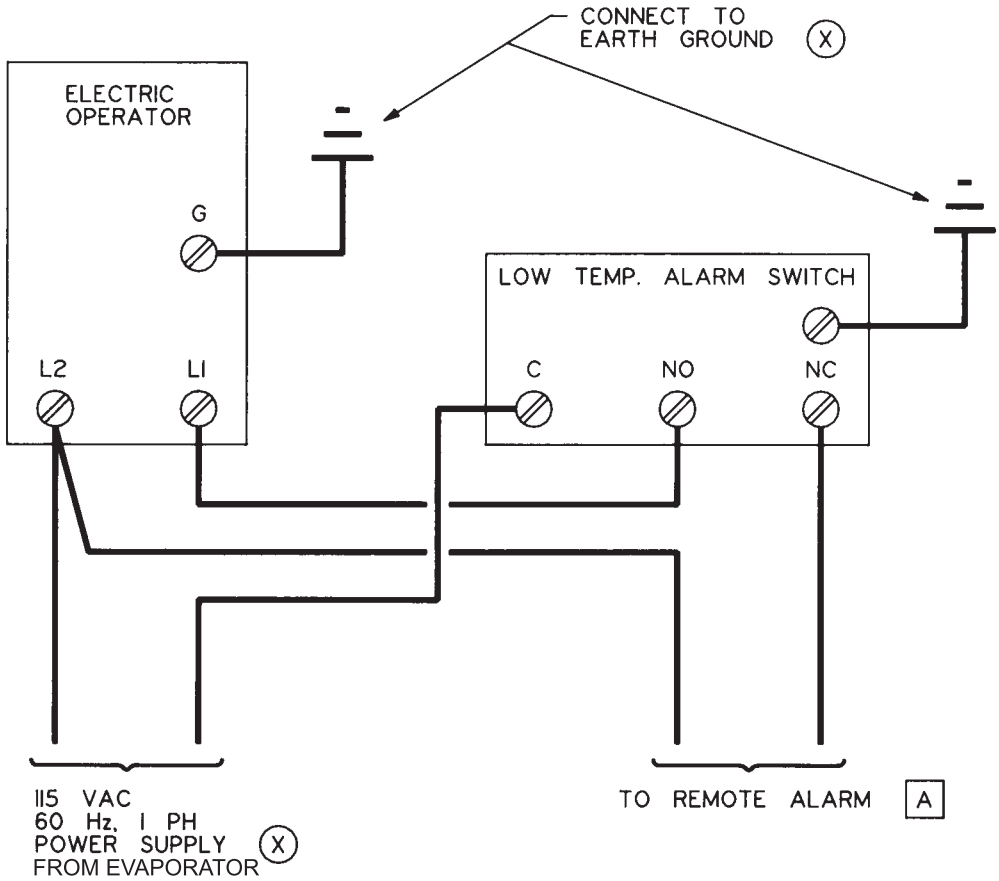
WHEN ORDERING MATERIAL, ALWAYS SPECIFY MODEL AND SERIAL NUMBER OF APPARATUS.

AMMONIA CONNECTIONS CYLINDERS TO VACUUM REGULATOR - INSTALLATION PIPING

1450 Lb/24 Hr Ammonia Vacuum Regulator - Check Unit

60.210.010.040

ISSUE 11 7-14



NOTES: (X) NOT FURNISHED BY EVOQUA WATER TECHNOLOGIES.

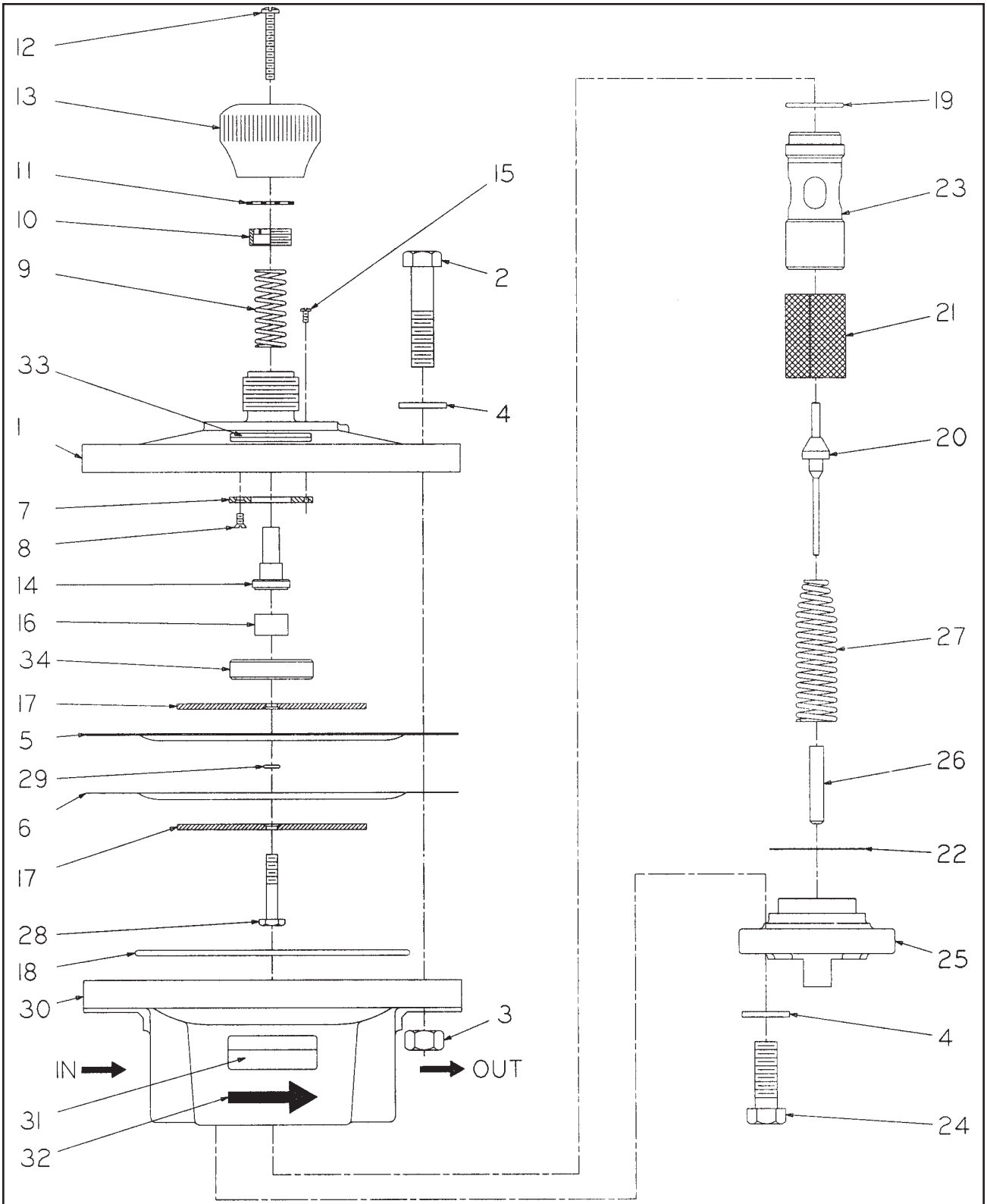
[A] ACCESSORY ITEM FURNISHED ONLY IF SPECIFICALLY LISTED IN QUOTATION.

FIELD WIRING (NOT BY EVOQUA WATER TECHNOLOGIES) MUST CONFORM TO LOCAL ELECTRICAL CODES.

EVAPORATOR ARRANGEMENT - INSTALLATION WIRING

50.177.130.010

ISSUE 4 7-14



U28166 - CHLORINE, SULFUR DIOXIDE & CARBON DIOXIDE; U28167 - AMMONIA

VACUUM REGULATOR (STANDARD) - PARTS

25.052.001.026A

ISSUE 2 1-95

NOTE: FOR PARTS LIST, SEE DWG. 25.052.001.026B.

VACUUM REGULATOR-CHECK UNIT

KEY NO.	PART NO.	QTY.	DESCRIPTION
1	P 58514	1	BONNET
2	P 8449	8	BOLT (HEX.HD.,STL.) 1/2"-13 x 2-1/4" LG.
3	P 889	8	HEX. NUT (STL.) 1/2"-13
4	P 7358	12	1/2" WASHER (STL.)
5	P 51348	1	DIAPHRAGM (HYPALON) (TOP)
6	P 51349	1	DIAPHRAGM (BOTTOM) (FOR CHLORINE)
	OR		
	P 55203	1	DIAPHRAGM (BOTTOM) (FOR AMMONIA)
7	P 50599	1	PLATE
8	P 49588	1	MACH. SCREW (FLT. HD., MONEL) #6-32 x 5/16" LG.
9	P 51344	1	BIAS SPRING
10	P 50230	1	ADJUSTER
11	P 51150	1	WASHER
12	P 51342	1	MACH. SCREW (PAN HD.,SS) #10-24 x 1-1/2" LG.
13	P 51343	1	KNOB
14	P 48587	1	SPOOL
15	PE 21184	2	MACH. SCREW (BIND.HD.,BRASS) #4-40 x 1/4" LG.
16	P 51346	1	SPACER
17	P 51347	2	BACKING PLATE (FOR CHLORINE)
	OR		
	P 51763	2	BACKING PLATE (FOR AMMONIA)
18	AAB 4529	1	GASKET
19	PXB 42310	1	O-RING (122) TFE, 1-1/8" ID x 1-5/8"OD
20	AAC7985	1	STEM UNIT (ALL GASES)
21	P 41866	1	STRAINER
22	P 41869	1	LEAD GASKET
23	U 19788	1	SEAT & RETAINER UNIT
24	P 6582	4	BOLT (HEX.HD.,STL.) 1/2" - 13 x 1-1/2" LG.
25	P 58486	1	CAP
26	P 41870	1	BUSHING GUIDE
27	P 51352	1	MAIN SPRING
28	P 51351	1	SCREW
29	P 51358	1	O-RING (010) HYPALON, 1/4" ID x 3/8" OD (BETWEEN DIA-PHRAGMS)
30	P 58487	1	BODY
31	L 1965	1	WARNING LABEL
32	P 51359	2	ARROW DECAL
33	L 2556	1	CAUTION LABEL (FOR CHLORINE)
	OR		
	L 2499	1	CAUTION LABEL (FOR AMMONIA)
34	P 59385	1	DAMPENER BUSHING

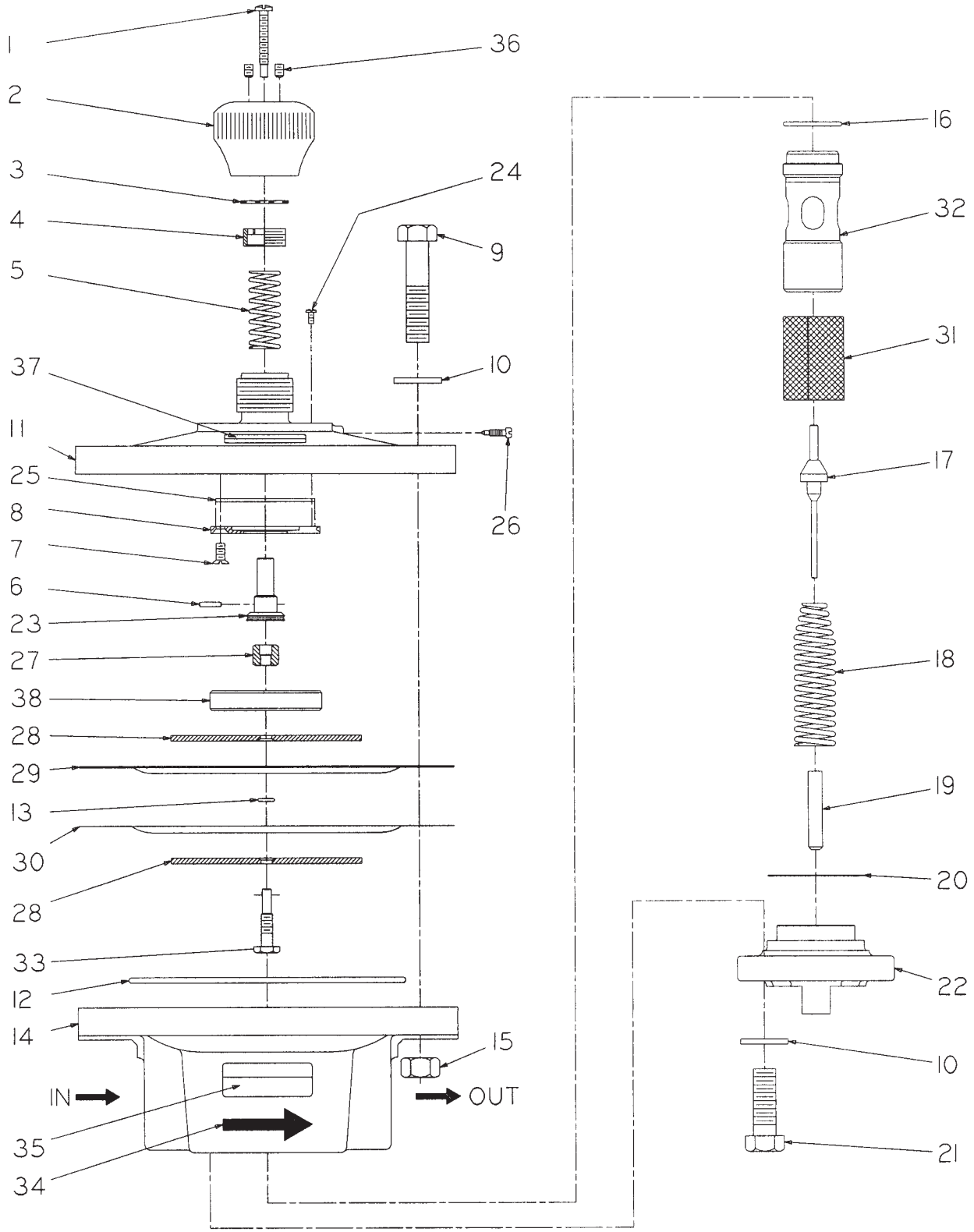
WHEN ORDERING MATERIAL, ALWAYS SPECIFY MODEL AND SERIAL NUMBER OF APPARATUS.

U28166 - CHLORINE, SULFUR DIOXIDE & CARBON DIOXIDE; U28167 - AMMONIA

VACUUM REGULATOR (STANDARD) - PARTS LIST

25.052.001.026B

ISSUE 4 12-08



U28172 - CHLORINE, SULFUR DIOXIDE & CARBON DIOXIDE; U28173 - AMMONIA

VACUUM REGULATOR (AUTOMATIC SWITCHOVER) - PARTS

25.052.001.032A

ISSUE 2 1-95

NOTE: FOR PARTS LIST, SEE DWG. 25.052.001.032B.

VACUUM REGULATOR-CHECK UNIT

KEY NO.	PART NO.	QTY.	DESCRIPTION
1	P 51638	1	DOG POINT SCREW
2	P 51343	1	KNOB
3	P 51150	1	ANTI FRICTION WASHER (TFE)
4	P 50230	1	SPRING ADJUSTER
5	P 51344	1	BIAS SPRING
6	P 52306	1	GROOVE PIN (SS) 3/32" DIA. x 1/2" LG.
7	PN 706	1	MACH. SCREW (FLT.HD.,MONEL) #6-32 x 5/16" LG.
8	P 53690	1	DETENT PLATE
9	P 8449	8	BOLT (HEX.HD.,STL.) 1/2" - 13 x 2-1/4" LG.
10	P 7358	12	1/2" WASHER (STL.)
11	P 58519	1	BONNET
12	AAB 4529	1	GASKET
13	P 51358	1	O-RING (010) HYPALON, 1/4" ID x 3/8" OD
14	P 58487	1	BODY
15	P 889	8	HEX. NUT (STL.) 1/2"-13
16	PXB 42310	1	O-RING (122) TFE, 1-1/8" ID x 1-5/16" OD
17	AAC7985	1	STEM UNIT (ALL GASES)
18	P 51352	1	MAIN SPRING
19	P 41870	1	BUSHING GUIDE
20	P 41869	1	LEAD GASKET
21	P 6582	4	BOLT (HEX.HD.,STL.) 1/2"-13 x 1-1/2" LG.
22	P 58486	1	CAP
23	U 25221	1	SPOOL DETENT UNIT
24	PE 18687	2	MACH. SCREW (BIND.HD.,BRASS) #4-40 x 1/4" LG.
25	P 53691	2	ROD DETENT
26	P 52295	1	SCREW ADJUST
27	P 51639	1	SPACER
28	P 51347	2	BACKING PLATE (FOR CHLORINE)
	OR		
	P 51763	2	BACKING PLATE (FOR AMMONIA)
29	P 51348	1	DIAPHRAGM (HYPALON) (TOP)
30	P 51349	1	DIAPHRAGM (BOTTOM) (FOR CHLORINE)
	OR		
	P 55203	1	DIAPHRAGM (BOTTOM) (FOR AMMONIA)
31	P 41866	1	STRAINER
32	U 19788	1	SEAT & RETAINER UNIT
33	P 52479	1	HEX. HEAD SCREW
34	P 51359	2	ARROW DECAL
35	L 1965	1	WARNING LABEL
36	PE 6132	2	SET SCREW (SLOTTED HEADLESS CUP PT.BRASS) #10-32 x 1/4" LG.
37	L 2556	1	CAUTION LABEL (FOR CHLORINE)
	OR		
	L 2499	1	CAUTION LABEL (FOR AMMONIA)
38	P 59386	1	DAMPENER BUSHING

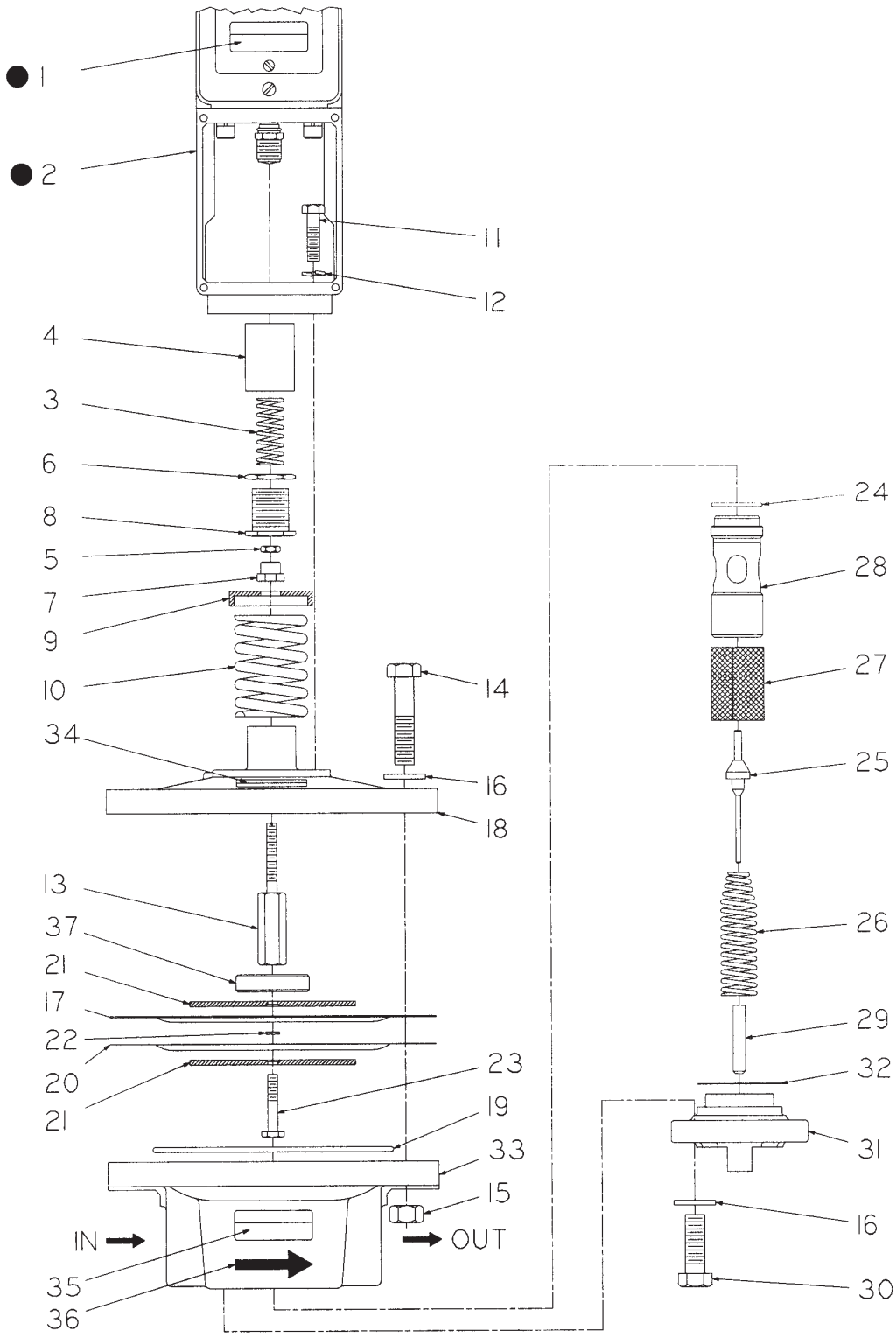
WHEN ORDERING MATERIAL, ALWAYS SPECIFY MODEL AND SERIAL NUMBER OF APPARATUS.

U28172 - CHLORINE, SULFUR DIOXIDE & CARBON DIOXIDE; U28173 - AMMONIA

VACUUM REGULATOR (AUTOMATIC SWITCHOVER) - PARTS LIST

25.052.001.032B

ISSUE 4 12-08



NOTE: ● NOT PART OF U29296 OR U29297.
FOR PARTS LIST, SEE DWG. 50.177.001.012B.

