These instructions describe the installation, operation and maintenance of the subject equipment. Failure to strictly follow these instructions can lead to an equipment rupture that may cause significant property damage, severe personal injury and even death. If you do not understand these instructions, please call De Nora Water Technologies for clarification before commencing any work at 215-997-4000 and ask for a Field Service Manager. De Nora Water Technologies, Inc. reserves the rights to make engineering refinements that may not be described herein. It is the responsibility of the installer to contact De Nora Water Technologies, Inc. for information that cannot be answered specifically by these instructions.

Any customer request to alter or reduce the design safeguards incorporated into De Nora Water Technologies equipment is conditioned on the customer absolving De Nora Water Technologies from any consequences of such a decision.

De Nora Water Technologies has developed the recommended installation, operating and maintenance procedures with careful attention to safety. In addition to instruction/operating manuals, all instructions given on labels or attached tags should be followed. Regardless of these efforts, it is not possible to eliminate all hazards from the equipment or foresee every possible hazard that may occur. It is the responsibility of the installer to ensure that the recommended installation instructions are followed. It is the responsibility of the user to ensure that the recommended operating and maintenance instructions are followed. De Nora Water Technologies, Inc. cannot be responsible deviations from the recommended instructions that may result in a hazardous or unsafe condition.

De Nora Water Technologies, Inc. cannot be responsible for the overall system design of which our equipment may be an integral part of or any unauthorized modifications to the equipment made by any party other that De Nora Water Technologies, Inc.

De Nora Water Technologies, Inc. takes all reasonable precautions in packaging the equipment to prevent shipping damage. Carefully inspect each item and report damages immediately to the shipping agent involved for equipment shipped “F.O.B. Colmar” or to De Nora Water Technologies for equipment shipped “F.O.B Jobsite”. Do not install damaged equipment.

De Nora Water Technologies, COLMAR OPERATIONS
COLMAR, PENNSYLVANIA, USA
IS ISO 9001: 2008 CERTIFIED
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1 INTRODUCTION

1.1 General

Process chemicals like chlorine or sulfur dioxide, are available as a liquid, but are normally fed as a gas, and may be fed directly from their storage container (cylinder or ton container) provided each liquid's vaporizing requirements do not exceed the container's maximum vaporization rate. When large quantities of gaseous chemical are required, a liquid chemical vaporizer may be used. The vaporizer does not increase or decrease the pressure of the chemical being vaporized, but changes its state from liquid to gas.

NOTE: The following documents are referenced within this instruction manual:

115.3002 - Vaporizer Piping Connections
115.3003 - Typical manifold Piping for Vaporizers
115.3004 - Vaporizer Pressure Relief Piping With Rupture Disc
115-3005 - Expansion Chamber Assembly
115-3006 Vaporizer Components
115.3020 - Vaporizer Control Circuit Wiring Diagram, 120 Vac
115.3021 - Vaporizer Control Circuit Wiring Diagram, 240 Vac
115.3024 - Vaporizer Heater Circuit, 208, 240 & 575 Vac, 3 phase
115.3025 - Vaporizer Heater Circuit, 380 & 480 Vac, 3 phase
115.6010 - Gas Pressure Reducing Valve, ADVANCE Series 861 Instruction Manual
115.6020 - Gas Pressure Relief Valve and Rupture Disc Instruction Manual

1.2 Component Description

Series VAX4600 Vaporizer utilizes an electrically heated water bath to add the necessary heat to the liquid chemical for vaporization. The unit consists of a hot water tank, a chemical vaporizing chamber, a NEMA 4X heater control circuit, a NEMA 4X water level control circuit, chemical and hot water monitoring instruments, cathodic protection circuit, and ABS structural foam enclosure.

NOTE: The standard vaporizer is not recommended for outside, unprotected installations.

1.2.1 Water Tank

The water tank is constructed of corrosion-resistant welded stainless steel. It houses six electric water heaters and all water condition sensing and control devices (e.g. water level, water temperature) in a standard NEMA 4X design.

1.2.2 Chemical Vaporizing Chamber

The chamber is constructed of 6" Schedule 80 steel pipe. Its all-welded construction conforms to ASME codes for unfired pressure vessels. Externally mounted fins are utilized to aid in the efficient transfer of heat from the water bath to the liquid chemical. Internally mounted baffles aid in superheating of the chemical vapors and dropping out entrained liquid droplets as they rise from the liquid level to the vaporizer discharge. See Figure 1.