U29296 - CHLORINE, SULFUR DIOXIDE & CARBON DIOXIDE; U29297 - AMMONIA

VACUUM REGULATOR (EVAPORATOR ARRANGEMENT) - PARTS

50.177.001.012A

ISSUE 1 2-01

VACUUM REGULATOR-CHECK UNIT

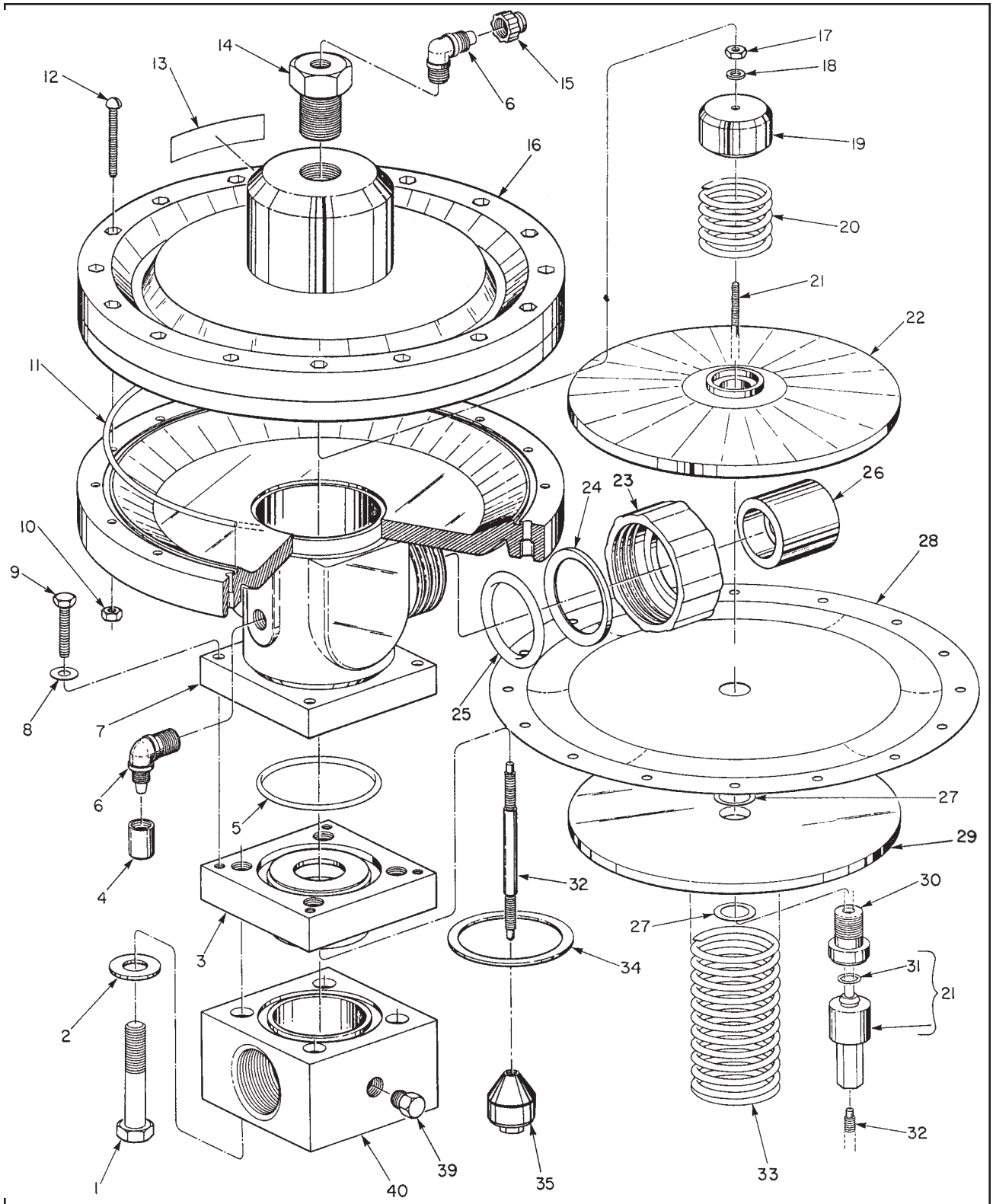
KEY NO.	PART NO.	QTY.	DESCRIPTION
●■ 1	L 2016	1	WARNING LABEL (PART OF KEY NO. 2)
● 2	U 20068	1	HYDRAMOTOR
3	P 51344	1	BIAS SPRING
4	P 57106	1	ADAPTER
5	P 6239	1	NUT (JAM. STL.) 1/4-20
6	P 57108	1	LOCKNUT
7	P 57109	1	BIAS SPRING SEAT
8	P 57110	1	ADJUSTER
9	P 57111	1	SPRING CAP
10	P 57112	1	RETURN SPRING
11	P 875	4	BOLT (HEX.HD.,STL.) 5/16"-18 x 1-1/4" LG.
12	P 4763	4	LOCKWASHER (C.STL.) 5/16"
13	P 57107	1	ADJUSTER STUD
14	P 8449	8	BOLT (HEX.HD.,STL.) 1/2-13 x 2-1/4" LG.
15	P 889	8	NUT (HEX.STL.) 1/2-13
16	P 7358	12	WASHER (STL.) 1/2
17	P 51348	1	DIAPHRAGM HYPALON
18	P 58488	1	BONNET
19	AAB4529	1	GASKET
20	P 51349	1	DIAPHRAGM (FOR CHLORINE)
	OR		
	P 55203	1	DIAPHRAGM (FOR AMMONIA)
21	P 51347	2	BACKING PLATE
	OR		
	P 51763	2	BACKING PLATE
22	P 51358	1	O-RING (010) HYPALON, 1/4" ID x 3/8" OD
23	P 51351	1	SCREW
24	PXB 42310	1	O-RING (122) TFE, 1-1/8" ID x 1-5/16" OD
25	AAC7985	1	STEM UNIT (ALL GASES)
26	P 51352	1	MAIN SPRING
27	P 41866	1	STRAINER
28	U 19788	1	SEAT & RETAINER
29	P 41870	1	GUIDE BUSHING
30	P 6582	4	BOLT (HEX. HD.,STL.) 1/2-13 x 1-1/2" LG.
31	P 58486	1	CAP
32	P 41869	1	LEAD GASKET
33	P 58487	1	BODY
34	L 2556	1	CAUTION LABEL (FOR CHLORINE)
	OR		
	L 2499	1	CAUTION LABEL (FOR AMMONIA)
35	L 1965	1	WARNING LABEL
36	P 51359	2	ARROW DECAL
37	P 59385	1	BUSHING

NOTE: ● NOT PART OF U29296 OR U29297.
■ PART OF U20068.

WHEN ORDERING MATERIAL, ALWAYS SPECIFY MODEL AND SERIAL NUMBER OF APPARATUS.

U29296 - CHLORINE, SULFUR DIOXIDE & CARBON DIOXIDE; U29297 - AMMONIA
VACUUM REGULATOR (EVAPORATOR ARRANGEMENT) - PARTS LIST

50.177.001.012B
ISSUE 2 12-08



U27549 - CHLORINE, SULFUR DIOXIDE & CARBON DIOXIDE; U27551 - AMMONIA

PRESSURE CHECK-PRESSURE RELIEF VALVE - PARTS

50.177.000.075A

ISSUE 3 12-08

NOTE: FOR PARTS LIST, SEE DWG. 50.177.000.075B.

VACUUM REGULATOR-CHECK UNIT

KEY NO.	PART NO.	QTY.	DESCRIPTION
▲ 1	P 36387	4	BOLT (HEX.HD.,STL.) 1/2"-13 x 2-3/4" LG.
▲ 2	P 19803	4	1/2" WASHER (STL.)
3	U 25259	1	PRESSURE CHECK SEAT
4	P 37823	1	CAPNUT
5	P 57183	1	O-RING (232) VITON, 2-3/4" ID x 3" OD (FOR Cl2, CO2, SO2)
	OR		
	P 41703	1	O-RING (232) BUNA-N, 2-3/4" ID x 3" OD (FOR NH3)
6	P 39235	2	90° ELBOW - HALF UNION (PVC) 3/8" TUBING x 1/4" NPT
7	U 26560	1	BODY UNIT
8	P 16556	4	1/4" WASHER (MONEL)
9	P 32413	4	BOLT (HEX.HD.,MONEL) 1/4"-20 x 1-1/2" LG.
10	P 35110	16	HEX. NUT (SS) #10-24
11	P 57181	1	O-RING (170) VITON, 7-3/4" ID x 7-15/16" OD FOR Cl2, CO2, SO2)
	OR		
	P 57195	1	O-RING (170) BUNA-N, 7-3/4" ID x 7-15/16" OD (NH3 ONLY)
12	P 35113	16	MACH.SCREW (RD.HD.,MONEL) #10-24 x 1-1/4" LG.
13	P 54516	1	LABEL
14	P 23664	1	REDUCING BUSHING (PVC) 3/4" NPT x 1/4"
15	PXB 39334	1	UNION NUT (1/2"-20) 3/8" TUBING
16	U 26559	1	BONNET UNIT
17	P 51366	1	HEX. NUT (SILVER) #10-24
18	P 3194	1	WASHER (SILVER)
19	P 51387	1	SPRING RETAINER
20	P 51444	1	RELIEF SPRING
21	U 27488	1	PRESSURE CHECK UNIT - (FOR Cl2, CO2, SO2)
	OR		
	U 27489	1	PRESSURE CHECK UNIT - (FOR NH3)
22	P 54860	1	TOP BACKING PLATE
23	P 36802	1	UNION NUT - (PVC) 1-1/2" PIPE
24	P 37015	1	NUT WASHER
25	P 28509	1	RING GASKET
26	P 51378	1	ADAPTER
27	P 51373	2	GASKET
28	P 51392	1	DIAPHRAGM
29	P 54859	1	BOTTOM BACKING PLATE
30	P 51370	1	SCREW
▼ 31	PXA 38437	1	O-RING (013) VITON, 7/16" ID x 9/16" OD (FOR Cl2, CO2, SO2)
	OR		
	P 38437	1	O-RING (013) BUNA-N, 7/16" ID x 9/16" OD (FOR NH3)
32	P 54050	1	STEM
33	P 51394	1	SPRING
▲ 34	P 51386	1	GASKET (LEAD)
35	U 27935	1	CHECK (FOR Cl2, CO2, SO2)
	OR		
	P 57044	1	CHECK (NH3)
▲ 39	AAA2562	1	PIPE PLUG 1/4" NPT
▲ 40	P 58742	1	BODY

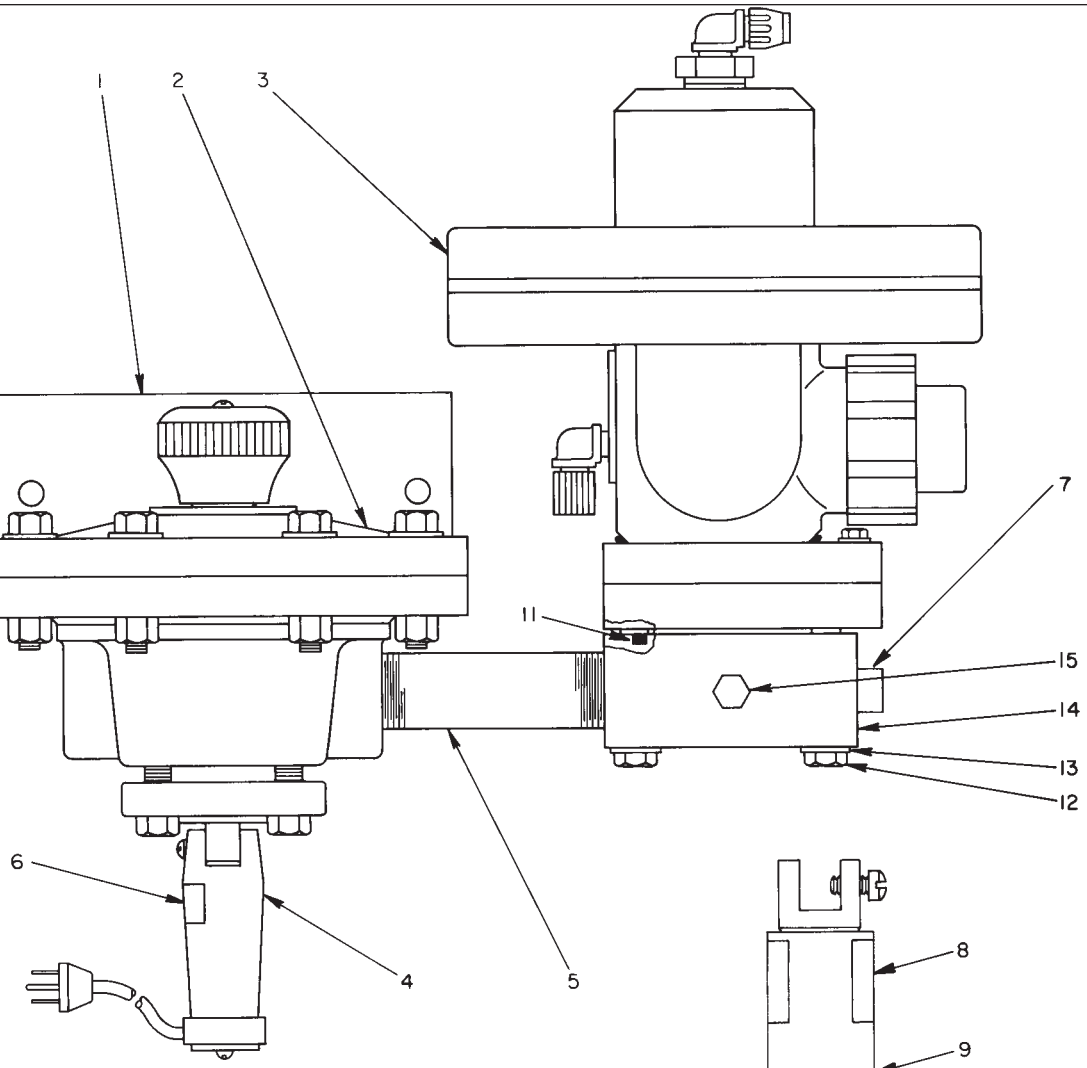
NOTE: ▼ PART OF KEY NO. 21.
▲ NOT PART OF U27551 OR U27549.

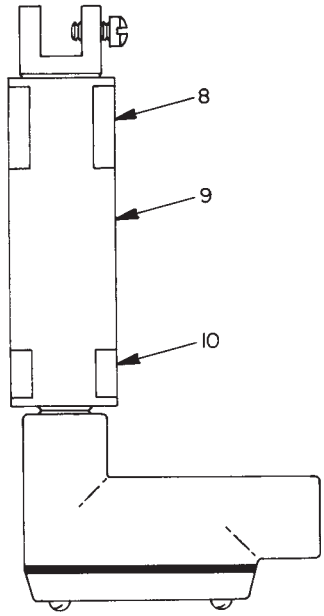
WHEN ORDERING MATERIAL, ALWAYS SPECIFY MODEL AND SERIAL NUMBER OF APPARATUS.

U27549 - CHLORINE, SULFUR DIOXIDE & CARBON DIOXIDE; U27551 - AMMONIA
PRESSURE CHECK-PRESSURE RELIEF VALVE - PARTS LIST

50.177.000.075B
ISSUE 4 5-04

VACUUM REGULATOR-CHECK UNIT





OUTDOOR HEATER

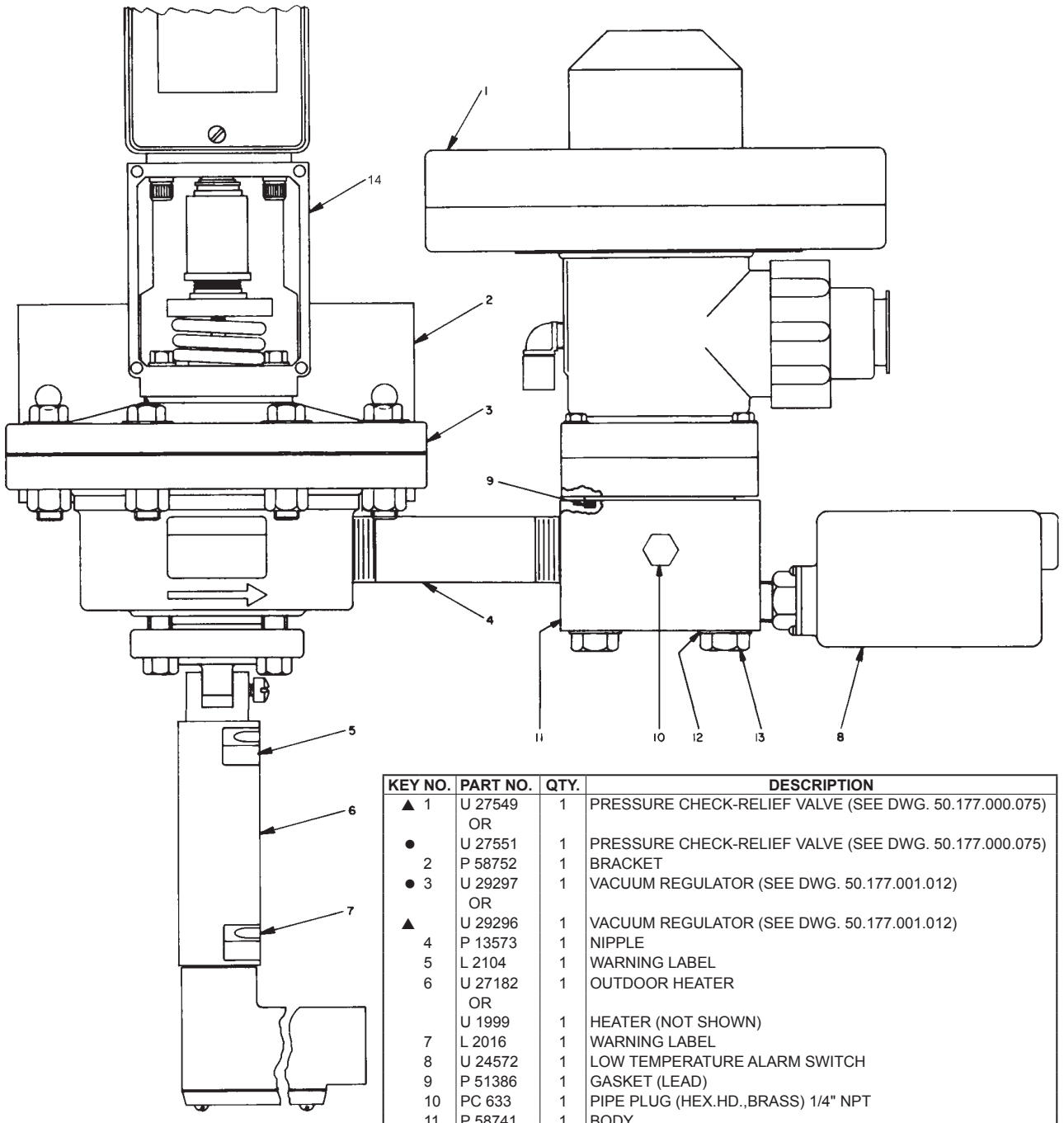
KEY NO.	PART NO.	QTY.	DESCRIPTION
1	P 58752	1	BRACKET
▲ 2	U 28166	1	VACUUM REGULATOR (SEE DWG. 25.052.001.026)
	OR		
●	U 28167	1	VACUUM REGULATOR (SEE DWG.25.052.001.026)
▲ 3	U 27549	1	PRESSURE CHECK-PRESSURE RELIEF VALVE (SEE DWG. 50.177.000.075)
	OR		
●	U 27551	1	PRESSURE CHECK-PRESSURE RELIEF VALVE (SEE DWG. 50.177.000.075)
4	U 1999	1	HEATER
5	P 13573	1	NIPPLE
6	L 2104	1	WARNING LABEL
7	P 8045	1	1" PIPE PLUG (SQ.HD.,STL.)
● 8	L 2104	2	WARNING LABEL
9	U 27182	1	OUTDOOR HEATERS
● 10	L 2016	2	WARNING LABEL
11	P 51386	1	GASKET (LEAD) PART OF KEY NO. 3
12	P 36387	4	BOLT (HEX.HD.,.STEEL) 1/2"-13 x 2-3/4" LG.
13	P 19803	4	1/2" WASHER (S.S.)
14	P 58742	1	INLET BODY
15	AAA2562	1	1/4" PIPE PLUG

NOTE: ● PART OF KEY NO. 9.
● USED FOR AMMONIA.
▲ USED FOR CHLORINE, SULFUR DIOXIDE, OR CARBON DIOXIDE.

WHEN ORDERING MATERIAL, ALWAYS SPECIFY MODEL AND SERIAL NUMBER OF APPARATUS.

VACUUM REGULATOR-CHECK UNIT
3000 LB/24 HR CAPACITY - PARTS
Standard Arrangement

50.177.000.011
ISSUE 2 10-04



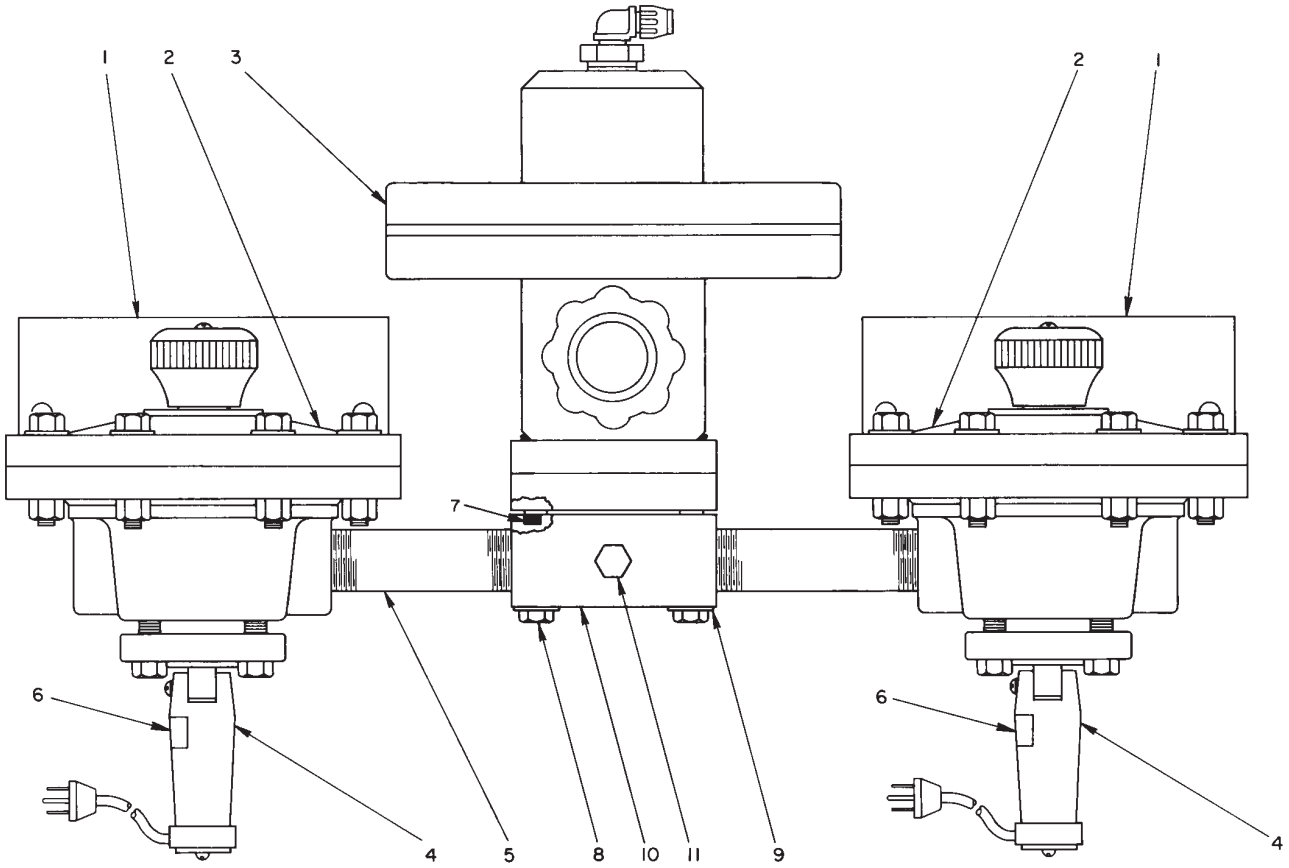
KEY NO.	PART NO.	QTY.	DESCRIPTION
▲ 1	U 27549	1	PRESSURE CHECK-RELIEF VALVE (SEE DWG. 50.177.000.075)
	OR		
●	U 27551	1	PRESSURE CHECK-RELIEF VALVE (SEE DWG. 50.177.000.075)
2	P 58752	1	BRACKET
● 3	U 29297	1	VACUUM REGULATOR (SEE DWG. 50.177.001.012)
	OR		
▲	U 29296	1	VACUUM REGULATOR (SEE DWG. 50.177.001.012)
4	P 13573	1	NIPPLE
5	L 2104	1	WARNING LABEL
6	U 27182	1	OUTDOOR HEATER
	OR		
	U 1999	1	HEATER (NOT SHOWN)
7	L 2016	1	WARNING LABEL
8	U 24572	1	LOW TEMPERATURE ALARM SWITCH
9	P 51386	1	GASKET (LEAD)
10	PC 633	1	PIPE PLUG (HEX.HD.,BRASS) 1/4" NPT
11	P 58741	1	BODY
12	P 19803	4	1/2" WASHER (STL.)
13	PC 36387	4	BOLT (HEX.HD.,STL.) 1/2"-13 x 3-1/4" LG.
■ 14	U20068	1	HYDRAMOTOR

NOTE: ● USED FOR AMMONIA.
▲ USED FOR CHLORINE, SULFUR DIOXIDE, OR CARBON DIOXIDE.
■ NOT PART OF U29297 OR U29296.

WHEN ORDERING MATERIAL, ALWAYS SPECIFY MODEL AND SERIAL NUMBER OF APPARATUS.