The vaporizing chamber also houses the chemical monitoring sensors for temperature and pressure.

NOTE: Superheat is the increase in the gas temperature above the boiling point at a given pressure (minimum 10°F [5.5°C] above boiling point), and is required to prevent the gas from reliquefying as it flows in the system. See Figure 2 for boiling points. Heat tracing and/or insulation of gas pressure piping is recommended to maintain superheat. Loss of superheat may cause reliquefaction and subsequent damage to the gas feeder.
Figure 1 - Vaporizer Flow Diagram

Figure 2 - Chemical Boiling Points at System Pressure
1.2.3 Control Circuits (Refer to Bulletins 115.3024 and 115.3025)

a. Heater Control

The heater circuit is supplied wired to accommodate one of the following source voltages 240, 480, or 575 Vac, 50/60 Hz, 3 phase (other voltages or single phase are supplied optionally). The heaters are controlled by a tank mounted electrically operated, field-adjustable thermostat which controls the heater magnetic contactor (relay) to regulate water bath temperature. The magnetic contactor and safety switch are wall mounted, but optionally may be installed on the rear of the water tank.

b. Water Level Control (Refer to Bulletins 115.3020 or 115.3021)

The water level control circuit consists of a low water level cutoff switch, a low water level alarm switch, and a water level control switch. The low water level cutoff switch is wired in series with the heater control circuit to prevent actuation of heaters when there is a low or no water condition.

The water level control switch is field wired to a solenoid valve in the water supply line providing automatic water level control. The low water level alarm switch may be field wired to a light or horn to warn of a low water level condition.

1.2.4 Monitoring Instruments

All monitoring instruments are panel mounted on the front of the vaporizer (see front cover). They consist of the chemical pressure and temperature gauges (used to determine gas superheat utilizing Figure 2), the water level sight glass, the water temperature gauge, and the cathodic protection ammeter with adjustment potentiometer.

1.2.5 Cathodic Protection (See Figure 3)

This circuit is designed to prevent electrolytic degradation of the water tank and vaporization chamber. It utilizes two sacrificial magnesium anodes, a milliammeter to indicate current flow and a potentiometer to adjust the electrolytic current. The anodes will dissolve to provide an electrolytically stable water tank. A zero or low current reading on the ammeter at all potentiometer settings indicates a need to replace the anodes.

![Cathodic Protection Wiring](image-url)
1.2.6 Corrosion Resistant Enclosure (See Figure 4)

The enclosure consists of six pieces: a bottom and a top, two sides and a front and back bezel. The bezels are pressure-formed ABS and the sides, top and bottom are structural foam plastic. Easy removal of the front bezel exposes all control and monitoring components. The back bezel is provided for safe covering of all control components and magnetic contactor. The enclosure is easily cleaned with any household cleaner and a damp cloth.

1.3 Specifications

1.3.1 Electrical Requirements:

Voltage: 240, 380, 480, 575 Vac, 50/60 Hz, 1 or 3 phase

Power Consumption: Heater wattage is based on the maximum vaporization requirements of the unit. See Table I.

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Chlorine</th>
<th>Sulfur Dioxide</th>
<th>Total Heater Wattage</th>
</tr>
</thead>
<tbody>
<tr>
<td>4000 PPD (75 kg/h)</td>
<td>3000 PPD (60 kg/h)</td>
<td>9 kW</td>
<td></td>
</tr>
<tr>
<td>6000 PPD (120 kg/h)</td>
<td>4500 PPD (85 kg/h)</td>
<td>12 kW</td>
<td></td>
</tr>
<tr>
<td>8000 PPD (150 kg/h)</td>
<td>6000 (1150 kg/h)</td>
<td>15 kW</td>
<td></td>
</tr>
<tr>
<td>10,000 PPD (200 kg/h)</td>
<td>7500 (140 kg/h)</td>
<td>18 kW</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1. All internal heater wiring is sized per NEC requirements.
2. Each chemical has different rates of vaporization, resulting in the capacities listed in Table I.
3. Control Circuit Voltage-120 Vac, 60 Hz or 240 Vac, 50 Hz
4. Control Circuit Power Consumption - The vaporizer is supplied with dry contacts as standard. Field attached indicators (horns, lights, etc.) vary in power consumption, therefore, refer to the manufacturer’s specifications for specific wattage usage.