VACUUM REGULATOR-CHECK UNIT - 3000 LB/24 HR CAPACITY - PARTS
Evaporator Arrangement

50.177.000.026
ISSUE 5 5-04



KEY NO.	PART NO.	QTY.	DESCRIPTION
1	P 58752	2	BRACKET
▲ 2	U 28172	2	VACUUM REGULATOR (SEE DWG.25.052.001.032)
	OR		
●	U 28173	2	VACUUM REGULATOR (SEE DWG.25.052.001.032)
▲ 3	U 27549	1	PRESSURE CHECK-PRESSURE RELIEF VALVE (SEE DWG.50.177.000.075)
	OR		
●	U 27551	1	PRESSURE CHECK-PRESSURE RELIEF VALVE (SEE DWG.50.177.000.075)
4	U 1999	2	HEATER
	OR		
	U 27182	2	OUTDOOR HEATER (NOT SHOWN)
5	P 13573	2	NIPPLE
6	L 2104	2	WARNING LABEL
7	P 51386	1	GASKET (LEAD)
8	P 36387	4	BOLT (HEX.HD.,STEEL) 1/2"-13 x 2-3/4" LG.
9	P 19803	4	1/2" WASHER (S.S.)
10	P 58742	1	INLET BODY
11	AAA2562	1	1/4" PIPE PLUG

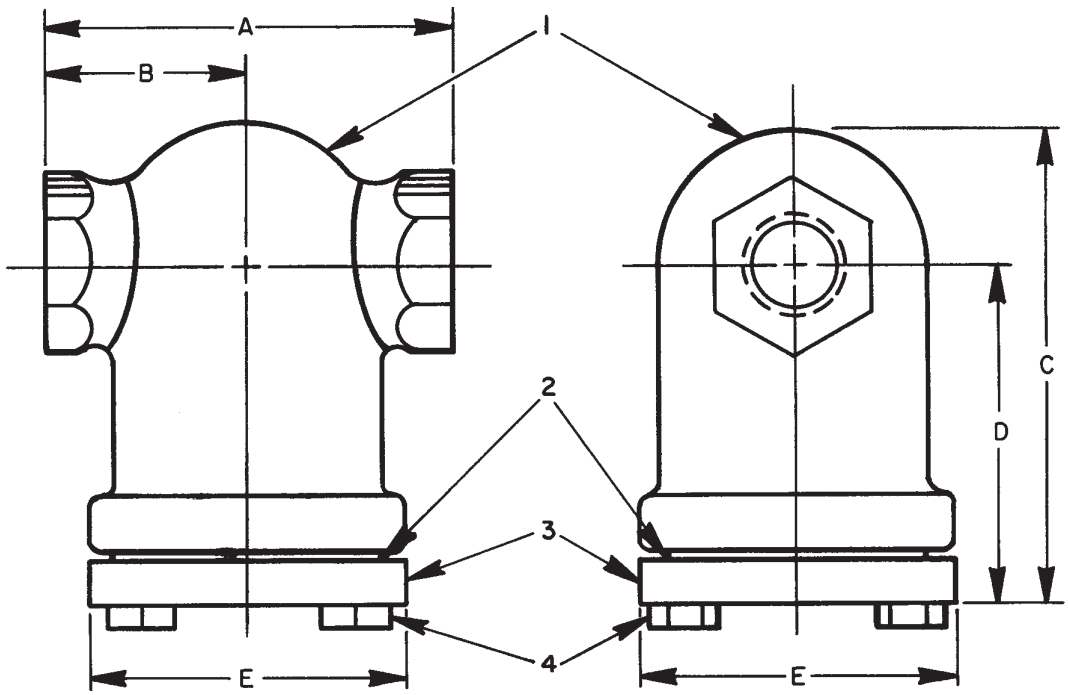
NOTE: ● USED FOR AMMONIA.
▲ USED FOR CHLORINE, SULFUR DIOXIDE, OR CARBON DIOXIDE.

WHEN ORDERING MATERIAL, ALWAYS SPECIFY MODEL AND SERIAL NUMBER OF APPARATUS.

VACUUM REGULATOR-CHECK UNIT - 3000 LB/24 HR CAPACITY - PARTS
Automatic Switchover Arrangement

50.177.000.021
ISSUE 3 5-04

VACUUM REGULATOR-CHECK UNIT



KEY NO.	PART NO.	QTY.	DESCRIPTION
1	P 58543	1	HOUSING (3/4")
	OR		
	P 58544	1	HOUSING (1")
2 ▲	P 40754	1	GASKET (3/4")
	OR		
	P 37621	1	GASKET (1")
3	U 28197	1	SCREEN AND COVER UNIT (3/4")
	OR		
	U 28198	1	SCREEN AND COVER UNIT (1")
4	PC 6582	4	BOLT (HEX HD.,STL.) 1/2-13 x 1-1/2" LG.(3/4")
	OR		
	PC 2253	4	BOLT (HEX HD.,STL.) 5/8-11 x 1/2" LG. (1")

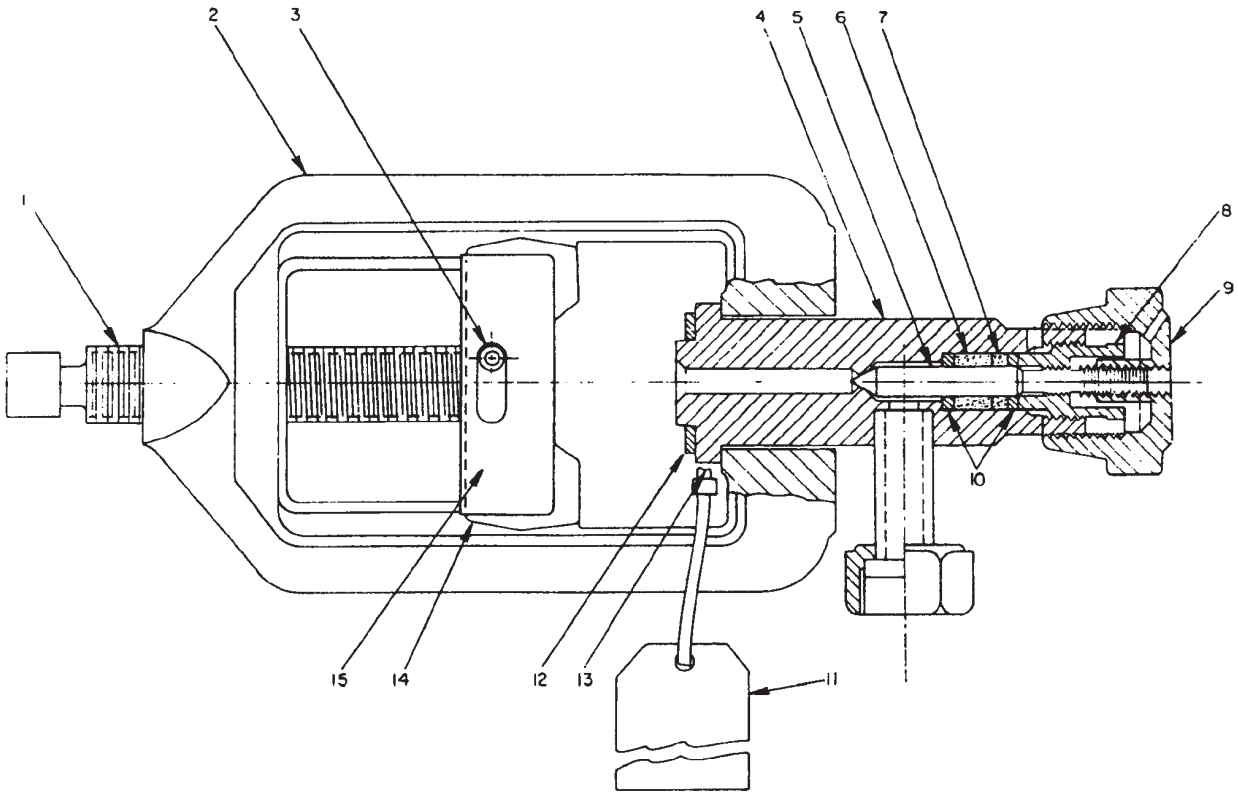
DIMENSIONS		
CAP. LB/24 HR	3000	10,000
SIZE	3/4"	1"
A	4-1/2"	7"
B	2-1/4"	3-1/2"
C	5-31/32"	7-9/32"
D	4"	4-5/8"
E	3-1/2"	4-1/2"

NOTE: ▲ PART OF SCREEN REPLACEMENT KIT.
U27148 - 3/4" PIPE SIZE SCREEN REPLACEMENT KIT.
U27149 - 1" PIPE SIZE SCREEN REPLACEMENT KIT.

WHEN ORDERING MATERIAL, ALWAYS SPECIFY MODEL AND SERIAL NUMBER OF APPARATUS.

U28199 - 3/4" PIPE SIZE; U28200 - 1" PIPE SIZE
STRAINER - PARTS
Used in Series V-2000 Gas Feeders

50.150.005.033
ISSUE 3 12-08



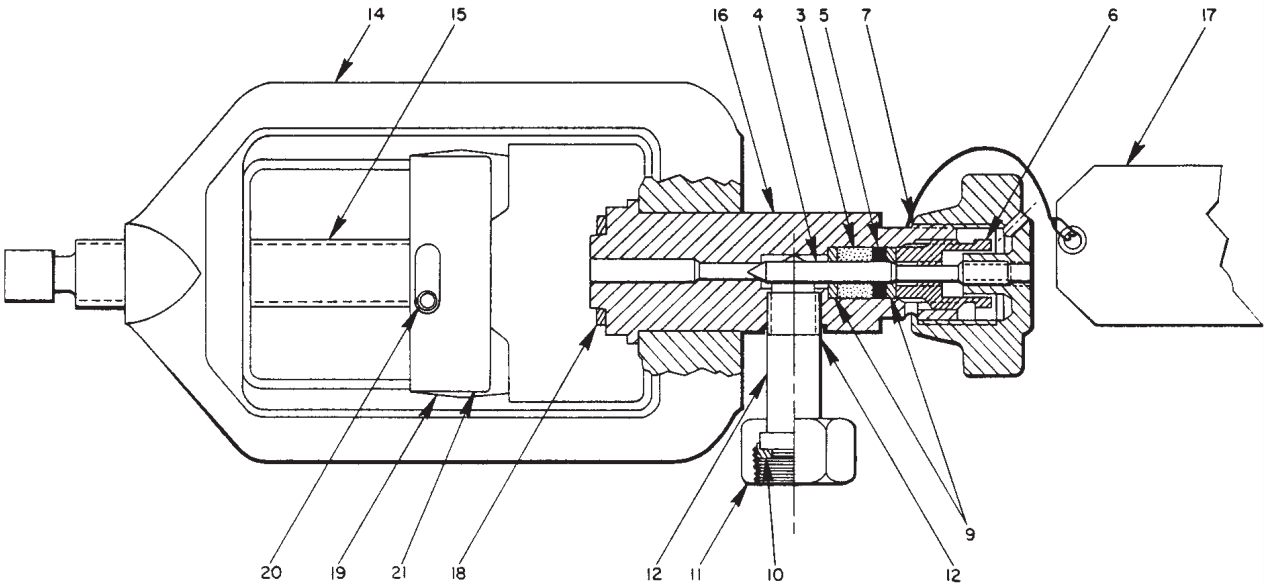
KEY NO.	PART NO.	QTY.	DESCRIPTION
1	P19386	1	YOKE SCREW
2	P58460	1	YOKE
3	P39774	1	GROOVE-PIN (STL.) 1/8” DIA. X 7/8” LG.
4	U28109	1	VALVE BODY
5	P2949	1	STEM
6	P45544	1	PACKING
7	P45547	1	PLASTIC WASHER
8	P58540	1	PACKING NUT
9	P2947	1	HANDLE
10	P45546	2	COLLAR
11	L3076	1	INSTRUCTION CARD
12	P16191	1	LEAD GASKET
13	P41796	1	CABLE STRAP
14	P25121	1	YOKE CLAMP
15	P59369	1	TAG

WHEN ORDERING MATERIAL, ALWAYS SPECIFY MODEL AND SERIAL NUMBER OF APPARATUS.

U28110 AUXILIARY CYLINDER VALVES - PARTS

50.150.001.012

ISSUE 3 9-07



KEY NO.	PART NO.	QTY.	DESCRIPTION
3	P45544	1	PACKING
4	P6731	1	VALVE STEM
5	P45547	1	PLASTIC WASHER
6	P6730	1	PACKING NUT
7	P6729	1	HANDLE
9	P45545	1	COLLAR
▲ 10	P2519	1	LEAD GASKET
11	PS6749	1	UNION NUT
12	PS6714	1	UNION NIPPLE
14	P44783	1	YOKE
15	P26155	1	YOKE SCREW
▲ 16	P55050	1	VALVE BODY
17	L2493	1	INSTRUCTION CARD
18	P16191	1	LEAD GASKET
19	P26144	1	YOKE SLIDE
20	P39774	1	GROOVE-PIN (STL.) 1/8" DIA. x 7/8" LG.
21	P59369	1	TAG

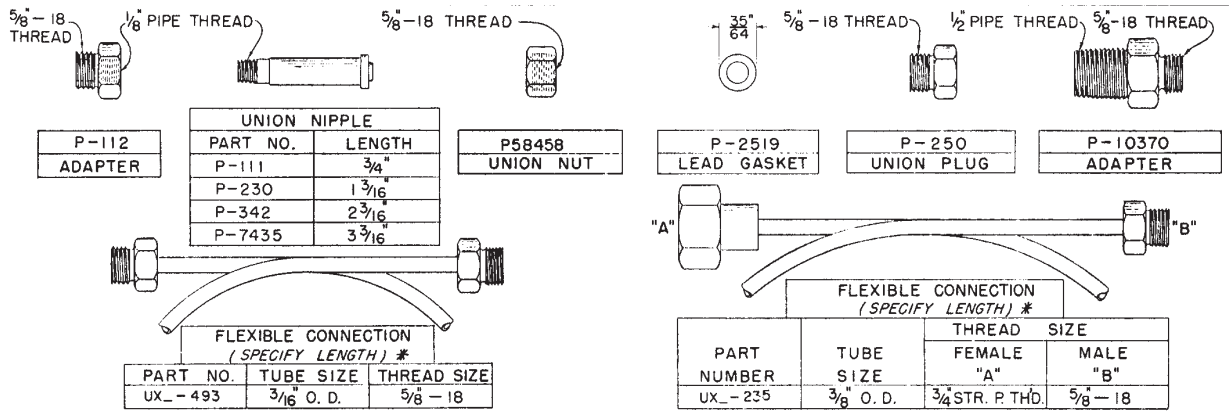
NOTE: ▲ NOT PART OF U2065 OR U26595.

WHEN ORDERING MATERIAL, ALWAYS SPECIFY MODEL AND SERIAL NUMBER OF APPARATUS.

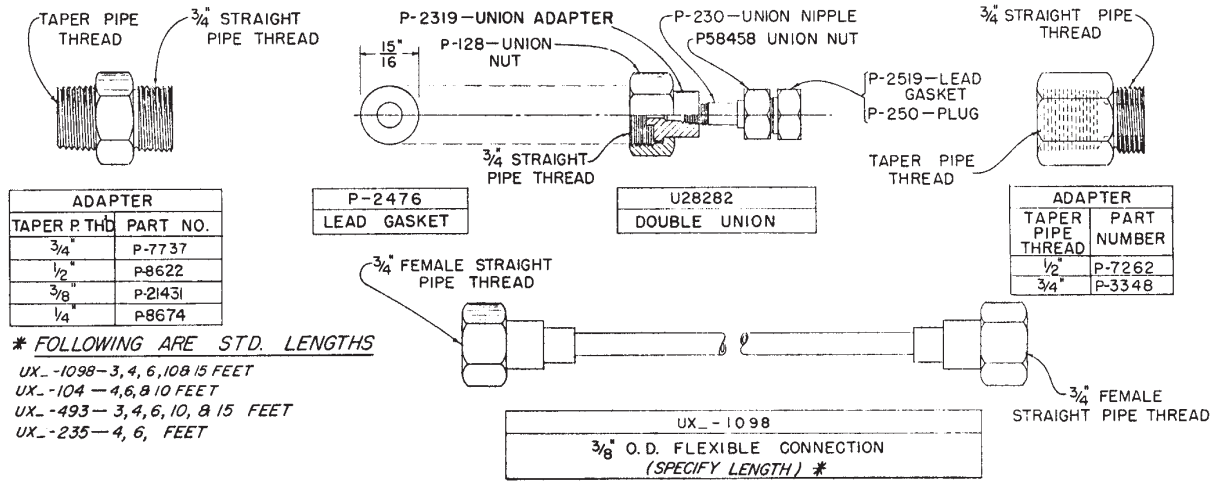
U26595 AMMONIA AUXILIARY CYLINDER VALVE-YOKE TYPE - PARTS

910.200.003.010

ISSUE 4 1-09



MEDIUM FLEXIBLE CONNECTIONS & ACCESSORIES



LARGE FLEXIBLE CONNECTIONS & ACCESSORIES

NOTE: THE CHLORINE INSTITUTE RECOMMENDS THAT FLEXIBLE CONNECTIONS BE REPLACED ANNUALLY OR SOONER IF THERE IS EVIDENCE OF DETERIORATION. SEE CHLORINE HANDLING MANUAL. SIMILAR RECOMMENDATIONS APPLY FOR SULFUR DIOXIDE AND CARBON DIOXIDE.

WHEN ORDERING MATERIAL, ALWAYS SPECIFY MODEL AND SERIAL NUMBER OF APPARATUS.

FLEXIBLE CONNECTIONS & ACCESSORIES - PARTS

50.150.007.021
ISSUE 15 5-07

ASCO General Controls
50-60 Hanover Rd, Florham Park, NJ 07932

H11 Hydramotor® Actuator
Pressure Limit, Push-Type

INSTALLATION AND SERVICE

SDI: H11-1
Effective: 12-96
Supersedes: I/O 13 (6-88)

MOUNTING POSITIONS

DESCRIPTION

Hydramotor® valves consist of three components: the actuator described in this sheet (Figure 1) together with a mounting yoke and a valve body.

H11 hydraulic actuators push when energized and retract, powered by an internal return spring, when deenergized, providing ON-OFF control of valves. The operating mechanism is completely immersed in oil, eliminating usual maintenance and service.

OPERATION (Figure 2)

When the actuator terminals are powered, relief valves close and an electric motor-driven pump applies hydraulic pressure to a spring-loaded piston. When the stem reaches full travel, a limit switch opens the pump motor circuit. The relief valves remain closed, holding the stem in its extended position until the actuator is deenergized, opening the relief valves and allowing the internal return spring to retract the piston.

NOTE: When the actuator is held in its energized position, the motor may restart intermittently to maintain proper pressure against the piston.

INSTALLATION

CAUTION

- **This actuator should be installed and/or serviced by trained and experienced service technicians.**
- **Turn off electric power supply before wiring actuator to prevent electrical shock and damage to equipment.**
- **All wiring must conform to applicable electrical codes and ordinances (NEC Class 1).**
- **Limit controls must be capable of handling electrical load shown on actuator nameplate (volts, frequency). Wire limit controls in hot side of circuit. Do not connect additional wiring to limit switch.**
- **Maximum connected load of motor and auxiliary switch must not exceed 2000 VA.**
- **Ensure actuator selected is appropriate for the application.**
- **Actuators used in areas where dust, corrosive or explosive elements are present should be equipped with proper protective shields. Replace protective shields before operating valve.**
- **Actuator surface temperature should be kept below 175° F (80°C).**
- **Check application for proper voltage. A 60 cycle actuator is suitable for 50 cycle operation but power stroke timing will increase by approximately 20%.**

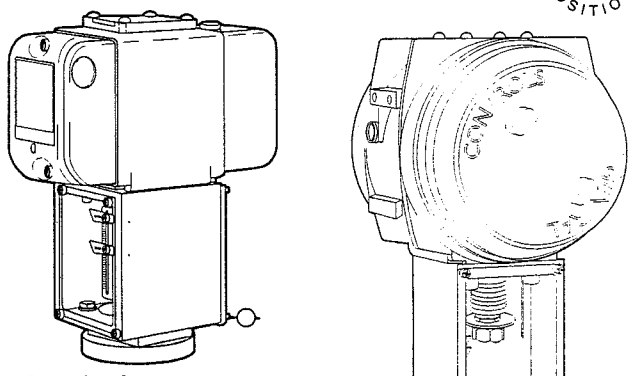


Figure 1. H11 Hydramotor® with Mounting Yoke

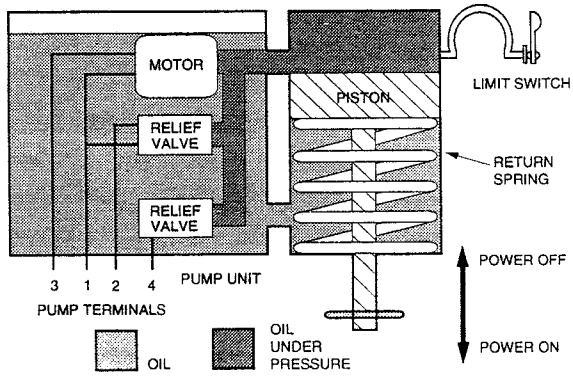


Figure 2. Typical H11 Operation

1. Follow equipment manufacturer's wiring instructions. Typical wiring connections are shown in Figures 3 and 4.
2. Check power source, actuator and all operating and limit switches in electrical circuit for proper operation.

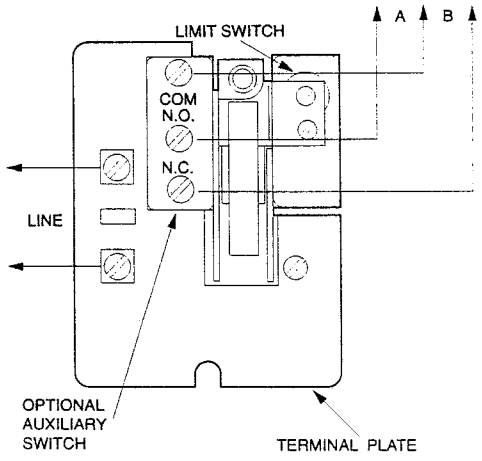


Figure 3. Two-Wire Circuit with Auxiliary Switch

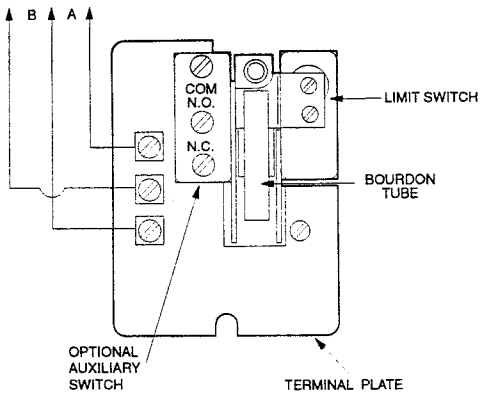


Figure 4. Three-Wire Circuit with Auxiliary Switch

ACTUATOR REMOVAL/REPLACEMENT

Actuator Removal

1. Loosen lock screw, unscrew union nut to detach valve stem from actuator shaft (Figure 5).

CAUTION

Do not damage the polished surfaces of valve stem or actuator shaft.

2. Energize actuator to relieve pressure of closing spring.
3. Remove mounting bolts or bushing nut, depending on type of mounting, holding yoke to valve body.
4. Deenergize actuator and lift off of valve body.

Actuator Replacement

Replace actuator with unit having identical catalog number. Reassembly is the reverse of disassembly:

1. Energize new actuator.
2. Secure actuator to valve.
3. Line up prongs of stem head nut with slot in actuator shaft.
4. Deenergize actuator.
5. Be sure prongs are in slot.
6. Tighten union nut fingertight.
7. Tighten lock screw to 25 in-lb.
8. Test for proper operation.

TERMINAL PLATE REMOVAL/REPLACEMENT (Figure 6)

NOTE: To replace the power unit, the terminal plate must be removed to gain access to power unit mounting bolts.

CAUTION

When removing terminal plate with bourdon tube (1), do not adjust the two factory preset screws (2) that actuate limit switch (3).

1. **Turn off all electrical power to actuator.**
2. Remove covers. Remove two terminal plate screws (4) holding terminal plate, and one screw (5) holding pressure limit bourdon tube to actuator. Note position of O-rings (6). Lift terminal plate away from frame.

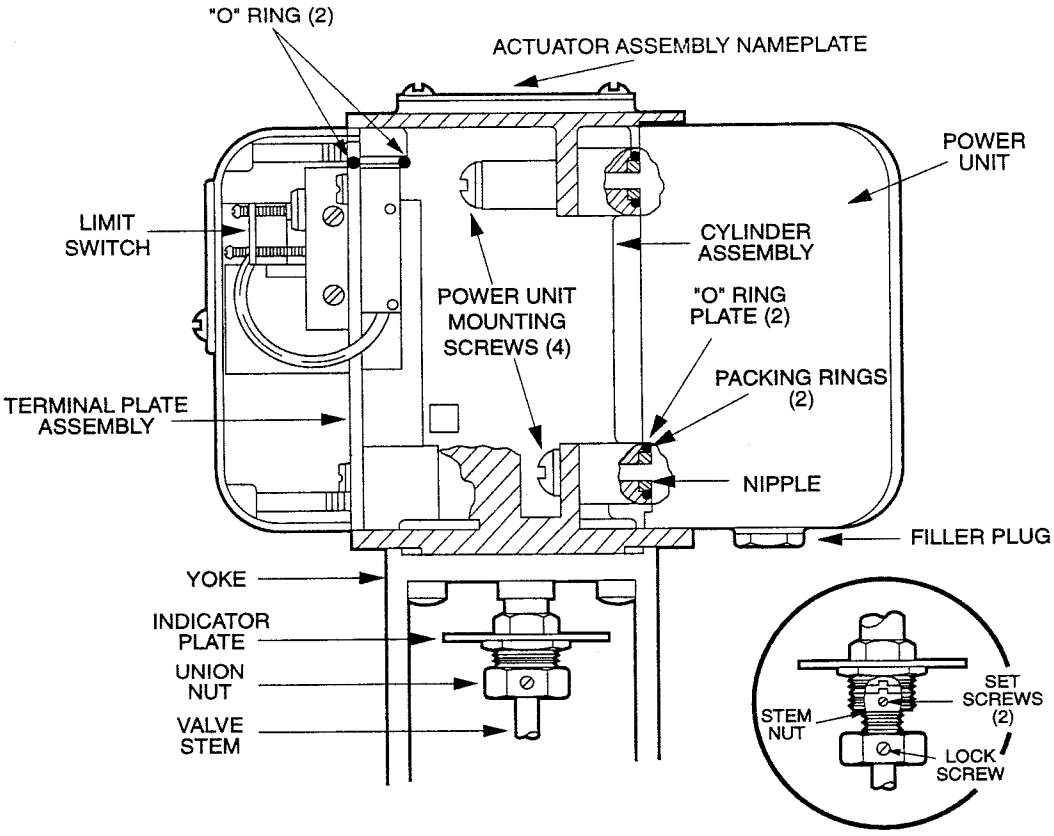


Figure 5. H11 Cross Section

3. Note the proper position of leads between terminal plate and power unit. Tag leads if necessary to identify for reassembly. Pull lead clips from power unit.
4. Proceed with power unit removal if necessary.
5. When installing terminal plate, insert leads of terminal plate on proper terminals of power unit. Position terminal plate in frame using a gentle downward motion. *Be sure O-rings are in place.*

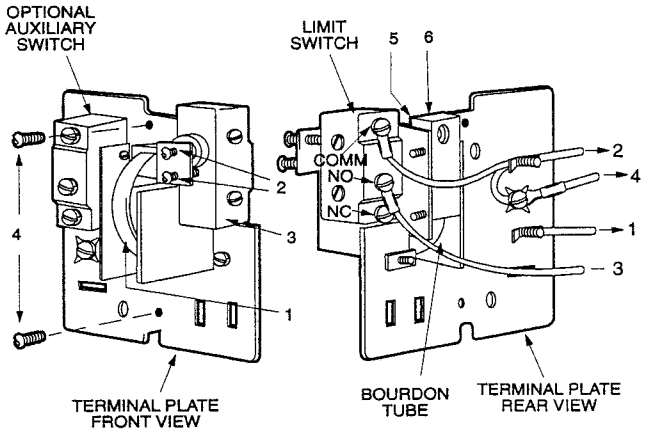


Figure 6. H11 Terminal Plate with Limit and Auxiliary Switches

POWER UNIT REMOVAL/REPLACEMENT

1. Remove terminal plate, as described above. Remove four screws holding power unit to frame (figure 7) and pull power unit straight away, noting position of O-rings.
2. Put new O-rings in place. Position new power unit to frame carefully to prevent damage to O-rings.
3. Replace bolts holding power unit; tighten to 70±10 in-lb.
4. Connect clips on leads to power unit.
5. Replace terminal plate carefully (see step 5 above).

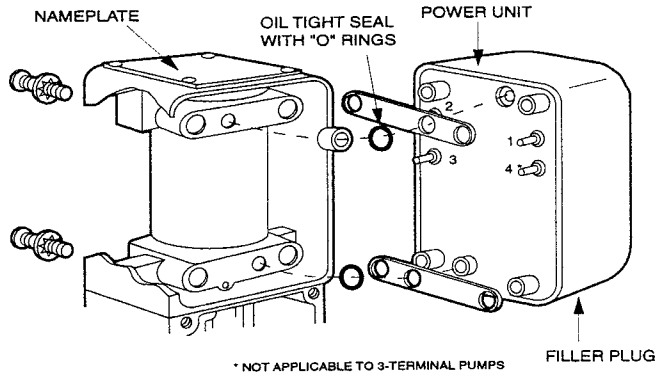


Figure 7. Exploded View of H11 (Covers Removed)

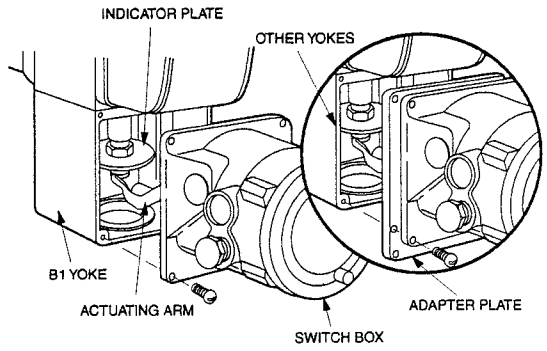


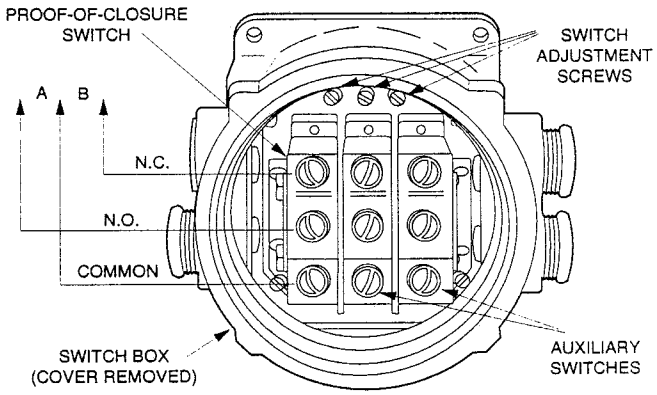
Figure 8. Yoke Mounted Auxiliary Switch Box

YOKE-MOUNTED AUXILIARY SWITCH KIT

A yoke-mounted switch unit with up to 3 SPDT independently adjustable auxiliary switches may be installed (figure 8).

Installation: The auxiliary switch unit is supplied with necessary hardware for installation – screws and adapter plate (if necessary) and replaces the dust shield where applicable. Mount adapter plate to yoke and auxiliary switch unit to adapter plate with self-tapping screws. Actuating arm tip must be under actuator stem indicator plate.

Adjustment (Figure 9): Each switch in auxiliary switch unit may be adjusted separately to actuate at any point of actuator stem travel. Turn individual switch adjustment screw *clockwise* to actuate switch closer to deenergized position. Turn screw only 1/8-turn at a time and check operation. Do not attempt to set switch for operation within 1/8" of either end of stroke.



A – N.O. when actuator deenergized

B – N.C. when actuator deenergized

Figure 9. Auxiliary Switch Adjustment

FILLING REPLACEMENT POWER UNIT WITH OIL

Standard units are filled with MIL-H-5606 oil. Units with F5 in catalog number, for low ambient temperature use, are filled with Dow-Corning DC560 silicone oil. Either oil is available from ASCO General Controls and most industrial suppliers.

CAUTION

Do not mix MIL-H-5606 oil with DC560 oils. Oil must be filtered if secured from a source other than ASCO General Controls. Take care that dirt, dust or lint does not enter pump unit or cylinder.

One pint of ASCO General Controls MIL-H-5606 oil is included with each replacement power unit assembly.

1. Filler plug is on bottom of unit. Actuator must be removed from valve body before filling with oil. (See Actuator Replacement). Unscrew filler plug (Figure 5).

CAUTION

Actuator must be energized to evacuate entrained air. This is a force limit actuator. Force limit switch is inoperative when actuator is removed from valve. When powering actuator do not allow shaft to extend over 1/2 inch from deenergized position.

2. Fill power unit with oil, not to exceed one pint. Power actuator ON and OFF for 15 minutes to release air from cylinder and bring oil temperature to 68° F (20° C) or above. Add enough oil to fill reservoir to within 1/4" of base of filler port.
3. Replace plug and tighten.

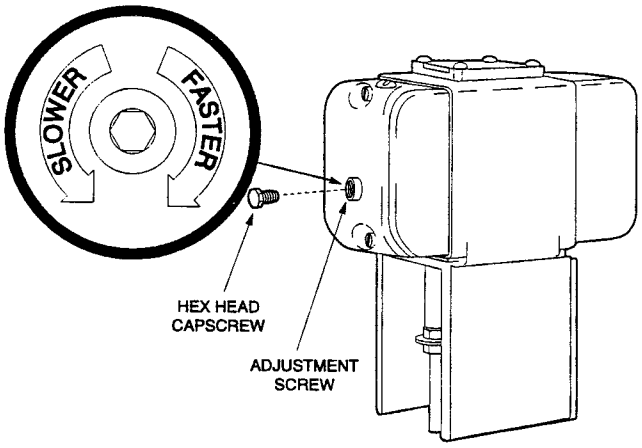


Figure 10. Actuator Adjustment

OPENING SPEED ADJUSTMENT

Certain actuators are equipped with adjustment screw located on the power unit, opposite the terminal plate (Figure 10).

1. If the actuator is on a valve plumbed in an active system, close manual cock upstream of valve.
2. Deenergize the actuator.
3. Remove the hex cap screw.
4. Turn the screw only 1/2 turn at a time. Turn the screw clockwise to obtain a faster power stroke or turn it counterclockwise for a slower power stroke.
5. Energize the actuator and check the speed after each adjustment. Adjust until the desired speed is obtained.
6. Open manual cock upstream of valve and check the valve under normal usage. Be sure action is fast enough to provide proper light off if valve is used on gas burner.

CAUTION

Do not attempt to obtain speeds faster than 22 seconds or slower than 60 seconds for full 1 1/4" actuator stroke.

If the adjustment screw is turned to full clockwise or counter clockwise, the position valve will not operate.

REPLACEMENT PARTS ORDERING PROCEDURE

When ordering replacement or spare parts, specify the item number together with its name, the actuator catalog number serial number, and voltage, as shown on actuator nameplate. Specify the number of switches, and whether standard or explosion/weatherproof housing is desired. See also parts list SDP H10/H11.

NOTE: Stem, stem nut and stem nut set screws are part of the valve body. When ordering parts for valve assembly, consult factory or valve parts list.

Table 1. Parts Common to Power Unit Kits

(May be ordered separately)

Description	No. Reqd.	Part No.
Strainers*	2	50751A
Nipple*	1	15358A
O-Ring Plates*	2	18764A
Power Unit Screws*	2	101957-416-12
Power Unit Screws*	2	2754-416A24Z
Lockwashers*	4	3090-416LZ
O-Rings*	2	16606A56-7
Oil (pint, MIL-H-5606)*	1	S156202A
Oil (pint, DC560)	1	S156201A

* Included in power unit kit.

CHLORINE HANDLING MANUAL

(Cl_2)

BOOK NO. WT.025.000.001.UA.IM.0614

W3T98244

REGIONAL OFFICES

INSTALLATION, OPERATION, MAINTENANCE, AND SERVICE INFORMATION

Direct any questions concerning this equipment that are not answered in the instruction book to the Reseller from whom the equipment was purchased. If the equipment was purchased directly from Evoqua Water Technologies, Colorado Springs, CO contact the office indicated below.

UNITED STATES

725 Wooten Road
Colorado Springs, CO 80915
TEL: (800) 524-6324

CANADA

If the equipment was purchased directly from Evoqua Water Technologies, Canada, contact the nearest office indicated below.

ONTARIO

Evoqua Water Technologies Ltd.
2045 Drew Road
Mississauga, Ontario
L5S 1S4
(905) 944-2800

QUEBEC

Evoqua Technologies des Eaux Itee
505 Levy Street
St. Laurent, Quebec
H4R 2N9
(450) 582-4266

CHLORINE HANDLING MANUAL

WARNING:

CHLORINE IS A HAZARDOUS CHEMICAL THAT CAN CAUSE INJURY AND DEATH IF NOT HANDLED PROPERLY. THIS MANUAL CONTAINS ONLY GENERAL INFORMATION ON THE PHYSICAL PROPERTIES, STORAGE, AND HANDLING OF CHLORINE. IT IS NOT INTENDED TO REPLACE OR LIMIT SAFETY PROCEDURES IN YOUR FACILITY.

SAFETY PROCEDURES IN AN INDUSTRIAL SETTING MUST BE DESIGNED IN ACCORDANCE WITH ALL GOVERNMENTAL REGULATIONS AND NATIONAL SAFETY CODES, AFTER GIVING FULL CONSIDERATION TO THE SPECIFIC NEEDS OF THE INDUSTRIAL FACILITY INVOLVED.

EVOQUA WATER TECHNOLOGIES CANNOT ANTICIPATE THE SPECIFIC SAFETY PROCEDURES REQUIRED AT EVERY INDUSTRIAL FACILITY. ACCORDINGLY, EVOQUA WATER TECHNOLOGIES DOES NOT GUARANTEE THAT SAFETY PROCEDURES DESIGNED IN ACCORDANCE WITH THIS MANUAL WILL COMPLETELY ELIMINATE HAZARDS AND THUS ASSUMES NO LIABILITY FOR ACCIDENTS THAT MAY OCCUR IN YOUR FACILITY.

READ THIS ENTIRE MANUAL AND BE FULLY FAMILIAR WITH YOUR EQUIPMENT AND YOUR ENTIRE INDUSTRIAL SYSTEM SO THAT THE SAFETY PROCEDURES YOU ESTABLISH WILL MEET THE NEEDS OF THE EMPLOYEES IN YOUR FACILITY. READING ONLY PART OF THE MANUAL WILL NOT HELP YOU ANALYZE THE NEEDS OF YOUR FACILITY. CONTACT YOUR CHLORINE SUPPLIER, THE CHLORINE INSTITUTE, INC., OR SIMILAR ORGANIZATION TO OBTAIN A MATERIAL SAFETY DATA SHEET (MSDS) AND MORE DETAILED INFORMATION ON CHLORINE. INFORMATION IS AVAILABLE FROM: THE CHLORINE INSTITUTE, INC., 1300 WILSON BOULEVARD, ARLINGTON, VA 22209.

PLEASE NOTE THE PUBLICATION DATE AND POSSIBLE OBSOLESCENCE OF THIS MATERIAL AS A RESULT OF SCIENTIFIC AND MEDICAL DEVELOPMENTS AFTER THE DATE OF PUBLICATION. THIS APPLIES TO ALL MATERIALS YOU REVIEW IN THE COURSE OF DEVELOPING SAFETY PROCEDURES FOR USE AT YOUR FACILITY.

Table Of Contents

Table Of Contents (Cont'd)

1 INTRODUCTION

This manual discusses the characteristics, storage and handling of chlorine used with Evoqua Water Technologies equipment. Chlorine is used with Evoqua Water Technologies equipment primarily as a disinfectant in water or wastewater treatment.

WARNING:

CHLORINE IS HAZARDOUS. TO AVOID SEVERE PERSONAL INJURY OR DEATH BY SUFFOCATION, READ THIS MANUAL AND THE CHLORINE SUPPLIER'S PRECAUTIONS BEFORE HANDLING OR CONNECTING CHLORINE TO EVOQUA WATER TECHNOLOGIES EQUIPMENT.

WHEN WORKING WITH CHLORINE:
ENSURE THAT APPROVED, SELF-CONTAINED BREATHING APPARATUS IS ALWAYS AVAILABLE AND PERSONNEL ARE PROPERLY TRAINED IN ITS USE.
ENSURE THAT SAFETY EQUIPMENT, SUCH AS VENTILATION FANS AND BREATHING APPARATUS, IS INSPECTED AND MAINTAINED IN ACCORDANCE WITH THE MANUFACTURER'S INSTRUCTIONS.
ENSURE THAT APPROPRIATE PLACARDS AND WARNING SIGNS ARE IN PLACE AND PROMINENTLY DISPLAYED IN THE AREAS WHERE THE GAS IS STORED.

IN CASES OF ACCIDENT:
USE SAFETY EQUIPMENT TO PROTECT THE RESCUER AND MOVE VICTIM TO FRESH AIR. IF BREATHING HAS STOPPED, START ARTIFICIAL RESPIRATION IMMEDIATELY.
IF HEART HAS STOPPED, START CPR (CARDIOPULMONARY RESUSCITATION) IMMEDIATELY. IN ALL CASES, OBTAIN MEDICAL ATTENTION AS SOON AS POSSIBLE.

TO AVOID ACCIDENTAL GAS RELEASE:
KNOWLEDGEABLE DESIGN PERSONNEL SHOULD OVERSEE AND APPROVE EQUIPMENT INSTALLATION AND SUITABILITY OF THE SYSTEM FOR WHICH IT IS INTENDED. QUALIFIED PERSONNEL SHOULD PERFORM PERIODIC INSPECTION TO ENSURE PROPER MAINTENANCE OF THE EQUIPMENT.
MONITOR SAFETY PROGRAMS AND CONDUCT PERIODIC TRAINING PROGRAMS, ESPECIALLY ON EMERGENCY SITUATIONS. SAFETY PROGRAMS ARE AVAILABLE FROM YOUR GAS SUPPLIER.

LOCAL LAWS:
UNDER NO CIRCUMSTANCES SHOULD THE INFORMATION IN THIS BOOK BE CONSTRUED AS SUBSTITUTING FOR OR SUPERSEDING ANY LOCAL, STATE, OR FEDERAL LAWS AND REGULATIONS CONCERNING THE STORAGE, HANDLING, OR USE OF CHLORINE.

2 TECHNICAL DATA AND CHARACTERISTICS OF CHLORINE

The following general information on chlorine may be useful in planning a chlorinator installation; however, a specific application may require more information than that included here. For further information, consult your chlorine supplier, the Chlorine Institute, Inc., or similar organization.

Chlorine in commerce is a liquefied gas under pressure. It is a clear, amber-colored liquid. The gas has a greenish-yellow color and a strong, pungent odor. It is an irritant to the skin and respiratory system. In the moisture-free state at ordinary temperatures, it is relatively non-corrosive. In the presence of moisture, however, it is highly corrosive. Accordingly, every precaution should be taken to avoid leaks, to stop them promptly if they occur, and to keep moisture out of valves, tubing, etc., not specifically designed to handle moist chlorine. Among the important physical properties of chlorine are:

Specific Gravity, Dry Gas
2.48 at 32° F and 1 atm referred to air.

Specific Gravity, Liquid
1.47 at 32° F and 53 . 5 psia.

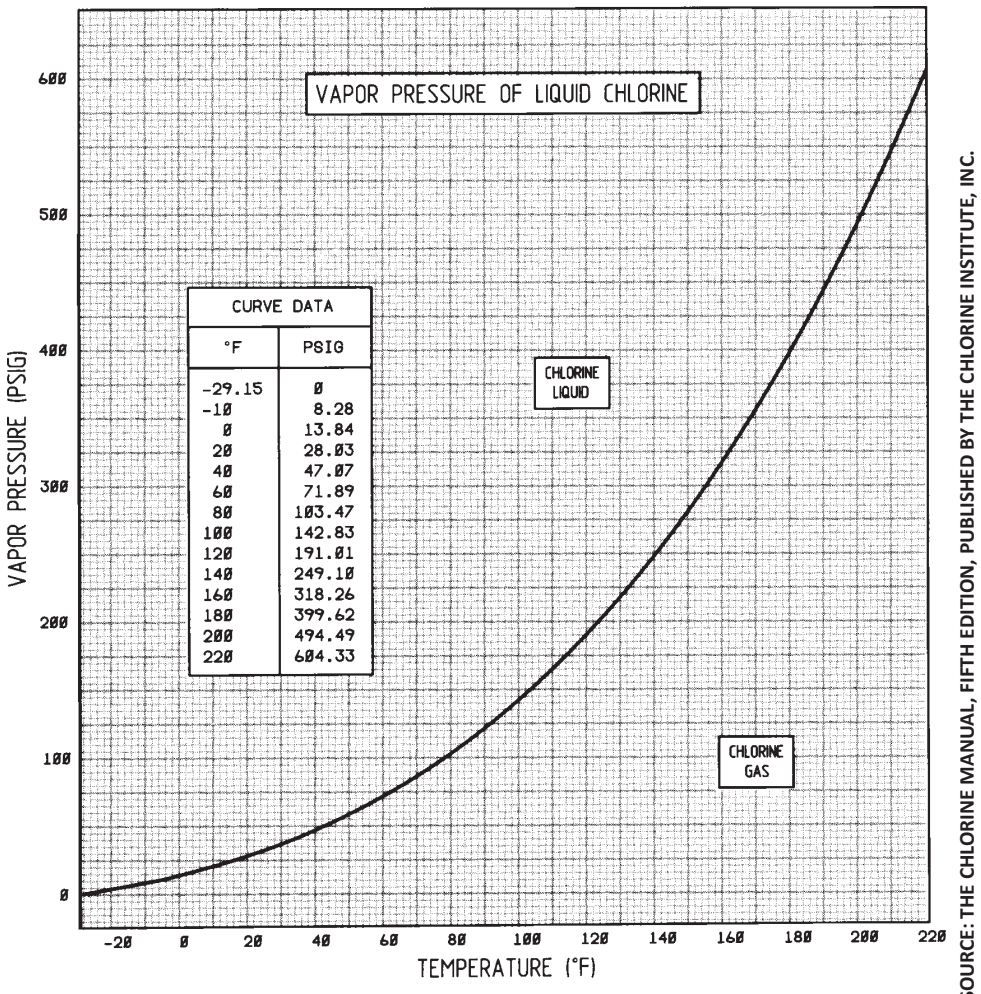
Liquid to Gas volume Ratio
1:456.5 at 32° F and 1 atm.

Latent heat of Vaporization
123.9 Btu per lb at boiling point, -29.2° F.

Specific Volume, Dry Gas
1 lb = 4.99 of at 32° F and 1 atm.

Specific Volume, Liquid
1 lb = 0.0109 cf at 32° F and 53.5 psia.

Weight, Dry Gas
1 cf = 0.2006 lb at 32° F and 1 atm.



SOURCE: THE CHLORINE MANUAL, FIFTH EDITION, PUBLISHED BY THE CHLORINE INSTITUTE, INC.

Figure 1 – Chlorine Pressure vs Temperature

Weight, Liquid
1 cf = 91.56 lb at 32° F.

Solubility in Water*
6.93 lbs./100 gals at 60° F and 1 atm.

Pressure vs Temperature
See Figure 1

***NOTE: Theoretical values shown. Actual solubility in water based on chlorinator performance has proven to be 3500 ppm or 2.92 lbs/100 gals maximum.**

Chlorine is an oxidizing agent and will support combustion but is not explosive or flammable. Many organic chemicals will react with chlorine, some violently. Steel will ignite spontaneously in the presence of chlorine at 483° F.

3 SUPPLY CONTAINERS

Table 1 gives details on the supply containers most commonly used with Evoqua Water Technologies equipment.

Some large installations that would normally use single unit tank cars but are not serviced by railroad facilities use tank motor vehicles (tank trailers) which usually range in capacity from 15 to 22 tons.

All supply containers must conform to appropriate Department of Transportation (DOT) and Canadian Transport Commission (CTC) regulations. It is the responsibility of the supply container manufacturer and the chlorine supplier to meet these requirements.

3.1 RATES

In general, using a remote vacuum type chlorinator, the maximum sustained gas withdrawal rate at which chlorine may be taken from a 100 or 150 pound cylinder is one pound per day per degree Fahrenheit (1.0 lb/24 hrs/°F). The corresponding rate for ton containers is about 8.0 lbs/24 hrs/°F. At an assumed liquid temperature of 70° F (and using a remote vacuum type chlorinator) the above figures translate into 70 lbs/24 hrs for cylinders and 560 lbs/24 hrs for ton containers. For a direct feed cylinder pressure operated chlorinator these rates become 42 and 336 lbs/24 hrs respectively. These rates can be increased substantially for brief periods. Do not place containers in a water bath or apply direct heat in order to permit higher withdrawal rates.