NOTE: See note on 115.3020 and 115.3021 regarding current ratings of contacts when used to directly power indicators. A 10 amp fuse is recommended to protect this circuit.

1.3.2 Mechanical Requirements:

Chamber - The gas vaporization chamber is manufactured from 6" ASTM SA-53-B seamless carbon steel pipe. All welds are in accordance with ASME boiler and pressured vessel codes, Section VIII, Division I. Both inlet and outlet connections are 1" NPTF.

Tank - The water tank is constructed of stainless steel and holds a minimum of 37 gallons (140 liters) of water. PVC foam 1/2" (13 mm) thick surrounds all exterior surfaces to insulate from excessive heat loss.

Pressure Reducing Valve - See Bulletins 115.6010 and 115.3011

Pressure Relief Valve - The relief valve is designed to relieve at 250 psig (1700 kPa/17 bar). It is mounted downstream of a rupture disc assembly which is designed to rupture at 250 psig (1700 kPa/17 bar). An optional pressure switch or gauge may be installed between the relief valve and rupture disc to indicate a ruptured disc condition. (See Bulletin 115.6020)

Liquid Expansion Chamber - The expansion chamber is designed to permit a gaseous “air” pad in the liquid line to prevent excessive over pressure in the liquid line. It is mounted downstream of a rupture disc assembly designed to rupture at 400 psig (2760 kPa/27 bar). An optional pressure switch or gauge may be installed between the rupture disc and expansion chamber to indicate a ruptured condition (Figure 14). The chamber conforms to D.O.T. Spec. 3AA1800. See Bulletin 115.3005.
Figure 4 - Cabinet Dimensions & Utility Connection Locations
1.3.3  **Operating Pressure**

Vaporizer:
- Minimum: 45 psi
- Normal: 100 psi
- Maximum allowable working pressure: 666 psi @ 212°F (however, rupture disk will rupture at 275 psi)

The vaporizer chamber is stamped with a U and W-L stamp which means it is arc or gas welded and for lethal service.

1.3.4  **EMC Testing**

The vaporizer has been evaluated for RF interference over a frequency range of 80-1000 MHz and showed overall acceptable immunity. However, it may show a low level of susceptibility to radio frequency emissions as listed below. Additionally, no interference will be seen unless the intensity of field strength at these frequencies exceeds 2.3 volts/meter.

<table>
<thead>
<tr>
<th>Frequencies (MHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>180-200</td>
</tr>
<tr>
<td>207-210</td>
</tr>
<tr>
<td>367-380</td>
</tr>
<tr>
<td>380-405</td>
</tr>
<tr>
<td>420-465</td>
</tr>
<tr>
<td>563-570</td>
</tr>
<tr>
<td>684-701</td>
</tr>
<tr>
<td>738-746</td>
</tr>
</tbody>
</table>

Interference of any duration will not effect the vaporizer’s performance unsafely at any frequency. Intermittent operation under conditions of RF interference will not effect the instrument’s operation irreversibly. Prolonged operation under conditions of RF interference, though not unsafe, may damage some instrument components and is not recommended.

1.4  **Principle of Operation**

Liquid is transferred from its source (cylinder, ton container, rail car) to the vaporizer chamber by source pressure. The chamber is immersed in a temperature controlled heated water bath, which increases the temperature of the chemical causing it to vaporize. Liquid chemical enters the chamber and automatically maintains the required level as necessary to meet the vaporization rate for the gas demand. A change in demand will automatically cause the liquid level to adjust. As the gas vaporizes and rises, it is deflected around internal baffles and is superheated as it leaves the chamber. Superheat is a function of the system pressure and temperature, refer to Figure 2 to calculate actual superheat. After the gas leaves the vaporization chamber, it proceeds to the pressure reducing valve, which decreases and regulates the downstream pressure to approximately 40 psig (270 kPa/ 2.7 bar). The regulated gas then enters the dispensing system and continues on to the point of application.
2 INSTALLATION

2.1 Location
The vaporizer should be located as close to the liquid chemical source as possible. The length of chemical liquid and gas lines should be kept to a minimum. A vaporizing room should have provisions to exhaust any leaking gas. A lifting device above the vaporizer is also required. See Figure 5 for dimension requirements.