It is not practical to withdraw chlorine as a gas from tank cars (or tank trailers).

3.1.1 MANIFOLDING FOR GAS WITHDRAWAL

When higher gas withdrawal rates are required, cylinders or the gas valves (upper) of ton containers may be manifolded. A typical arrangement for manifolding cylinders is shown in Figure 2.

If cylinders or ton containers are manifolded, it is essential that all supply containers be at the same temperature to prevent the transfer of liquid chlorine from a warmer container to a cooler container, possibly resulting in a container becoming overfilled through reliquefaction of chlorine in the cooler container.

TABLE 1 - CHLORINE CONTAINER INFORMATION

TYPE OF CONTAINER	NET WEIGHT	TARE WEIGHT	GROSS WEIGHT	OUTSIDE DIAMETER	LENGTH
CYLINDERS	100 lb 150 lb	63 - 115 lb 85 - 140 lb	163 - 215 lb 235 - 290 lb	8-1/4" - 10-3/4" 10-1/4" - 10-3/4"	3'3-1/2" - 4'11" 4'5" - 4'8"
TON CONTAINER	2000 lb	1300 - 1650 lb	330 - 3650 lb	2'6"	6'7-3/4" - 6'10-1/2"
SINGLE UNIT TANK CARS	16 tons 30 tons 55 tons 85 tons 90 tons	- - - - -	- - - - -	10'5" - 12'0" 12'4-1/2" - 13'7" 14'3" - 15'1" 14'11" - 15'1" 14'11" - 15'1"	32'2" - 33'3" 33'10" - 35'11-1/2" 29'9" - 43'0" 43'7" - 50'0" 45'8" - 47'2"

Dimensional data from Chlorine Manual, Fifth Edition, published by the Chlorine Institute, Inc.

(1) The 150 lb cylinder is generally most readily available. Either the 100 lb or 150 lb size may be shipped full or empty via truck or rail in small lots or in full truck or carloads.

(2) Chlorine from Single Unit Tank Cars is generally unloaded directly from the car as needed in order to eliminate the necessity of storage tanks. Cars are leased to the consumer during this period and are consigned to private sidings only. Two parallel tracks are recommended to facilitate the handling of cars and to permit continuous operation without shut-down periods while cars are being switched.

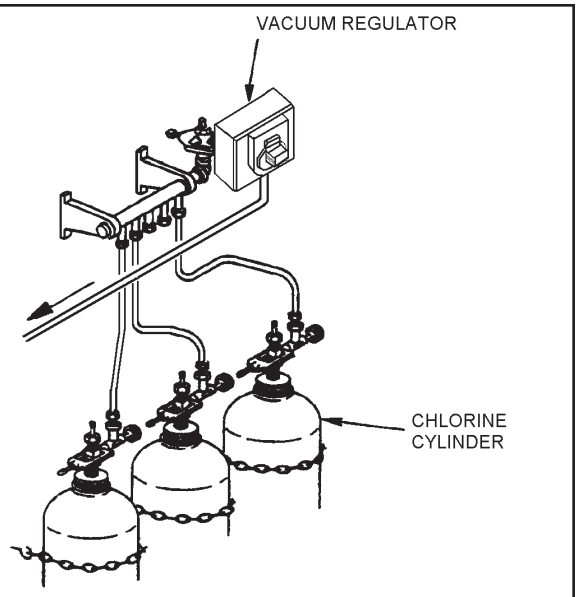


Figure 2 – Manifolding Cylinders

3.2 MAXIMUM LIQUID WITHDRAWAL RATE

The generally accepted alternate to manifolding ton containers is to withdraw liquid chlorine from the lower valve and use an evaporator. By this means, a ton container can be emptied in approximately five hours, which is equivalent to 9600 lbs/24 hrs.

Liquid can be withdrawn from tank cars at up to nearly 8,000 pounds per hour, or 192,000 pounds per 24 hours.

3.2.1 MANIFOLDING FOR LIQUID WITHDRAWAL

<u>WARNING</u>: IN ACCORDANCE WITH CHLORINE INSTITUTE RECOMMENDATIONS, DO NOT MANIFOLD TON CONTAINERS FOR SIMULTANEOUS LIQUID CHLORINE WITHDRAWAL. THIS MANIFOLDING CAN CAUSE OVERPRESSURIZATION AND RUPTURE.

3.3 CONTAINER VALVES

Standard cylinder and ton container valves are identical in design, except that the cylinder valve includes a pressure relief device. Cylinder valves are shown in Figure 3 and ton container valves in Figure 4.

See Figure 5 for captive yoke type auxiliary container valves (valve connection style #820, recognized by the Compressed Gas Association as the only acceptable means of connecting to container valves). The external threads on the container valve are used only for securing the protective cap.

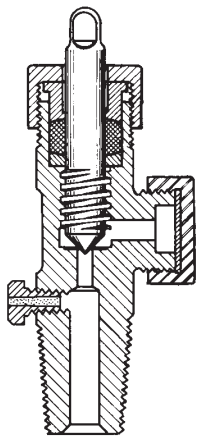


Figure 3 – Standard Cylinder Valve

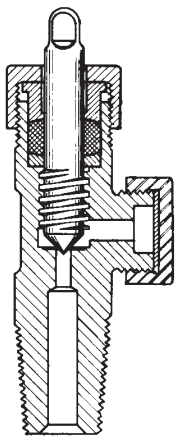
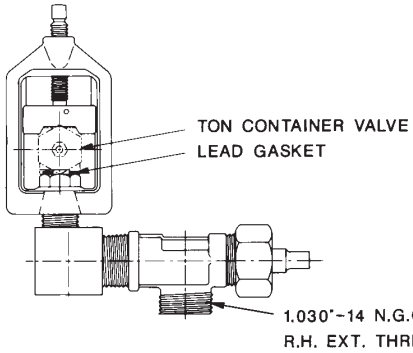
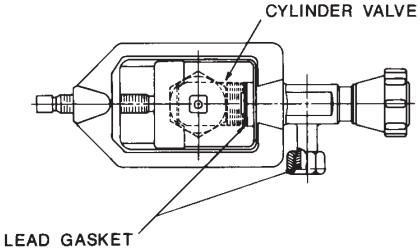


Figure 4 – Standard Ton Container Valve



CAPTIVE YOKE AUXILIARY TON CONTAINER VALVE



CAPTIVE YOKE AUXILIARY CYLINDER VALVE

Figure 5 – Auxiliary Ton Container Valve

Cylinders are equipped with one valve that is normally used for gas withdrawal. Ton containers are equipped with two valves, as shown in Figure 6.

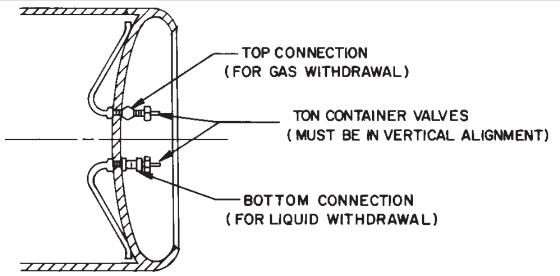


Figure 6 – Ton Container Valves

The upper valve is used for gas withdrawal and the lower valve for liquid withdrawal. Tank cars are equipped with four standard angle valves, as shown in Figure 7.

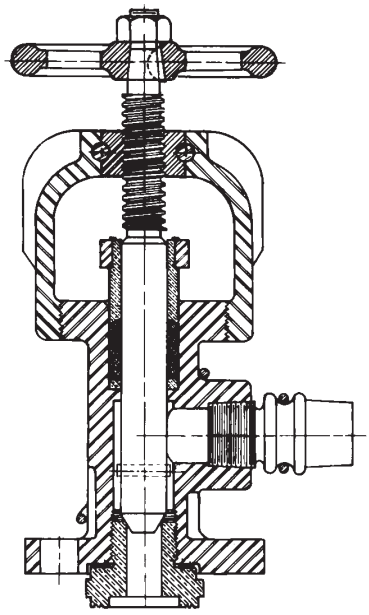


Figure 7 – Standard Angle Valve

Outlet is one-inch female ANSI Standard taper pipe thread. The liquid withdrawal valves are located on the longitudinal center line of the tank car. The valves on the transverse center line are connected to the vapor space and are used to obtain chlorine gas under pressure for testing the piping or for air padding the tank car.

3.4 PRESSURE RELIEF DEVICES

All chlorine supply containers are equipped with some type of device for relief of pressure. Cylinder valves have a fusible metal plug screwed into the body of the valve, as shown in Figure 3. The fusible metal melts when the temperature increases to 158-165° F to relieve pressure and prevent rupture of the cylinder.

Ton containers are equipped with six fusible metal plugs (see Figure 8), three of which are in each end, spaced 120 degrees apart.

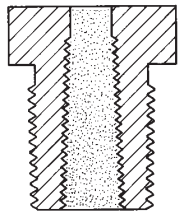


Figure 8 – Standard Fusible Plug for Ton Containers

Tank cars have an excess-flow valve (see Figure 9) located under each liquid valve. While this valve may close during a catastrophic pipe line failure, its main function is to close automatically if the angle valve is broken off in transit. Tank cars also have a pressure relief device (see Figure 10) located in the center of the manway. The relief level varies with the type of car or tank.

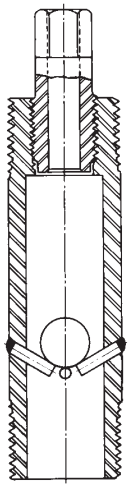


Figure 9 – Excess-Flow Valve

3.5 STORAGE OF CONTAINERS

Store chlorine containers of any type under cover and in cool, well ventilated locations protected from fire hazards and adequately protected from extreme weather conditions. During the summer months, full containers should be shielded from the direct rays of the sun, otherwise a dangerous build-up of pressure might result (see Figure 1 and Paragraph 3.3). If stored out of doors, keep containers in fenced-off areas for protection. Avoid storage in subsurface areas because chlorine is heavier than air and will not readily rise from

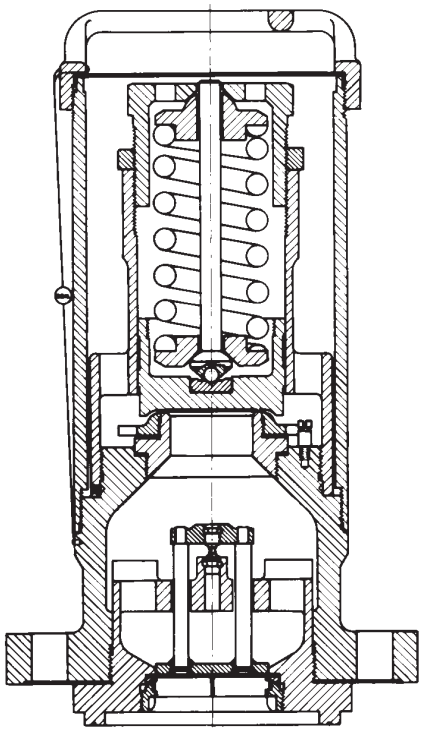


Figure 10 – Standard Safety Relief Device

subsurface locations should leaks occur. Do not store or use chlorine containers near other chemicals or gases.

WARNING: STORE CYLINDERS IN AN UPRIGHT POSITION. TO AVOID SEVERE PERSONAL INJURY OR EQUIPMENT DAMAGE, SUPPLY CYLINDERS MUST BE SECURED IN SUCH A MANNER (E.G., CHAIN) AS TO PREVENT THEIR BEING KNOCKED OVER. TON CONTAINERS MUST BE SECURED IN SUCH A MANNER (E.G., CROCKS) TO PREVENT THEIR ROLLING OUT OF PLACE.

Do not remove the protective cap or hood from cylinders or ton containers until they are ready to be put in actual use. Do not store containers in a heavily traveled area where physical contact damage could occur.

It is essential that areas used to house chlorine containers or equipment be continuously monitored for the presence of chlorine in the air. This may be a requirement of applicable laws and/or regulations.

When containers are moved from a storage area to an area where they will be used, allow sufficient time to stabilize the temperature, and therefore the pressure, of the container and the chlorine before it is used.

The chlorine inventory depends to a large extent on local availability. Consult with chlorine suppliers in the area; review appropriate fire code requirements concerning storage of oxidizing materials and other applicable laws and regulations.

When planning space for stored containers, sufficient space must be allowed for empty containers. The best way to determine the amount of chlorine remaining in a container is to weigh the container continuously on a scale. This also makes it possible to record the amount of chlorine used. Portable or dormant scales in beam, dial, or digital types and with varying platform sizes are available.

WARNING: ALWAYS REMOVE WHEELS AND AXLES OF PORTABLE SCALES SO THAT THE SCALE CANNOT MOVE WHEN CYLINDERS ARE ON THE PLATFORM.

Preferably, scales for cylinders should be installed with their platform flush with the floor to eliminate the necessity of lifting the cylinders. Some low profile scales such as the Wallace & Tiernan® Cylinder Scale are low enough that cylinders can be placed on the scale without lifting. Others are installed with ramps. If scales are pit mounted, a trapped drain should be provided.

Scales for ton containers are usually installed above the floor, since ton containers are usually handled by overhead conveyor. Many of these scales do not have platforms since the ton containers are usually supported by cradles or trunnions.

Special high-capacity scales are provided at some installations using tank cars. These scales are usually pit mounted below the railroad siding with the dial or digital unit housed above ground beside the track.

Some of the dial or digital scales are equipped with loss-of-weight recording systems providing a permanent record of chlorine usage.

3.6 HANDLING CONTAINERS

Always handle chlorine containers with utmost care. To prevent injury or damage, do not drop chlorine containers and do not permit containers to strike each other or other objects. To prevent damage to the valve, valve protecting caps or hoods must always be in place when containers are moved.

Handle cylinders with a simple two-wheel hand truck of the barrel pattern. Hand trucks should be well balanced and equipped with chains or clamps to prevent the cylinders from falling off the truck.

WARNING: NEVER LIFT CYLINDERS BY THE VALVE PROTECTING HOOD. THE HOOD MAY SEPARATE FROM THE CYLINDER, CAUSING THE CYLINDER TO FALL.

Never lift cylinders by sling or magnetic devices. If lifting is necessary, use a specially designed cradle. Contact your chlorine supplier for recommendations or information.

When moving ton containers, due consideration must be given to the fact that the liquid in the container represents a live load in addition to the dead load of the container and the liquid. The most accepted way of moving ton containers is by overhead conveyor and lifting beam (see Figure 11).

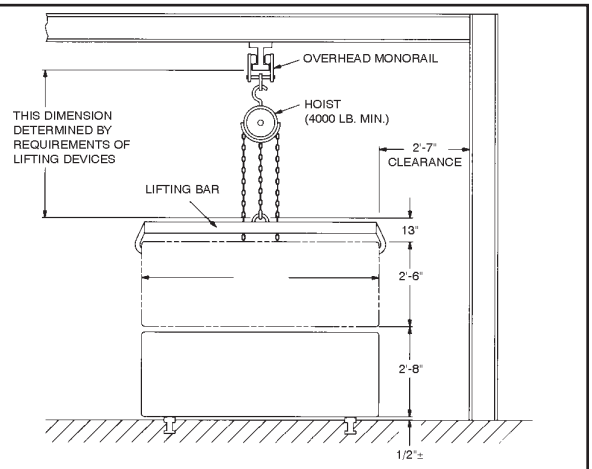


Figure 11 – Ton Container Handling

Rails or roller conveyors have also been used. Fork lift trucks, in addition to having adequate capacity, must have the containers restrained and be sufficiently stable to prevent tipping.

3.7 USING CONTAINERS

If containers have been stored in an area other than that in which they will be used, they should be allowed to stabilize at the new temperature before being used. Containers should always be used in the order in which they are received to avoid unnecessarily long storage and possible difficulty with valves that have not been opened or closed for too long a period.

WARNING: CYLINDERS ARE NORMALLY USED IN AN UPRIGHT POSITION FOR GAS WITHDRAWAL. TO AVOID SEVERE PERSONAL INJURY OR EQUIPMENT DAMAGE, SUPPLY CYLINDERS MUST BE SECURED IN SUCH A MANNER (E.G., CHAIN) AS TO PREVENT THEIR BEING KNOCKED OVER. TON CONTAINERS MUST BE USED IN A HORIZONTAL POSITION WITH THE TWO VALVES IN A VERTICAL LINE. TON CONTAINERS MUST BE SECURED IN SUCH A MANNER (E.G., CHOCKS) TO PREVENT THEIR ROLLING OUT OF PLACE.

When withdrawing gas from a ton container, connection is made to the upper valve (see Figure 6). Liquid withdrawal is accomplished by connecting to the lower valve.

It is recommended that special 3/8-inch square box wrenches, rather than adjustable wrenches, be used for opening cylinder and ton container valves. Length of the wrench should not exceed eight inches. It is good practice to leave the wrench in place so the valve can be closed quickly in case of an emergency. Maximum discharge can be accomplished with one full turn of the valve. Excessive force must not be used in opening valves. Never strike the wrench with anything other than the heel of the hand. Loosening the packing nut a maximum of 1/2 turn is acceptable, provided the packing nut is tightened after the valve is operated. Contact your chlorine supplier if these procedures do not permit operation of the valve.

Angle valves on tank cars must be opened fully to aid the operation of the excess flow valve.

Always test for leaks before putting new containers in service. The system can be pressurized by opening the container valve and then closing it. The valve can be opened again after it is determined that there are no leaks.

WARNING: ALWAYS WEAR PROTECTIVE CLOTHING WHEN CHECKING FOR LEAKS. REFER TO "PERSONNEL SAFETY" FOR INFORMATION ON HEALTH HAZARDS AND SAFETY PRECAUTIONS.

It is not unusual during humid conditions for condensation to collect on the outside of the container. A buildup of frost on the container indicates that withdrawal rates are too high to permit the surrounding air to supply the heat necessary to evaporate the liquid chlorine. Increasing the circulation of room temperature air past the container may correct the condition. Do not apply direct heat to the container in any way. It may be necessary to shut off the container valve and permit it to warm up again before putting it back in service.

After emptying the container, the valve must be closed before disconnecting to prevent the entry of moisture. After disconnecting, the valve cap and the valve protecting cap or hood must be replaced before the container is moved. Empty containers should be segregated from full containers and should be tagged.

Tank cars are unloaded by means of one of the liquid valves. One of the gas valves can be connected to the system to permit pressure testing with gaseous chlorine rather than liquid. The flexible connection used for tank car unloading must be designed for and installed in such a manner to allow for the significant increase in height as the car unloads. Since

tank car pressure is the only force causing the chlorine to discharge, many cars are padded with dry air by the producer or the user. Reference to Chlorine Institute Pamphlet 66, Chlorine Tank Car Loading, Unloading, Air Padding, Hydrostatic Testing, should be made for information on user air padding. It is essential that air padding pressure be kept as low as possible for satisfactory operation of the chlorination equipment since excessive air padding pressures can have a negative impact on evaporator performance. The depletion of the liquid chlorine supply in the car is accompanied by a sharp drop in tank car pressure.

After the angle valve is closed and the discharge line emptied, the piping may be disconnected. The valve outlet plugs should be replaced and the discharge piping capped immediately.

4 PIPING

4.1 PIPING MATERIALS AND JOINTS

If the chlorinator capacity is low enough, the vacuum regulator or the complete chlorinator may be mounted directly on a cylinder or ton container valve, totally eliminating pressure piping. In this case, reference to the equipment instruction book provides all necessary details.

Pressure connections from all chlorine containers are normally made by means of flexible connections made of copper tubing. Use yoke type connections at container valves. The chlorinator or vacuum regulator instruction book should be referred to for details for use of flexible connections along with the required auxiliary cylinder or ton container valves, header valves, and auxiliary header valves (if required).

WARNING: ALWAYS REPLACE FLEXIBLE CONNECTIONS ANNUALLY (OR SOONER IF THERE IS EVIDENCE OF DETERIORATION).

The usual practice for chlorine liquid or gas pressure lines, at the commonly encountered pressures and temperatures at chlorinator installations, is the use of 3/4 or 1.0 inch schedule 80 carbon steel seamless pipe with Class 3000 forged steel fittings; two-bolt flanges (commonly referred to as oval ammonia unions) are also often used. Both screwed and socket welded construction are common. Threaded joints should be made up using litharge and glycerine for permanent joints, white lead or TFE tape for others.

To facilitate maintenance, the number of line valves should be kept to a minimum. Insulation is required only in those cases where it is necessary to prevent chlorine gas lines from becoming chilled, or liquid lines from becoming overheated.

More complete details, along with ASTM and ANSI specifications, can be obtained by referring to Chlorine Institute Pamphlet 6, Piping Systems For Dry Chlorine.

WARNING: TWO COMMON CAUSES OF CHLORINE PIPING LEAKS ARE:
1. RE-USE OF GASKETS. THIS SHOULD NEVER BE DONE. ALWAYS HAVE AN ADEQUATE SUPPLY ON HAND AND ALWAYS USE NEW GASKETS OF THE CORRECT MATERIAL AND SIZE AS IDENTIFIED ON THE EQUIPMENT PARTS DRAWING.
2. IMPROPERLY MADE-UP THREADED PIPE JOINTS. SEE CHLORINE INSTITUTE MANUAL OR PAMPHLET 6 FOR RECOMMENDED PROCEDURE.

4.2 GAS PIPING INSTALLATION REQUIREMENTS

Reliquefaction of a gas should be avoided. If liquid chlorine is carried downstream to the chlorinator or vacuum piping, it may soften the plastic components and affect their structural strength. Liquid can wash any collected contaminants into the vacuum regulator and can also cause erratic surging, freezing, and pressure release, which can damage the diaphragm and control valves. Cold conditions in a gas pipe line (cold to the touch, dripping of water condensed from the atmosphere, frost, ice) are an indication that liquid chlorine is present in the line and is flashing to gas. Refer to the proper guidelines that follow.

It is important to observe the correct temperature conditions in conducting chlorine gas under pressure from the location of the containers to the point of use. To avoid difficulty with reliquefaction of chlorine, pressure piping and control equipment receiving gas under pressure should be at a higher temperature than that of the chlorine containers. In general, a difference of 5° to 10° F is recommended.

Pitch pressure lines uphill from the gas source toward the chlorinators if possible.

Install a pressure reducing valve or the chlorinator vacuum regulator close to, but higher than, the source of gas. The use of a chlorine pressure reducing valve is also recommended in those localities where severe temperature changes are likely to be encountered during a 24-hour period.

It is preferable to run chlorine pressure gas lines overhead through relatively warm areas rather than along the floor or through basement areas where lower temperatures may be encountered. Do not run these gas lines along exterior walls that may be cold in winter months. Do not run pressure gas lines under windows from which cold air descends in winter months.

If the source of gas is one or more ton containers connected to a manifold, install a drip leg of 1.0-inch schedule 80 seamless steel pipe approximately 18 inches long in a tee in the manifold with the lower end capped. Locate the drip leg immediately downstream of the last container connection to intercept the liquid that comes from the ton containers' gas eduction tubes when initially opened.

Gas may be withdrawn from two or more containers simultaneously provided all containers are at the same temperature. Refer to Paragraph 3.1.

The installation of chlorine gas strainers in pipe lines upstream from pressure reducing valves or vacuum regulators is a common practice. These strainers can also serve as traps for a small amount of liquid chlorine. Figure 12 illustrates a typical strainer.

4.3 LIQUID PIPING INSTALLATION REQUIREMENTS

It is important to avoid conditions that will encourage

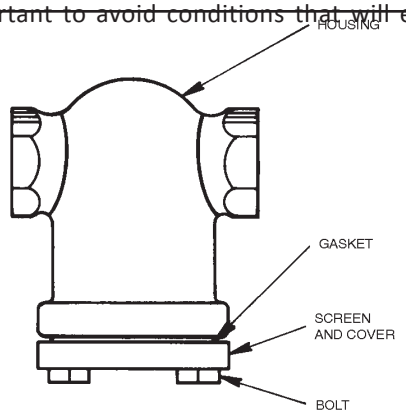


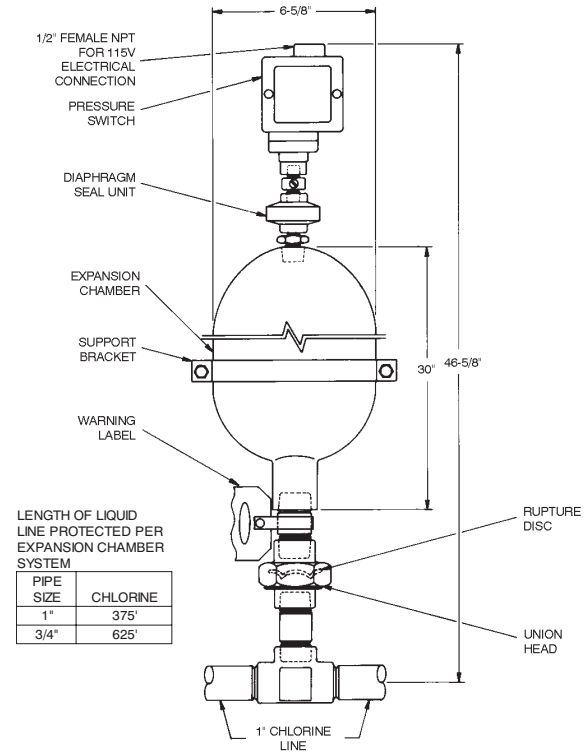
Figure 12 – Chlorine Gas Strainer

vaporization. Thus it is important to keep liquid chlorine lines as cool as, or cooler than, the containers themselves by eliminating restrictive fittings and always operating with fully opened line valves. Avoid running liquid chlorine lines through overheated areas where gasification is likely.

Valves in liquid chlorine lines should be kept to a minimum. It is particularly important to avoid situations where it is easy to close two valves in a line thus trapping liquid that, upon an increase in temperature, will expand and develop higher than acceptable pressures.

A liquid line pressure relief system (which includes a rupture disc and an expansion chamber) is required where liquid may be trapped in the line or where it is necessary to run lines a considerable distance. The relief system is detailed in Figure 13.

The expansion chamber provides an area for expansion in the event that valves at both ends of the line are closed. Relief system placement must be based not only on length of line but also placement of valves.



LENGTH OF LIQUID LINE PROTECTED PER EXPANSION CHAMBER SYSTEM

PIPE SIZE	CHLORINE
1"	375'
3/4"	625'

Figure 13 – Liquid Line Pressure Relief System

4.4 PRESSURE RELIEF AND VENT PIPING REQUIREMENTS

All pressure relief vent line systems must be treated as though they contain chlorine. Use the same materials for pressure relief vent lines as used for chlorine gas piping, unless the vent line is a combination pressure relief/vacuum relief line in which case the material must be suitable for moist chlorine gas (PVC or polyethylene tubing).

Vent lines must be run in such a way that moisture collecting traps are avoided. A continuous gradient is preferred. The end of all vent lines must be turned down and screened.

Manifolding of vent lines is an acceptable practice provided only like vents are manifolded (i.e., evaporator water vapor vents must be separate from gas pressure reducing valve pressure vents, etc.). The interior cross sectioned area of a common vent or pressure relief line should be approximately equal to the sum of the cross sectional areas of the individual vent lines.

WARNING: THE VENT LINE AND RELIEF LINE MUST TERMINATE IN AN AREA GAS FUMES CANNOT CAUSE INJURY TO PERSONNEL OR DAMAGE. DO NOT TERMINATE THE VENT LINE AND RELIEF LINE AT A LOCATION ROUTINELY USED BY PERSONNEL, SUCH AS WORK AREAS OR PATHWAYS NOR NEAR ANY WINDOWS OR VENTILATION SYSTEM INTAKES. IF AN AREA MEETING THESE REQUIREMENTS IS NOT AVAILABLE, REFER TO THE CHLORINE INSTITUTE'S CHLORINE MANUAL AND PAMPHLET NO. 9 FOR ALTERNATE METHOD OF RELIEF DISPOSAL.

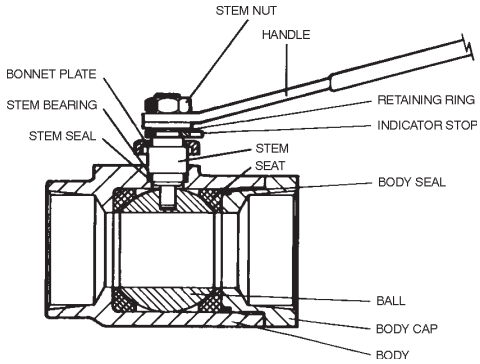


Figure 15 – Gas and Liquid Ball Valve

4.5 VALVES

Yoke type auxiliary cylinder, yoke type auxiliary ton container, and header valves are described adequately in the chlorinator or vacuum regulator instruction book.

Line valves are used to isolate alternate sources of supply (manifolded banks of ton containers or tank cars), individual evaporators or pressure type chlorinators. Sufficient line valves should be provided for flexibility of system operation consistent with the recommended practice of eliminating redundant or unnecessary valves.

Valves are usually of approximately globe pattern as shown in Figure 14 or ball type as shown in Figure 15.

Care should be taken that only valves designed by the manufacturer specifically for chlorine service are used. Ball valves must include a provision for venting the cavity in the closed position to the upstream side.

4.6 PRESSURE GAUGES AND SWITCHES

Whenever pressure gauges and switches are used in chlorine liquid or gas lines, they must be of the type protected by a flanged diaphragm seal specifically designed for chlorine service to prevent the entry of chlorine into the gauge or switch mechanism. The fill material must be suitable for chlorine service. The connection between the seal and the gauge or switch must not be broken. If the connection is inadvertently broken, the complete assembly must be discarded and replaced, unless it can be returned to the manufacturer for repair.

Frequently, valves are installed between chlorine lines and the gauge or switch diaphragm seal to permit removal without taking the line out of service. A means of relieving the pressure in the isolated piping, gauge, or switch is strongly recommended.

WARNING: RELEASING EVEN A SMALL AMOUNT OF LIQUID CHLORINE IS DANGEROUS AND REQUIRES EXTREME CAUTION TO AVOID SEVERE PERSONAL INJURY. ALWAYS USE PROTECTIVE EQUIPMENT WHEN RELIEVING PRESSURE, EVEN IN ISOLATED CHLORINE GAS PIPING.

Since small size line valves for chlorine are not readily available, many times a header valve is used as shown in Figure 16.

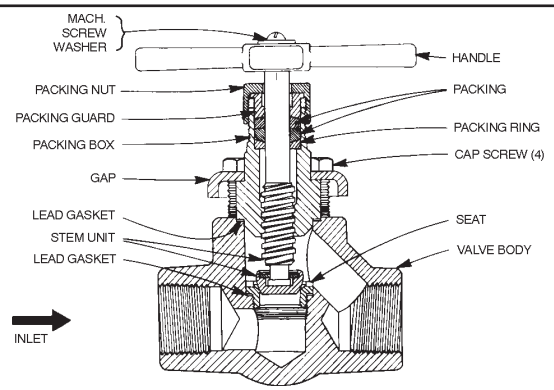


Figure 14 – 3/4- and 1-Inch Line Valves

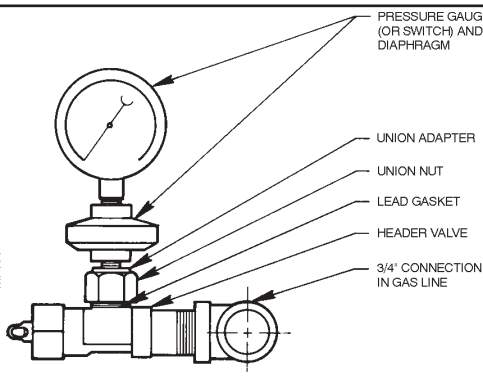


Figure 16 – Chlorine Pressure Gauge or Switch Mounted on Header Valve

4.7 PRESSURE RELIEF DEVICES

There are two types of pressure relief devices in use in chlorine piping systems. The first, as shown in Figure 13, is usually employed in liquid chlorine piping to protect the piping from rupture due to high pressure from thermal expansion of the liquid chlorine. It consists of a rupture disc that ruptures before the pipe line itself can rupture, an expansion chamber that allows for relief of the over-pressure condition without releasing chlorine to the atmosphere, and a pressure switch to warn of the disc rupture.

The second type, as shown in Figure 17, is usually used in gas piping at the evaporator discharge. This system consists of a rupture disc that keeps chlorine out of the valve during normal operation, a pressure relief valve, and a pressure switch to warn of disc rupture.

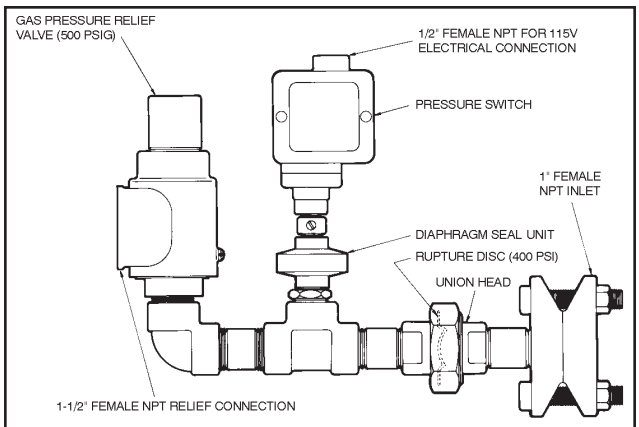


Figure 17 – Evaporator Pressure Relief System

<u>WARNING</u>: THE RELIEF LINE MUST TERMINATE IN AN AREA WHERE GAS FUMES CANNOT CAUSE DAMAGE OR INJURY TO PERSONNEL. DO NOT TERMINATE THE RELIEF LINE AT A LOCATION ROUTINELY USED BY PERSONNEL, SUCH AS WORK AREAS OR PATHWAYS, NOR NEAR WINDOWS OR VENTILATION SYSTEM INTAKES. IF AN AREA MEETING THESE REQUIREMENTS IS NOT AVAILABLE, REFER TO THE CHLORINE INSTITUTE'S CHLORINE MANUAL AND PAMPHLET NO. 9 FOR AN ALTERNATE METHOD OF RELIEF DISPOSAL.

4.8 PREPARATION FOR USE

Normal plumbing practices will result in the entry of cutting oils, greases, and other foreign materials into the piping.

In addition, the line will have been open to the atmosphere during construction, allowing moisture to enter. It is therefore essential that all piping be thoroughly cleaned and dried prior to exposure to chlorine.

<u>WARNING</u>: INCOMPLETE CLEANING CAN RESULT IN VIOLENT REACTIONS BETWEEN CHLORINE AND THESE MATERIALS.

Steam cleaning is an acceptable method for removal of the above materials. Provision must be made for removal of condensate and foreign materials. For alternate methods if steam is not available, refer to Chlorine Institute Pamphlet 6, Piping Systems for Dry Chlorine.

After proper cleaning, all chlorine piping should be hydrostatically tested to one and one half times the expected maximum operating pressure. Prior to testing, all gauges, switches, rupture discs, etc., that could be damaged during testing must be removed and connections plugged. Any moisture absorbing packing or gaskets left in the system during hydrostatic testing must be removed and replaced with new packing or gaskets. After hydrostatic testing, it is essential that all piping be thoroughly dried with inert gas (e.g., nitrogen) or dry air having a dew point of -40° F or below. The dew point of the air or gas leaving the piping must be checked and drying continued until the dew point is at or below -40° F, which may require quite some time.

<u>WARNING</u>: MOISTURE MUST BE REMOVED FROM ANY PART OF THE EQUIPMENT THAT IS NORMALLY EXPOSED TO DRY CHLORINE ONLY. WHILE DRY CHLORINE IS NONCORROSIVE, MOIST CHLORINE IS EXTREMELY CORROSIVE TO COMMON METALS, SUCH AS BRASS OR STEEL, POSSIBLY RESULTING IN A LEAK AND SEVERE PERSONAL INJURY. ALSO, IF WATER IS TRAPPED IN A SECTION OF PIPING OR EQUIPMENT, SUBSEQUENT HEATING OR FREEZING OF THE WATER MAY RESULT IN HIGH ENOUGH PRESSURE TO RUPTURE THE PIPING OR EQUIPMENT, POSSIBLY CAUSING SEVERE PERSONAL INJURY.

A very acceptable alternate to hydrostatic testing, if proper facilities do not exist for drying, is to test with nitrogen or dry air having a dew point of -40° F or below. The same provision of removing equipment that could be damaged by test pressure applies.

<u>WARNING</u>: TO AVOID SEVERE PERSONAL INJURY, BEFORE PLACING THE PIPING SYSTEM INTO SERVICE, PRESSURE TEST WITH CHLORINE GAS, NOT LIQUID. EACH VOLUME OF CHLORINE LIQUID THAT LEAKS AND THEN EVAPORATES RESULTS IN APPROXIMATELY 460 VOLUMES OF CHLORINE GAS.

The chlorine container valve should be opened only slightly during this phase of testing or preferably closed again after pressurizing the system. The piping should be tested in the smallest sections permitted by the existing valves to minimize

the discharge of chlorine through any leaks.

WARNING: IT IS ESSENTIAL THAT PROPER BREATHING APPARATUS BE AVAILABLE BEFORE CHLORINE IS ADMITTED TO ANY PIPING SYSTEM OR EQUIPMENT. THIS APPARATUS WILL BE DISCUSSED FURTHER UNDER "PERSONNEL SAFETY".

Chlorine leaks are best located using a dauber moistened with commercial 26° Baume' aqueous ammonia (household ammonia is not strong enough) . A white cloud will be formed at the site of any leak. A plastic squeeze bottle that directs ammonia vapor, not liquid, at the joint being tested may also be used.

When a leak is detected, the system must be depressurized before corrective action is taken. The best method of depressurizing the system is through one of the chlorinators. At least one chlorinator must be readily available for this purpose before testing with chlorine begins.

5 PERSONNEL SAFETY

5.1 GENERAL

Proper consideration of personnel safety begins with the provision of properly sized and arranged housing so that operating personnel have adequate room to perform their duties. It is preferable that any room used for chlorine storage or equipment have two doors that open outward and that are equipped with panic bars.

Rooms housing chlorination equipment, and chlorine containers that are "in service" or "in reserve", should be heated when the room temperature falls below 50° F. Comfortable working temperatures of 65° to 75° F are recommended for the chlorine equipment room. The temperature of the chlorine container room (if separate) should normally be 5° to 10° F lower. All common methods of heating are acceptable, provided that care is taken to prevent overheating of chlorine containers. Radiators should not be located adjacent to containers. If space heaters are used, the warm air should be deflected away from the containers. Outside windows should be located or screened so that the rays of the sun do not fall directly on chlorine containers.

Natural ventilation may be adequate for a small chlorinator installation in a separate building when windows and doors can provide cross circulation; however, ventilation by means of a proper type electric fan is always recommended.

In all cases, installations must comply with appropriate regulations.

5.2 HEALTH HAZARDS

Exposure to a sufficiently high concentration of chlorine can result in difficulty in breathing and, if prolonged, finally death through suffocation. Chlorine's strong pungent odor may result in detection at levels as low as 1.0 ppm and most people will detect it by the time the concentration reaches 3.5 ppm. Concentrations of 5 ppm or more are so objectionable that only those who are unconscious or trapped will normally remain in the area. Increasing concentrations will produce eye irritation, coughing, throat irritation, vomiting, and labored breathing.

Even concentrations below the threshold of smell can result in minor eye and throat irritation if the exposure is long enough.

Liquid chlorine can cause burns and/or irritation when it is in contact with the skin or eyes.

Medical attention should be obtained immediately for personnel who have sufficient exposure to result in any symptoms beyond minor irritation. Properly trained and equipped first aid personnel are usually the first line of defense. While waiting for their arrival, the exposed individual must be removed to a safe area and be placed in a comfortable position. If breathing has stopped, artificial respiration must be started immediately. CPR administered by properly trained personnel is required if the heart has stopped.

If the exposed individual has difficulty breathing, oxygen should be administered only by those adequately trained in the procedure and the equipment used.

The proper procedure for emergency treatment of clothing or skin contaminated by chlorine is to flush the area with large quantities of water under a shower for at least 15 minutes. While still under the shower, affected clothing should be removed. No medical treatment or neutralization of the chlorine should be attempted except as directed by a physician.

Immediate flushing with tepid water should be administered if even small quantities of chlorine enter the eye or if the eye has been exposed to strong concentrations of chlorine. The eyelids must be parted and thorough flushing continued for at least 15 minutes. As mentioned previously for skin exposure, no medical treatment or neutralization should be attempted except as directed by a physician.

The attending physician may wish to refer to a Material Safety Data Sheet on chlorine as well as to the Chlorine Institute's Chlorine Manual and/or Pamphlet 63, First Aid and Medical Management of Chlorine Exposures.

5.3 SAFETY PRECAUTIONS

The first steps to be taken in providing proper safety precautions at any facility are the selection of safety equipment to be on hand, the proper location of the equipment, and the training of all personnel in proper procedures to avoid unnecessary chlorine releases and to deal with releases that occur.

Proper respiratory equipment is essential for all facilities regardless of size. For maximum safety, it is preferable to use air tank type pressure demand masks that have a self-contained air supply and, therefore, are suitable regardless of chlorine concentration.

All respiratory equipment must meet the requirements of the National Institute for Occupational Safety and Health. Following the respiratory equipment manufacturer's recommendation regarding maintenance and periodic testing is essential. This equipment should be stored outside the area containing chlorine or chlorine equipment in a manner protecting it from damage of any kind and so as to be readily available.

WARNING: DO NOT LOCK CABINETS OR CLOSETS IN WHICH RESPIRATORY EQUIPMENT IS STORED, AS THE EQUIPMENT MUST BE READILY AVAILABLE.

All personnel with no assigned responsibility for dealing with a chlorine release should be instructed to leave the area. Those responsible for correcting the situation should don respiratory equipment before doing so.

Protective clothing is recommended for handling even routine operations involving chlorine. In the event of a substantial release, protective clothing is required. Anyone desiring further information on protective clothing should refer to the Chlorine Institute Pamphlet 65, Protective Clothing for Chlorine.

Safety shoes, hard hats, and safety glasses should be used in accordance with standard plant practice.

Most leaks will occur in piping, valves, connections, and the pressurized portions of chlorine equipment. These leaks will usually be eliminated by tightening packing, replacing gaskets, or repairing the equipment.

WARNING: REPLACE FLEXIBLE CONNECTIONS ANNUALLY, OR SOONER IF THERE IS EVIDENCE OF DETERIORATION.

Emergency kits (meeting Chlorine Institute requirements) are available that can seal off most leaking areas of chlorine containers (i.e., valves, fusible plugs, or container wall). If these are on hand they must be used only by personnel thoroughly familiar with their use. The chlorine supplier should be contacted immediately for information, assistance, and advice on the disposition of the leaking container. The container should always be repositioned, if possible, so the leak is gas rather than liquid.

WARNING: NEVER UNDER ANY CIRCUMSTANCE SPRAY WATER ON A CHLORINE LEAK. THIS WILL ONLY MAKE IT WORSE.

Wall charts are available from most chlorine suppliers that provide much of the information contained in this manual.

5.4 EMERGENCY ACTION PLANS

The best emergency plan includes routine practices that are designed to minimize emergencies. Proper maintenance of all equipment associated with the storage, handling, and use of chlorine in accordance with the manufacturer's instructions is essential.

All equipment and piping containing chlorine under pressure must be tested periodically for leaks following procedures covered in Paragraph 4.8. Since it is not unusual for areas used for chlorine storage and chlorine equipment to be relatively unattended, it is important for the air in these areas to be monitored continuously with chlorine detectors, so that warning of leaks is given as early as possible. As with most emergencies, the earliest detection helps to minimize the damage to equipment and personnel. In addition to warning of leaks when the areas are unattended, chlorine detectors should warn of the presence of minor amounts of chlorine that may not be detected by personnel in the area.

Some chlorine leaks are minor but all require immediate attention.

In the event of a major release of chlorine, there should be no delay in contacting the agency in the community that is responsible for handling hazardous material releases. Appropriate names and telephone numbers must be prominently posted.

The chlorine supplier is probably the best source of assistance for most chlorine users. In addition, the Chlorine Institute's Chlorine Emergency Plan (CHLOREP) can provide vital assistance. In the United States this plan is activated through CHEMTREC (toll free 800-4249300). In Canada, contact CANUTEC (call collect 613-996-6666). These names and numbers must also be posted prominently.

The person responsible for making any of the calls listed above must be sure to give the agency contacted complete details including facility name, address, telephone number, and the names(s) of personnel to contact for further information. The description of the emergency should include size of container, corrective action already taken, local weather conditions, injuries, proximity to populated areas, and directions for easiest access to the site.

It is vital that the emergency plan include use of the "buddy system", i.e., no personnel should be allowed to work alone in an area with a chlorine leak even if the second person is only standing by. As indicated earlier, all personnel not involved in locating and correcting the leak should leave the area travelling in a crosswind direction to an area that is upwind and above the leak. Since it may not be possible for all personnel to be equipped with respiratory equipment, they should be instructed to use a wet cloth or handkerchief over the nose and mouth while leaving the area.

Chlorine Institute Pamphlet 64, Emergency Control Planning Checklist for Chlorine Facilities, may be of assistance in preparing the emergency plan. A Material Safety Data Sheet for Chlorine, available from the Institute or the supplier, should also be consulted.

No emergency plan should be implemented until it is reviewed by the chlorine supplier and the agency in the community having responsibility for hazardous material handling and disposal.

If it is apparent that fire will threaten or is present in a chlorine storage area, it is preferable to remove the containers. If this is not possible, the containers must be protected from the heat of the fire by spraying them with water. Do not spray water on any leaking container, however, since water will react with the chlorine, forming acids that will make the leak worse.

5.5 CHEMICAL DISPOSAL FACILITIES

Part of the planning for emergencies entails provision for disposal of any released chlorine. In most cases little can be done about the chlorine already released to the atmosphere except to try to prevent its dissipation into areas where damage to equipment and personnel will result.

At some large installations, scrubbers have been installed so that areas containing chlorine or chlorine equipment can be sealed off and the air removed to a process that will absorb the chlorine. The design of such a system is complex and should only be attempted by those thoroughly familiar with the process.

Absorption systems have been provided at some facilities to permit a leaking container to be emptied quickly if this is deemed essential. One pound of chlorine can be absorbed by 1. 4 pounds of sodium hydroxide (caustic soda), 3.7 pounds of sodium carbonate (soda ash), or 1.3 pounds of calcium hydroxide (hydrated lime).

WARNING: TO AVOID SEVERE PERSONAL INJURY WHEN USING CORROSIVE CHEMICALS, OBSERVE ALL SAFETY PRECAUTIONS RECOMMENDED BY THE CHEMICAL MANUFACTURER/ SUPPLIER.

In each case, one pound of the material should be dissolved in one gallon of water. Lime will actually be suspended in, rather than dissolved in, the water and requires constant agitation.

The tank and other equipment provided for an absorption system must be fabricated of materials suitable for the chemicals involved.

Provision must be made for dissolving the chlorine in the alkaline solution in such a way that the solution cannot be sucked back into the container.

Actually the safest way of disposing of the chlorine in the leaking container might be through the chlorination process, particularly if the process can absorb the chlorine at higher than normal rates without creating damage.

It is not generally permissible to ship a container damaged by leak or fire if it contains chlorine. If for some reason this seems necessary, the chlorine supplier must be contacted.

AMMONIA HANDLING MANUAL

(NH_3)

BOOK NO. WT.060.200.001.UA.IM.0614

W3T98247

REGIONAL OFFICES

INSTALLATION, OPERATION, MAINTENANCE, AND SERVICE INFORMATION

Direct any questions concerning this equipment that are not answered in the instruction book to the Reseller from whom the equipment was purchased. If the equipment was purchased directly from Evoqua Water Technologies, Colorado Springs, CO contact the office indicated below.

UNITED STATES

725 Wooten Road
Colorado Springs, CO 80915
TEL: (800) 524-6324

CANADA

If the equipment was purchased directly from Evoqua Water Technologies, Canada, contact the nearest office indicated below.