2.2 Mounting
Install the vaporizer on a mounting pad of concrete or other suitable material approximately 2" (50 mm) high. Secure using 3/8" diameter bolts. See Figure 4 for mounting hole dimensions.

NOTE: It is recommended that the vaporizer cabinet enclosure be removed from the water tank before moving the unit from the shipping skid to the mounting pad. This will prevent any damage to the cabinet. On completion of the vaporizer installation, the enclosure can be reinstalled.

Figure 5 - Cabinet Dimensions and Utility Locations
Figure 6 - Vaporizer Piping Connections
2.3 Piping (See Figures 6 and 7 and Bulletins 115.3002 and 115.3003)

NOTES: All chemical carrying pipes and fittings must be Schedule 80 seamless steel or forged steel conforming to ASTM A-105 and A-106, Grade B.

All piping, valves and fittings must be thoroughly cleaned of all oils and foreign matter prior to assembly in accordance with Chlorine Institute Pamphlet #6. Failure to do so may result in a combustible reaction. Steam is the best method of cleaning, but chlorinated solvents are also acceptable if used in conjunction with the manufacturer's safety recommendations.

Prior to assembly, threads on all chemical carrying pipes and fittings should be wrapped with Teflon tape. Alternately, a mixture of litharge and glycerin may be used on threads. However, if used, the pipe cannot be taken apart once set.

Connect the chemical gas, liquid lines, and water lines as shown in Figure 6. Plumbing must be in accordance with local codes. When installing the nipples, tees and 1" ammonia unions into the inlet and outlet ports of the chemical vaporizing chamber, be sure the unions are positioned beyond the vaporizer top plate to permit removal of the vaporizer chamber. Make sure the correct fittings on the chamber flange are used for the inlet and outlet piping or improper operation will result (See Figure 4). The flange is marked accordingly.

2.3.1 Gas Line Connections

a. Install the pressure relief valve as shown in Bulletin 115.6020 and Figure 6. The relief valve must be installed without a shutoff valve between it and the vaporizer gas outlet. Install a manual valve in parallel with the pressure relief valve. This valve will normally be in the closed position. It may be opened as a MANUAL vent valve ONLY. Route a 1" vent pipe from the pressure relief valve to a point outdoors where gas discharge can be tolerated. Position the end of the pipe downward so it will not collect foreign matter or water.

Figure 7 - Typical Manifold Piping
b. Install the pressure reducing valve as shown in Bulletins 115.6010, 115.3002 and Figure 6.

**NOTE:** The pressure reducing valve must be located as close as possible to the gas discharge of the vaporizer.

The outlet of the reducing valve should be routed to the process equipment. A 1/4" vent pipe (Schedule 80 seamless steel or forged steel conforming to ASTM A-105 and A-106, Grade B) should terminate outdoors in an area that can tolerate gas discharge. DO NOT MANIFOLD VENT LINES. Position piping so it will not collect foreign matter or water. A screen over the discharge of the vent line is recommended to prevent clogging.

c. An optional pressure switch set to actuate at 200 psig (1380 kPa/13.8 bar) may be installed in the gas line between the vaporizer discharge and the pressure relief valve assembly. This will act as an early warning of an over pressure condition to prevent relief valve venting. See Figure 6.

### 2.3.2 Liquid Line Connections

a. Install a 1" liquid inlet shutoff valve just prior to the vaporizer inlet ammonia union. An expansion chamber with rupture disc must be installed upstream of the shutoff valve. (See Figure 6) Additional expansion chambers must be installed in any lengths of liquid piping if they are between shutoff valves. All expansion chambers should have a capacity of at least 20% of the line volume which they protect and should be mounted at the highest point of the liquid line. Refer to Bulletin 115.6020 for optional configurations.

b. Route 1" pipe from the liquid inlet shutoff valve to the chemical source. (See Figure 7)

c. Install a flexible connector on the 1" pipe. Attach an isolating valve on the free end of the flexible connector and connect to the liquid valve of the chemical container.