ONTARIO

Evoqua Water Technologies Ltd.
2045 Drew Road
Mississauga, Ontario
L5S 1S4
(905) 944-2800

QUEBEC

Evoqua Technologies des Eaux Itee
505 Levy Street
St. Laurent, Quebec
H4R 2N9
(450) 582-4266

AMMONIA HANDLING MANUAL

WARNING:

AMMONIA IS A HAZARDOUS CHEMICAL THAT CAN CAUSE INJURY AND DEATH IF NOT HANDLED PROPERLY. THIS MANUAL CONTAINS ONLY GENERAL INFORMATION ON THE PHYSICAL PROPERTIES, STORAGE, AND HANDLING OF AMMONIA (ANHYDROUS AMMONIA). IT IS NOT INTENDED TO REPLACE OR LIMIT SAFETY PROCEDURES IN YOUR FACILITY.

SAFETY PROCEDURES IN AN INDUSTRIAL SETTING MUST BE DESIGNED IN ACCORDANCE WITH ALL GOVERNMENTAL REGULATIONS AND NATIONAL SAFETY CODES, AFTER GIVING FULL CONSIDERATION TO THE SPECIFIC NEEDS OF THE INDUSTRIAL FACILITY INVOLVED.

EVOQUA WATER TECHNOLOGIES CANNOT ANTICIPATE THE SPECIFIC SAFETY PROCEDURES REQUIRED IN EVERY INDUSTRIAL FACILITY. ACCORDINGLY, EVOQUA WATER TECHNOLOGIES DOES NOT GUARANTEE THAT SAFETY PROCEDURES DESIGNED IN ACCORDANCE WITH THIS MANUAL WILL COMPLETELY ELIMINATE HAZARD AND THUS ASSUMES NO RESPONSIBILITY FOR ACCIDENTS WHICH MAY OCCUR IN YOUR FACILITY.

READ THIS ENTIRE MANUAL AND BE FULLY FAMILIAR WITH YOUR EQUIPMENT AND YOUR ENTIRE INDUSTRIAL SYSTEM SO THAT THE SAFETY PROCEDURES YOU ESTABLISH WILL MEET THE NEEDS OF THE EMPLOYEES IN YOUR FACILITY. READING ONLY PART OF THE MANUAL WILL NOT HELP YOU ANALYZE THE NEEDS OF YOUR FACILITY. CONTACT YOUR AMMONIA SUPPLIER, THE COMPRESSED GAS ASSOCIATION OR SIMILAR ORGANIZATION TO OBTAIN A MATERIAL SAFETY DATA SHEET (MSDS) AND MORE INFORMATION ON ANHYDROUS AMMONIA. INFORMATION IS AVAILABLE FROM: THE COMPRESSED GAS ASSOCIATION, INC., 4221 WALNEY ROAD, 5TH FLOOR, CHANTILLY, VA 20151-2923.

PLEASE NOTE THE PUBLICATION DATE AND POSSIBLE OBSOLESCENCE OF THIS MATERIAL AS A RESULT OF SCIENTIFIC AND MEDICAL DEVELOPMENTS AFTER THE DATE OF PUBLICATION. THIS APPLIES TO ALL MATERIALS YOU REVIEW IN THE COURSE OF DEVELOPING SAFETY PROCEDURES FOR USE AT YOUR FACILITY.

Table Of Contents

Table Of Contents (Cont'd)

1 INTRODUCTION

This manual discusses the characteristics, storage, and handling of ammonia (anhydrous ammonia) used with Evoqua Water Technologies equipment. Ammonia is used with Evoqua Water Technologies equipment in conjunction with chlorine in water treatment.

Contact your gas supplier, the Compressed Gas Association, Inc., or similar organization to obtain more detailed information on ammonia. Information is available from: Compressed Gas Association, Inc., 1235 Jefferson Davis Highway, Arlington, VA 22202.

WARNING:
AMMONIA IS HAZARDOUS. TO AVOID SEVERE PERSONAL INJURY OR DEATH BY SUFFOCATION, READ THIS ENTIRE MANUAL AND THE GAS SUPPLIER'S PRECAUTIONS BEFORE HANDLING OR CONNECTING AMMONIA TO EVOQUA WATER TECHNOLOGIES EQUIPMENT.

WHEN WORKING WITH AMMONIA:
ENSURE THAT APPROVED, SELF-CONTAINED BREATHING APPARATUS IS ALWAYS AVAILABLE AND PERSONNEL ARE PROPERLY TRAINED IN ITS USE.
ENSURE THAT SAFETY EQUIPMENT, SUCH AS VENTILATION FANS AND BREATHING APPARATUS, IS INSPECTED AND MAINTAINED IN ACCORDANCE WITH THE MANUFACTURER'S INSTRUCTIONS.
ENSURE THAT APPROPRIATE PLACARDS AND WARNING SIGNS ARE IN PLACE AND PROMINENTLY DISPLAYED IN THE AREAS WHERE THE GAS IS STORED.

IN CASES OF ACCIDENT:
USE SAFETY EQUIPMENT TO PROTECT THE RESCUER, AND MOVE VICTIM TO FRESH AIR. IF BREATHING HAS STOPPED, START ARTIFICIAL RESPIRATION IMMEDIATELY. IF HEART HAS STOPPED, START CPR (CARDIOPULMONARY RESUSCITATION) IMMEDIATELY. IN ALL CASES, OBTAIN MEDICAL ATTENTION AS SOON AS POSSIBLE.

TO AVOID ACCIDENTAL GAS RELEASE:
KNOWLEDGEABLE DESIGN PERSONNEL SHOULD OVERSEE AND APPROVE EQUIPMENT INSTALLATION AND SUITABILITY OF THE SYSTEM FOR WHICH IT IS INTENDED.

QUALIFIED PERSONNEL SHOULD PERFORM PERIODIC INSPECTION TO ENSURE PROPER MAINTENANCE OF THE EQUIPMENT.
MONITOR SAFETY PROGRAMS AND CONDUCT PERIODIC TRAINING PROGRAMS ESPECIALLY ON EMERGENCY SITUATIONS. SAFETY PROGRAMS ARE AVAILABLE FROM YOUR GAS SUPPLIER.

LOCAL LAWS:
UNDER NO CIRCUMSTANCES SHOULD THE INFORMATION IN THIS BOOK BE CONSTRUED AS SUBSTITUTING FOR OR SUPERSEDING ANY LOCAL, STATE, OR FEDERAL LAWS AND REGULATIONS CONCERNING THE STORAGE, HANDLING, OR USE OF AMMONIA.

2 TECHNICAL DATA AND CHARACTERISTICS OF AMMONIA

The following general information on ammonia will be useful in planning an ammoniator installation. For more specific information on physical properties consult the MSDS on anhydrous ammonia.

Ammonia in commerce is a liquefied gas under pressure. It is a clear, colorless liquid. The gas is colorless and has a strong, pungent odor. It is an irritant to the skin and respiratory system. In the moisture-free state at ordinary temperatures

it is relatively non-corrosive. In the presence of moisture, however, it is highly corrosive.

Accordingly, every precaution should be taken to avoid leaks, to stop them promptly if they occur and to keep moisture out of valves, tubing, etc. not specifically designed to handle moist ammonia. Many grades of anhydrous ammonia are available, with varying amounts of moisture content. Consult your ammonia supplier for recommendations for your application. Among the important physical properties of ammonia are:

Specific Gravity, Dry Gas
0.5970 at 32° F and 1 atm referred to air.

Specific Gravity, Liquid
0.641 at 30° F and 59.7 psia.

Latent heat of Vaporization
588.2 Btu per lb at -27.7° F.

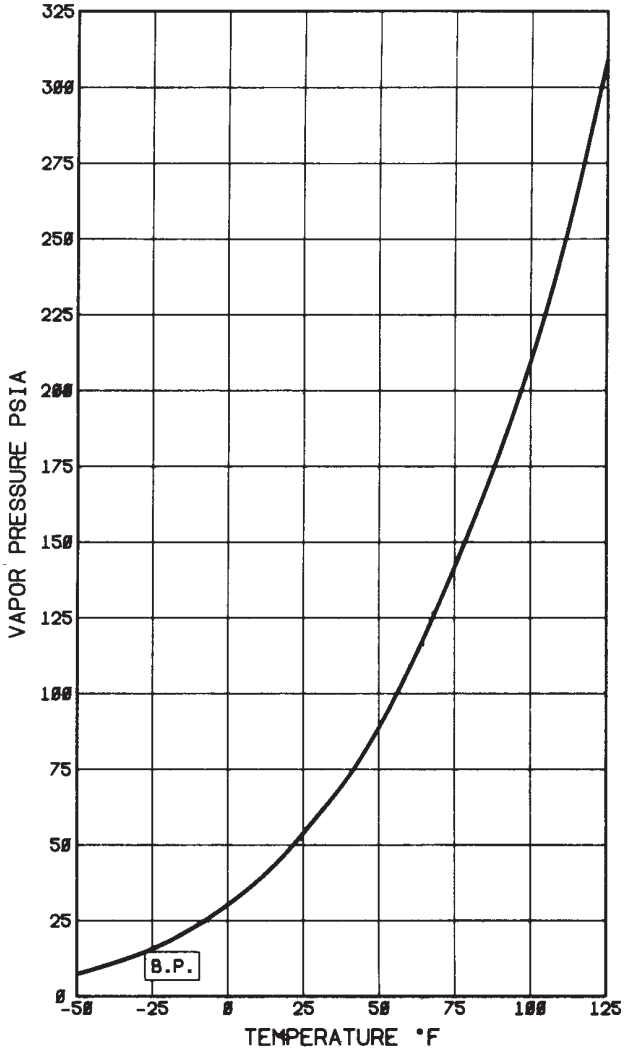
Specific Volume, Dry Gas
1 lb = 20.78 cf at 32° F and 1 atm.

Weight, Dry Gas
1 cf = 0.0562 lb at -27.7° F and 1 atm.

Weight, Liquid
1 cf = 42.54 lb at -27.7° F

Solubility in Water
37.0 lbs./100 gals at 60° F and 1 atm.

Pressure vs Temperature
See Figure 1



SOURCE: MATHESON GAS DATA BOOK (FIFTH EDITION)

Figure 1 - Vapor Pressure vs. Temperature

Ammonia does not generally create a fire hazard; however, at temperatures above 1562°F (850°C) ammonia gas is flammable in air in the range of 16%-25% by volume. Contact with chemicals such as bromine, chlorine, iodine, mercury, silver oxide or hypochlorites can result in the formation of explosive compounds.

3 SUPPLY CONTAINERS

The supply containers most commonly used with Evoqua Water Technologies equipment are cylinders, tank cars, and, on occasion, cargo tanks. Consultation with suppliers is recommended.

The 100-lb cylinders have an average tare weight of 88 to 134 lbs (depending on design) without protective hood, an average gross weight of 191-237 lbs with protective hood, an outside diameter of 12.25 to 12.50 inches and a length of 56 to 59 inches.

The 150-lb cylinders have an average tare weight of 135 to 195 lbs (depending on design) without protective hood, an average gross weight of 288 to 348 lbs with protective hood, an outside diameter of 14.75 to 15.00 inches and a length of 58 to 60 inches.

Tank cars and cargo tanks vary substantially in capacity and dimensions. Details can best be obtained by consulting with suppliers in any given area.

All supply containers must conform to appropriate Department of Transportation (DOT) and Canadian Transport Commission (CTC) regulations. It is the responsibility of the supply container manufacturer and the ammonia supplier to meet these requirements.

3.1 MAXIMUM WITHDRAWAL RATES

In general, using a remote vacuum type ammoniator, maximum sustained gas withdrawal rate at which ammonia may be taken from a 100 or 150-pound cylinder is 0.4 lb/day/°F depending somewhat on cylinder design. At an assumed liquid temperature of 70°F (and using a remote vacuum type ammoniator) the above figures translate into 28 lbs/24 hrs for cylinders. These rates can be increased for brief periods. Supply containers should never be placed in a water bath or have direct heat applied in order to permit higher withdrawal rates.

Using a direct feed ammoniator, the maximum sustained gas withdrawal rate from a 100 or 150-pound ammonia cylinder is approximately 0.4 x (°F-40) lbs/24 hrs. For example, at 70°F the maximum sustained gas withdrawal rate is approximately 12 lbs/24 hrs.

When higher gas withdrawal rates are required cylinders may be manifolded. A typical arrangement for manifolding cylinders is shown in Figure 2.

If cylinders are manifolded it is essential that all supply containers be at the same temperature to prevent the transfer of liquid ammonia from a warmer container to a cooler container possibly resulting in a container becoming overfilled through reliquefaction of ammonia in the cooler container.

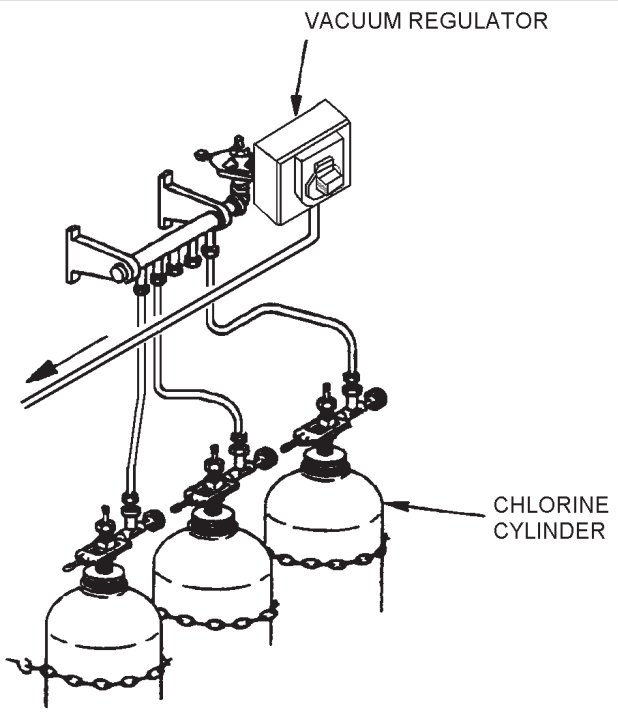


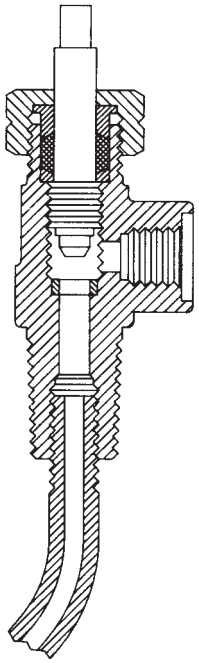
Figure 2 - Manifolding Cylinders

It is usually not practical to withdraw ammonia as a gas from tank cars (or cargo tanks). Liquid can be withdrawn from tank cars by various methods. If it is necessary contact your gas supplier or the Compressed Gas Association for recommendations.

3.2 CONTAINER VALVES

The standard cylinder valve is shown in Figure 3.

Valve outlet threads are 3/8-18 NGT-RH-INT as shown in Figure 3. Auxiliary cylinder valves are connected as indicated in Figure 4 using either a threaded or yoke type adapter.



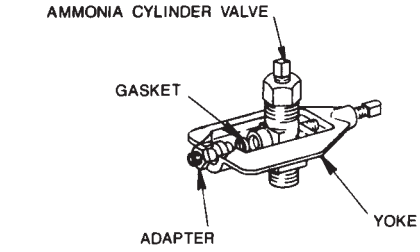
NOTE: Valve stem packing nut has left-hand thread, which is indicated by the V-notch on each corner of the hexagonal nut.

Figure 3 - Ammonia Cylinder Valve (CGA Outlet Connection No. 240)

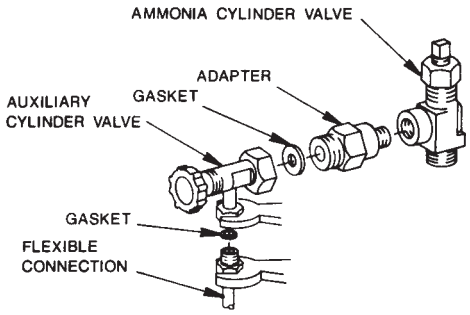
Cylinders are equipped with one valve, which is normally used for gas withdrawal.

Tank cars are usually equipped with three standard angle valves, however, some will have four valves.

Outlet is 1.0 inch female ANSI Standard taper pipe thread. The liquid withdrawal valves are located on the longitudinal center line of the tank car. The valve(s) on the transverse center line are connected to the vapor space are used to obtain ammonia gas under pressure for testing the piping or for air padding the tank car. (Valve stem packing nut has



YOKE FOR AMMONIA CYLINDER VALVE OR AUXILIARY CYLINDER VALVE - YOKE TYPE



UNION TYPE AUXILIARY CYLINDER VALVE CONNECTION

Figure 4 - Ammonia Auxiliary Cylinder Valves

left-hand thread, which is indicated by the V-notch on each corner of the hexagonal nut)

3.3 PRESSURE RELIEF DEVICES

Ammonia cylinders do not normally have a pressure relief device since this is not required unless the cylinder contains more than 165 pounds.

Most tank cars have an excess-flow valve located under each liquid valve. While this valve may close during a catastrophic pipe line failure its main function is to close automatically if the angle valve is broken off in transit. Tank cars also have a pressure relief device located in the center of the manway. The relief level varies with the type of car or tank.

3.4 STORAGE OF CONTAINERS

Ammonia cylinders are best stored under cover and in cool, well-ventilated locations protected from fire hazards and adequately protected from extreme weather conditions. During the summer months, full containers should be shielded from the direct rays of the sun, which otherwise might result in building up dangerous pressures (see Figure 1). If stored out of doors, keep cylinders in fenced off areas for protection. Do not store or use ammonia cylinders near other chemicals or gases.

WARNING: STORE CYLINDERS IN AN UPRIGHT POSITION. TO AVOID SEVERE PERSONAL INJURY OR EQUIPMENT DAMAGE, CYLINDERS MUST BE SECURED IN SUCH A MANNER (E.G., CHAIN) AS TO PREVENT THEIR BEING KNOCKED OVER.

Do not remove the protective cap or hood from cylinders until they are ready to be put into actual use. Do not store cylinders in a heavily traveled area where physical contact damage could occur.

It is essential that areas used to house ammonia cylinders or equipment be continuously monitored for the presence of ammonia in the air. This may be a requirement of pertinent laws and/or regulations.

When containers are moved from a storage area to an area in which they will be used sufficient time must be allowed to stabilize the temperature, and therefore pressure, of the container and the ammonia before it is used.

The ammonia inventory depends on local availability to a large extent. Consult with ammonia suppliers in the area.

When planning space for stored cylinders sufficient space must be allowed for empty cylinders.

The best way to determine the amount of ammonia remaining in a cylinder is to weigh the cylinder continuously on a scale. This also makes it possible to record the amount of ammonia used. Portable or dormant scales in beam, dial, or digital types and with varying platform sizes are available.

WARNING: ALWAYS REMOVE WHEELS AND AXLES OF PORTABLE SCALES SO THAT THE SCALE CANNOT MOVE WHEN CYLINDERS ARE ON THE PLATFORM.

Preferably, scales for cylinders should be installed with their platform flush with the floor to eliminate the necessity of lifting the cylinders. Some low profile scales are low enough that cylinders can be placed on the scale without lifting. Others are installed with ramps. If scales are pit mounted a trapped drain should be provided.

Special high capacity scales are provided at some installations using tank cars. These scales are usually pit mounted below the railroad siding with the dial or digital unit housed above ground beside the track.

Some of the dial or digital scales are equipped with loss-of-weight recording systems providing a permanent record of ammonia usage.

3.5 HANDLING CONTAINERS

Care must always be exercised when handling ammonia cylinders. They should not be dropped and should not be permitted to strike each other or other objects. Valve protecting caps or hoods must always be in place when cylinders are moved.

Cylinders should be handled with a simple two-wheel hand truck of the barrel pattern. Hand trucks should be well balanced and equipped with chains or clamps preventing the cylinders from falling off the truck.

WARNING: NEVER LIFT CYLINDERS BY THE VALVE PROTECTING CAP. IT IS NOT DESIGNED FOR THIS SERVICE (IT MAY SEPARATE FROM THE CYLINDER, CAUSING THE CYLINDER TO FALL).

Cylinders must never be lifted by sling or magnetic device. If lifting is necessary a specially designed cradle must be used.

3.6 USING CONTAINERS

If cylinders have been stored in an area other than that in which they will be used they should be allowed to stabilize at the new temperature before being used. Cylinders should always be used in the order in which they are received to avoid unnecessarily long storage and possible difficulty with valves that have not been opened or closed for too long a period.

WARNING: CYLINDERS ARE NORMALLY USED IN AN UPRIGHT POSITION FOR GAS WITHDRAWAL. TO AVOID SEVERE PERSONAL INJURY OR EQUIPMENT DAMAGE, SUPPLY CYLINDERS MUST BE SECURED IN SUCH A MANNER (E.G. CHAIN) AS TO PREVENT THEIR BEING KNOCKED OVER.

It is recommended that special 3/8-inch square box wrenches rather than adjustable wrenches be used for opening cylinder valves. Length of the wrench should not exceed eight inches. It is good practice to leave the wrench in place so the valve can be closed quickly in case of an emergency. Maximum discharge can be accomplished with one full turn of the valve. Excessive force must not be used in opening valves. Never strike the wrench with anything other than the heel of the hand. Loosening the packing nut a maximum of 1/2 turn is acceptable provided the packing nut is tightened after the valve is operated. Contact your ammonia supplier if these procedures do not permit operation of the valve.

Always test for leaks before putting new cylinders in service. The system can be pressurized by opening the valve and then closing it. The valve can be opened again after it is determined that there are no leaks.

It is not unusual during humid conditions for condensation to collect on the outside of the cylinder. A build-up of frost on the cylinder indicates that withdrawal rates are too high to permit the surrounding air to supply the heat necessary to evaporate the liquid ammonia. Increasing the circulation of room temperature air past the cylinder may correct the condition. Do not apply direct heat to the cylinder in any way. It may be necessary to shut off the cylinder valve and permit it to warm up again before putting it back in service. After emptying the cylinder the valve must be closed before disconnecting to prevent the entry of moisture. After disconnecting, the valve cap and the valve protecting cap must be replaced before the cylinder is moved. Empty cylinders should be segregated from full cylinders and should be tagged.

Tank cars are unloaded by means of one of the liquid valves. One of the gas valves can be connected to the system to permit pressure testing with gaseous ammonia rather than liquid. The flexible connection used for tank car unloading must be designed for and installed in such a manner to allow for the significant increase in height as the car unloads. Tank car pressure may be inadequate as a motivating force for unloading many cars.

Contact your gas supplier or the Compressed Gas Association for recommendations on compressors or air padding. It is essential that air padding pressure be kept as low as possible for satisfactory operation of the ammoniation equipment since excessive air padding pressures can have a negative impact on evaporator performance.

After the angle valve is closed and the discharge line emptied the piping may be disconnected. The valve outlet plugs should be replaced and the discharge piping capped immediately.

4 PIPING

4.1 PIPING MATERIALS AND JOINTS

If the ammoniator capacity is low enough the vacuum regulator may be mounted directly on a cylinder valve totally eliminating pressure piping. In this case reference to the equipment instruction book provides all necessary details.

Pressure connections from all ammonia cylinders are normally made by means of flexible connections made of steel tubing. The ammoniator or vacuum regulator instruction book should be referred to for details for use of flexible con-

nections along with the required auxiliary cylinder valves, header valves, and auxiliary header valves (if required).

WARNING: REPLACE FLEXIBLE CONNECTIONS ANNUALLY, OR SOONER IF THERE IS EVIDENCE OF DETERIORATION.

The usual practice for ammonia liquid or gas pressure lines at the commonly encountered pressures and temperatures at ammoniator installations, is the use of 3/4 or 1.0-inch schedule 80 carbon steel seamless pipe with Class 3000 forged steel fittings; two-bolt flanges (commonly referred to as oval ammonia unions) are often used. Both screwed and socket welded construction are common. Threaded joints should be made up using litharge and glycerine for permanent joints, white lead for others.

To facilitate maintenance, the number of line valves should be kept to a minimum. Insulation is required only in those cases where it is necessary to prevent ammonia gas lines from becoming chilled, or liquid lines from becoming overheated.

More complete details can be obtained by referring to Compressed Gas Association Pamphlet No. CGA G-2 American National Standard Safety Requirements for the Storage and Handling of Anhydrous Ammonia, ANSI K61.1.

WARNING: TWO COMMON CAUSES OF AMMONIA PIPING LEAKS ARE:
1. RE-USE OF GASKETS. THIS SHOULD NEVER BE DONE. ALWAYS HAVE AN ADEQUATE SUPPLY ON HAND AND ALWAYS USE NEW GASKETS OF THE CORRECT MATERIAL AND SIZE AS IDENTIFIED ON THE EQUIPMENT PARTS DRAWING.
2. IMPROPERLY MADE-UP THREADED PIPE JOINTS.

4.2 GAS PIPING INSTALLATION REQUIREMENTS

Reliquefaction of a gas should be avoided. If liquid ammonia is carried downstream to the ammoniator or vacuum piping it may soften the plastic components and affect their structural strength. Liquid can wash any collected contaminants into the vacuum regulator and can also cause erratic surging, freezing, and pressure release that can damage the diaphragm and control valves. Cold conditions in a gas pipe line (cold to the touch; dripping of water condensed from the atmosphere; frost; ice) are an indication that liquid ammonia is present in the line and is flashing to gas. Refer to the proper guidelines that follow.

It is important to observe the correct temperature conditions in conducting ammonia gas under pressure from the location of the cylinders to the point of use. To avoid difficulty with reliquefaction of ammonia, pressure piping and control equipment receiving gas under pressure should be at a higher temperature than that of the ammonia cylinders. In general, a difference of 5° to 10°F is recommended.

Pitch pressure lines uphill from the gas source toward the ammoniators if possible.

Install a pressure reducing valve or the ammoniator vacuum regulator close to, but higher than, the source of gas. The use of an ammonia pressure reducing valve is also recommended in those localities where severe temperature changes are likely to be encountered during a 24-hour period.

It is preferable to run ammonia pressure gas lines overhead through relatively warm areas rather than along the floor or through basement areas where lower temperatures may be encountered. Do not run these gas lines along exterior walls, which may be cold in winter months. Do not run pressure gas lines under windows from which cold air descends in winter months.

The installation of ammonia gas strainers in pipe lines upstream from pressure reducing valves or vacuum regulators is a common practice. These strainers can also serve as a trap for a small amount of liquid ammonia. Figure 5 illustrates a typical strainer.

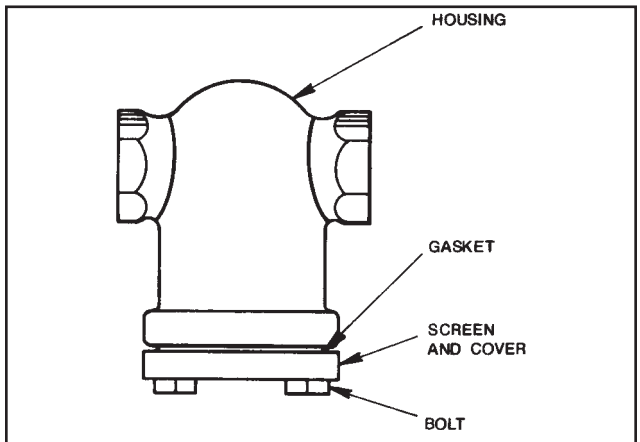


Figure 5 - Gas Strainer

4.3 LIQUID PIPING INSTALLATION REQUIREMENTS

It is important to avoid conditions that will encourage vaporization. Thus it is important to keep liquid ammonia lines as cool as, or cooler than the cylinders by eliminating restrictive fittings and always operating with fully opened line valves. Avoid running liquid ammonia lines through overheated areas where gasification is likely.

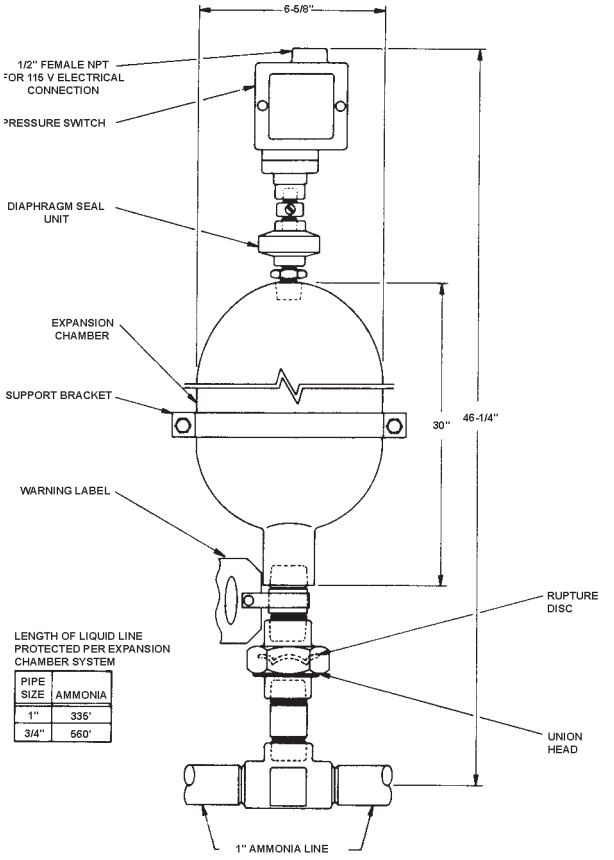
Valves in liquid ammonia lines should be kept to a minimum. It is particularly important to avoid situations where it is easy to close two valves in a line thus trapping liquid that, upon an increase in temperature, will expand and develop higher than acceptable pressures.

A liquid line pressure relief system (which includes a rupture disc and an expansion chamber) is required where liquid may be trapped in the line or where it is necessary to run lines a considerable distance. The relief system is detailed in Figure 6. The expansion chamber provides an area for expansion in the event that valves at both ends of the line are closed.

Relief system placement must be based not only on length of line but also placement of valves.

4.4 PRESSURE RELIEF AND VENT PIPING REQUIREMENTS

All pressure relief vent line systems must be treated as though they contain ammonia. Use the same materials for pressure relief vent lines as used for ammonia gas piping unless the vent line is a combination pressure relief/vacuum relief line in which case the material must be suitable for moist ammonia gas (PVC or polyethylene tubing).



NOTE: All piping to be seamless carbon stell sched. 80 and fittings to be forged steel. Expansion chamber meets ASME Sec.VIII, Div. 1 code for unfired pressure vessels.

Figure 6 - Liquid Line Pressure Relief System

Vent lines must be run in such a way that moisture collecting traps are avoided. A continuous up gradient is preferred. The end of all vent lines must be turned up with a rain cap and screened.

Manifolding of vent lines is an acceptable practice provided only like vents are manifolded (i.e., evaporator water vapor vents must be separate from gas pressure reducing valve pressure vents, etc.). The interior cross sectioned area of a common vent or pressure relief line should be approximately equal to the sum of the cross sectional areas of the individual vent lines.

WARNING: THE VENT LINE AND RELIEF LINE MUST TERMINATE IN AN AREA WHERE GAS FUMES CANNOT CAUSE INJURY TO PERSONNEL OR DAMAGE. DO NOT TERMINATE THE VENT LINE AND RELIEF LINE AT A LOCATION ROUTINELY USED BY PERSONNEL SUCH AS WORK AREA OR PATHWAYS NOR NEAR ANY WINDOWS OR VENTILATION SYSTEM INTAKES.

4.5 VALVES

Auxiliary cylinder and header valves are described adequately in the ammoniator or vacuum regulator instruction book.

Line valves are used to isolate alternate sources of supply (manifolded banks of cylinders or tank cars), individual evaporators or pressure type ammoniators. Sufficient line valves should be provided for flexibility of system operation consistent with the recommended practice of eliminating redundant or unnecessary valves.

Valves are usually of approximately globe pattern as shown in Figure 7 or ball type as shown in Figure 8.

Care should be taken that only valves designed by the manufacturer for ammonia service are used. Ball valves must include a provision for venting the cavity in the closed position to the upstream side.

4.6 PRESSURE GAUGES AND SWITCHES

Whenever pressure gauges and switches are used in ammonia liquid or gas lines they must be of the type protected by a flanged diaphragm seal specifically designed for ammonia service to prevent the entry of ammonia into the gauge or switch mechanism. The fill material must be suitable for ammonia service. The connection between the seal and the gauge or switch must not be broken. if the connection

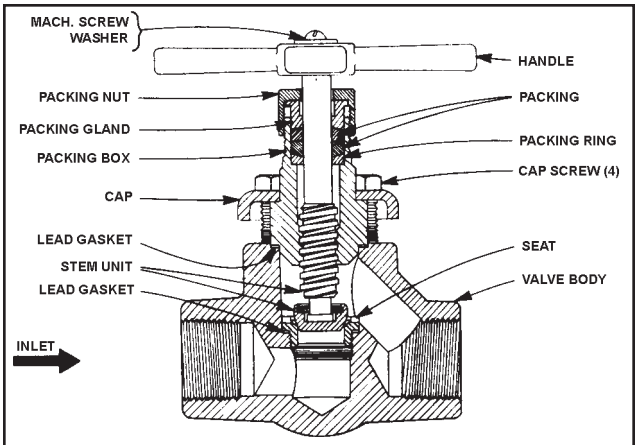


Figure 7 - 3/4- and 1-inch Line Valves

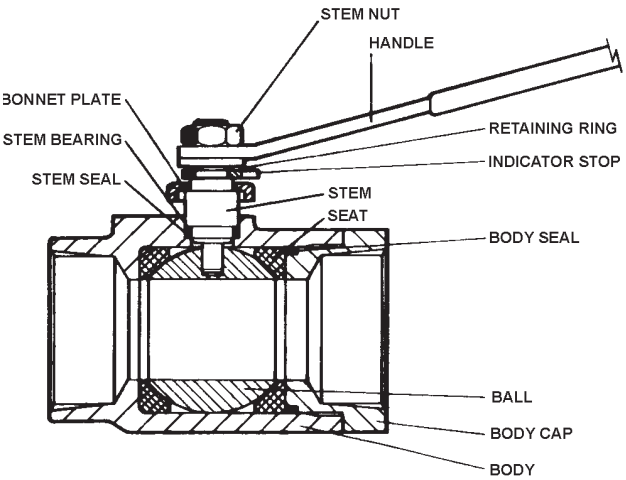


Figure 8 - Gas and Liquid Ball Valve

is inadvertently broken the complete assembly must be discarded and replaced unless it can be returned to the manufacturer for repair.

Frequently valves are installed between ammonia lines and the gauge or switch diaphragm seal to permit removal without taking the line out of service. A means of relieving the pressure in the isolated piping, gauge or switch is strongly recommended.

WARNING: WHEN PROTECTIVE EQUIPMENT IS USED, THE SMALL AMOUNT OF AMMONIA GAS RELEASED WHEN RELIEVING PRESSURE IN ISOLATED AMMONIA GAS PIPING IS USUALLY INCONSEQUENTIAL; HOWEVER, RELEASING EVEN A SMALL AMOUNT OF LIQUID AMMONIA REQUIRES EXTREME CAUTION TO AVOID SEVERE PERSONAL INJURY.

4.7 PRESSURE RELIEF DEVICES

There are two types of pressure relief devices in use in ammonia piping systems. The first, as shown in Figure 6, is usually employed in liquid ammonia piping to protect the piping from rupture due to high pressure from thermal expansion of the liquid ammonia. It consists of a rupture disc that ruptures before the pipe line itself can rupture, an expansion chamber that allows for relief of the overpressure condition without releasing ammonia to the atmosphere, and a pressure switch to warn of disc failure.

The second type, as shown in Figure 9, is usually used in gas piping at the evaporator discharge. This system consists of a rupture disc, which keeps ammonia out of the valve during normal operation, a pressure relief valve, and a pressure switch to warn of disc rupture.

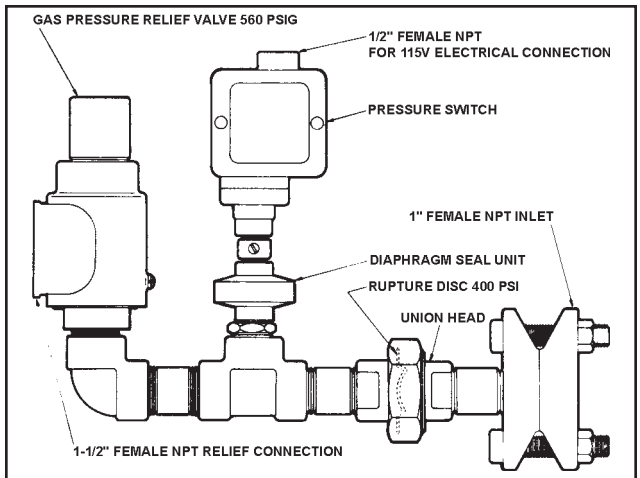


Figure 9 - Evaporator Pressure Relief System

WARNING: THE RELIEF LINE MUST TERMINATE IN AN AREA WHERE GAS FUMES CANNOT CAUSE DAMAGE OR INJURY TO PERSONNEL. DO NOT TERMINATE THE RELIEF LINE AT A LOCATION ROUTINELY USED BY PERSONNEL SUCH AS WORK AREAS OR PATHWAYS NOR NEAR WINDOWS OR VENTILATION SYSTEM INTAKES.

4.8 PREPARATION FOR USE

Normal plumbing practices will result in the entry of cutting oils, greases and other foreign materials into the piping. In addition the line will have been open to the atmosphere during construction allowing moisture to enter. it is therefore essential that all piping be thoroughly cleaned and dried prior to the exposure to ammonia. Incomplete cleaning can result in violent reactions between ammonia and these materials.

Steam cleaning is an acceptable method for removal of the above materials. Provision must be made for removal of condensate and foreign materials.

After proper cleaning, all ammonia piping should be hydrostatically tested to one and one-half times the expected maximum operating pressure. Prior to testing, all gauges, switches, rupture discs, etc. that could be damaged during testing must be removed and connections plugged. Any moisture absorbing packing or gaskets left in the system during hydrostatic testing must be replaced. After hydrostatic testing all piping must be thoroughly dried with inert gas (e.g. nitrogen) or dry air having a dew point of -40°F or below. The dew point of the air or gas leaving the piping must be checked and drying continued until the dew point is at or below -40°F, which may require some time.

A very acceptable alternate to hydrostatic testing, if proper facilities do not exist for drying, is to test with nitrogen or dry air having a dew point of -40°F or below. The same provision of removing equipment that could be damaged by test pressure applies.

WARNING: TO AVOID SEVERE PERSONAL INJURY, BEFORE PLACING THE PIPING SYSTEM INTO SERVICE PRESSURE TEST WITH AMMONIA GAS NOT LIQUID.

The ammonia container valve should only be opened slightly during this phase of testing or preferably closed again after pressurizing the system. The piping should be tested in the smallest sections permitted by the existing valves to minimize the discharge of ammonia through any leaks.

Ammonia leaks are best located using moist phenolphthalein or red litmus paper, which changes color in ammonia vapor.

When a leak is detected the system must be depressurized before corrective action is taken. The best method of depressurizing the system is through one of the ammoniators. At least one ammoniator must be readily available for this purpose before testing with ammonia begins.

WARNING: IT IS ESSENTIAL THAT PROPER BREATHING APPARATUS BE AVAIIABLE BEFORE AMMONIA IS ADMITTED TO ANY PIPING SYSTEM OR EQUIPMENT. THIS APPARATUS WILL BE DISCUSSED FURTHER UNDER "PERSONNEL SAFETY".

5 PERSONNEL SAFETY

5.1 GENERAL

Proper consideration of personnel safety begins with the provision of properly sized and arranged housing so that operating personnel have adequate room to perform their duties. It is preferable that any room used for ammonia storage or equipment have two doors which open outward and which are equipped with panic bars.

Rooms housing ammoniation equipment, and ammonia cylinders that are "in service" or "in reserve", should be heated when the room temperature falls below 50°F. Comfortable working temperatures of 65° to 75°F are recommended for the ammonia equipment room. The temperature of the ammonia cylinder room (if separate) should normally be 5° to 10°F lower. All common methods of heating are acceptable, provided that care is taken to prevent overheating of ammonia cylinders. Radiators should not be located adjacent to cylinders. If space heaters are used, the warm air should be deflected away from the cylinders. Outside windows should be located or screened so that the rays of the sun do not fall directly on ammonia cylinders.

Natural ventilation may be adequate for a small ammoniator installation in a separate building where windows and doors provide cross circulation. However, ventilation by means of a proper type electric fan is always recommended.

In all cases, installation must comply with appropriate regulations.

5.2 HEALTH HAZARDS

Exposure to a sufficiently high concentration of ammonia can result in difficulty in breathing and if prolonged, finally death through suffocation. Ammonia's strong pungent odor may result in detection at levels as low as 5 ppm and most people will detect it by the time the concentration reaches 20 ppm. Concentrations of 20 to 50 ppm or more are so objectionable that only those who are unconscious or trapped will normally remain in the area. Increasing concentrations will produce eye irritation, coughing, throat irritation, and labored breathing.

Even concentrations below the threshold of smell can result in minor eye and throat irritation if the exposure is long enough. Liquid ammonia can cause burns and/or irritation when it is in contact with the skin or eyes.

Medical attention should be obtained as quickly as possible for personnel who had sufficient exposure to result in any symptoms beyond minor irritation. Properly trained and

equipped first aid personnel are usually the first line of defense. While waiting for their arrival the exposed individual must be removed to a safe area and be placed in a comfortable position. If breathing has stopped artificial respiration must be started immediately. CPR administrated by properly trained personnel is required if the heart has stopped.

If the exposed individual has difficulty breathing, oxygen should be administered only by those adequately trained in the procedure and the equipment used.

The proper procedure for emergency treatment of clothing or skin contaminated by ammonia is to flush the area with large quantities of water under a shower for at least 15 minutes. While still under the shower affected clothing should be removed. No medical treatment or neutralization of the ammonia should be attempted except as directed by a physician.

Immediate flushing with tepid water should be administered if even small quantities of ammonia enter the eye or if the eye has been exposed to strong concentrations of ammonia. The eyelids must be parted and thorough flushing continued for at least 15 minutes. As mentioned previously for skin exposure no medical treatment or neutralization should be attempted except as directed by a physician.

The attending physician may wish to refer to a Material Safety Data Sheet on ammonia.

5.3 SAFETY PRECAUTIONS

The first steps to be taken in providing proper safety precautions at any facility are the selection of safety equipment to be on hand, the proper location of the equipment and the training of all personnel in proper procedures to avoid unnecessary ammonia releases and to deal with releases that occur.

Proper respiratory equipment is essential for all facilities regardless of size. In most cases the accidental releases of ammonia will be small. There will also be minor releases of ammonia when ammonia containers of any size are connected to or disconnected from the system piping. However, for maximum safety it is preferable to use air tank type pressure demand masks that have a self-contained air supply, and therefore, are suitable regardless of ammonia concentration.

All respiratory equipment must meet the requirements of the National Institute for Occupational Safety and Health. Following the respiratory equipment manufacturer's recommendation regarding maintenance and periodic testing is essential. This equipment should be stored outside the area containing ammonia or ammonia equipment in a manner protecting it from damage of any kind and to be readily available.

WARNING: DO NOT LOCK CABINETS OR CLOSETS IN WHICH RESPIRATORY EQUIPMENT IS STORED, AS THE EQUIPMENT MUST BE READILY AVAILABLE.

All personnel with no assigned responsibility for dealing with an ammonia release should be instructed to leave the area. Those responsible for correcting the situation should don respiratory equipment before doing so.

Protective clothing is recommended for handling even routine operations involving ammonia. In the event of a substantial release, protective clothing is required. Anyone desiring further information on protective clothing should contact reputable manufacturers or suppliers of such equipment.

Safety shoes, hard hats and safety glasses should be used in accordance with standard plant practice.

Most leaks will occur in piping, valves, connections and the pressurized portions of ammonia equipment. These leaks will usually be eliminated by tightening packing, replacing gaskets, or repairing the equipment.

WARNING: REPLACE FLEXIBLE CONNECTIONS ANNUALLY, OR SOONER IF THERE IS EVIDENCE OF DETERIORATION.

The ammonia supplier should be contacted immediately for information, assistance and advice on the disposition of the leaking cylinder. The cylinder should always be repositioned, if possible, so the leak is gas rather than liquid.

5.4 EMERGENCY ACTION PLANS

The best emergency plan includes routine practices that are designed to minimize emergencies. Proper maintenance of all equipment associated with the storage, handling and use of ammonia in accordance with the manufacturer's instructions is essential.

All equipment and piping containing ammonia under pressure must be tested periodically for leaks following procedures covered in Paragraph 4.8. Since it is not unusual for areas used for ammonia storage and ammonia equipment to be relatively unattended it is important f or the air in these areas to be monitored continuously with ammonia detectors so that warning of leaks is given as early as possible. As with most emergencies the earliest detection helps to minimize the damage to equipment and personnel. In addition to warning of leaks when the areas are unattended, ammonia

detectors will warn of the presence of minor amounts of ammonia that may not be detected by personnel in the area.

The most common leaks are relatively minor and require no action other than locating the leak and correcting it.

In the event of a major release of ammonia, there should be no delay in contacting the agency in the community that is responsible for handling hazardous material releases. Appropriate names and telephone numbers must be prominently posted.

The ammonia supplier is probably the best source of assistance for most ammonia users. If the release is equal to or exceeds the limit indicated in the Code of Federal Regulations 49 CFR Part 172 (100 pounds) the release must be reported to the National Response Center (toll free 800-424-8802). This name and number must also be posted prominently. Additional information can be found in U.S. Department of Transportation DOT P5800.3 Emergency Response Guidebook available from Superintendent of Documents, U.S. Printing office, Washington, D.C. 20402.

The person responsible for making any of the calls listed above must be sure to give the agency contacted complete details including facility name, address, telephone number and the name(s) of personnel to contact for further information. The description of the emergency should include size of cylinder, corrective action already taken, local weather conditions, injuries, proximity to populated areas and directions for easiest access to the site.

It is vital that the emergency plan include use of the “buddy system”, i.e., no personnel should be allowed to work alone in an area with an ammonia leak even if the second person is only standing by. As indicated earlier, all personnel not involved in locating and correcting the leak should leave the area, traveling in a crosswind direction to an area that is upwind. Since it may not be possible for all personnel to be equipped with respiratory equipment they should be instructed to use a wet cloth or handkerchief over the nose and mouth while leaving the area.

A Material Safety Data Sheet for Ammonia available from the producer or the supplier should also be consulted.

No emergency plan should be implemented until it is reviewed by the ammonia supplier and the agency in the community having responsibility for hazardous material handling and disposal.

If it is apparent that fire will threaten or is present in an ammonia storage area it is preferable to remove the cylinders. If this is not possible the cylinders must be protected from the heat of the f ire by spraying them with water.

Do not spray water on a leaking cylinder. The possibility exists that the water is warmer than the cylinder and the liquid ammonia, which would heat the ammonia and increase the rate of discharge.

Water in sufficient quantity (100 parts of water per part of ammonia) can be applied to an area containing ammonia vapor using spray or fog nozzles in an attempt to dissolve the ammonia in the water.

5.5 CHEMICAL DISPOSAL FACILITIES

Part of the planning for emergencies entails provision for disposal of any released ammonia. In most cases little can be done about the ammonia already released to the atmosphere except to try to prevent its dissipation into areas where damage to equipment and personnel will result.

At some large installations scrubbers have been installed so that areas containing ammonia or ammonia equipment can be sealed off and the air removed to a process that will absorb the ammonia.

The design of such a system is complex and should only be attempted by those thoroughly familiar with the process.

Absorption systems have been provided at some facilities to permit a leaking cylinder to be emptied quickly if this is deemed essential. One pound of ammonia can be absorbed by 10 pounds of water.

The tank and other equipment provided for an absorption system must be fabricated of materials suitable for the chemicals involved.

Provision must be made for dissolving the ammonia in the water in such a way that the solution cannot be sucked back into the container.

Actually the safest way of disposing of the ammonia in the leaking cylinder might be through the ammoniation process particularly if the process can absorb the ammonia at higher than normal rates without creating damage.

It is not generally permissible to ship a cylinder damaged by leak or fire if it contains ammonia. If for some reason this seems necessary the ammonia supplier must be contacted.