### 2.3.3 Water Line Connections (See Figure 6)

a. Install 1" overflow piping to the outlet provided on the top of the hot water tank. Route to drain. In order to fit the tank cover on the vaporizer, the overflow pipe must be run straight down the back of the water bath and exit at the top of the bottom opening on the back cover.

b. Connect 1" unrestricted vent pipe from the tee.

c. Connect 1/2" drain and fill pipe to the outlet provided at the base of the water tank header box. Install a 1/2" gate valve in the drain line.

d. Install a 1/2" gate valve in line for manual filling. For automatic filling, a 1/2" solenoid valve is supplied. Keep the manual valve closed at this time.

e. A 10 psig (70 kPa/0.7 bar) minimum potable water inlet must be provided to the filling valve.

f. Install a 4 gpm (15 l/m) flow control valve (noting the direction of flow) in the water fill piping.

### 2.4 Wiring

**CAUTION:** Keep electrical power OFF while working on electrical equipment. Do not apply electrical power directly to the heater circuit without water in the tank as damage will result.

Wire all components per Bulletins 115.3020 or 115.3021. Be sure any connected alarm devices do not exceed maximum power limitations.

**NOTE:** All wiring must be in accordance with local codes and regulations. Refer to the NATIONAL ELECTRICAL CODE (NFPA-70, ARTICLE 500) for special wiring requirements when feeding ammonia. Refer to Figure 8 for specific locations of terminals and water and heater control components.
2.4.1 Heater Circuit
   a. The magnetic contactor, if not cabinet mounted, must be installed on a suitable wall or electric panel and wired to the heater terminal strip (A-B-C). Refer to the manufacturer’s instruction manual. A contactor mounted on the vaporizer tank is pre-wired.

   b. Wire the magnetic contactor to a fused safety switch, unless factory installed, and then to the power source.

2.4.2 Control Circuits
   WARNING: Temperature controls are voltage sensitive. Applying improper voltage will destroy the switch.

   a. Wire the control circuit L1 and L2 to a fused safety switch and then to the power source.

   b. Wire the electric actuator on the pressure reducing valve or pilot solenoid valve (pneumatic models only) to the vaporizer terminal strip. See Bulletins 115.3020 or 115.3021.

   c. Connect the magnetic contactor coil to the control circuit terminal block.

   d. Wire the water fill solenoid valve to the control circuit terminal block. Do not apply power.

2.4.3 Alarm Switches
   a. The low water temperature alarm switch can be connected to an outside alarm system. If the water bath temperature is below a preset limit, the pressure reducing valve will close and the alarm switch will actuate.

   b. The high temperature alarm switch can be connected to an outside alarm system. If the water bath temperature exceeds a preset limit, power will be cut to the heaters and the alarm switch will actuate.

   c. The low water level alarm switch can be connected to an outside alarm system. If the water bath level drops below the set point, power will be cut to the heaters and the alarm switch will actuate.
3 OPERATION

3.1 General
This section covers the operating practices of the Series VAX4600 Vaporizer System, consisting of one vaporizer, one pressure relief valve, one (optional) pressure reducing valve and one or more liquid line expansion chambers.

3.2 Pre-startup Components

3.2.1 Vaporizer
Apply power to the vaporizer control circuit to energize the automatic water level control and actuate the water fill solenoid valve. Open the manual water shutoff valve allowing the water bath tank to fill.

3.2.2 Gas Pressure Relief Valve and Rupture Disc Assembly
The relief valve is calibrated at the factory to open at 250 psig (1700 kPa/17 bar). No additional adjustment is required. Be sure the manual bypass valve is closed before introducing chemical into the system. See Bulletins 115.6020 and 115.3004.

3.2.3 Pressure Reducing Valve (Electric and Pneumatic)
See Bulletin 115.6010. Check for operation by actuating the low water temperature alarm switch (reduce water bath temperature) and observing the valve operation (PRV is opened above the low water temperature alarm set point and closed below the set point).

3.2.4 Liquid Expansion Chamber Rupture Disc Assembly
See Bulletin 115.3005

3.3 Startup
All persons involved in the operation of the vaporizer equipment should be familiarized with its operation and any plant emergency procedures. Before continuing with the startup, contact Capital Controls with questions or to arrange a training program, if necessary.

3.3.1 Start-Up
a. Turn on the power to the heaters (control circuit already on) and allow the water bath temperature to stabilize. This may take 60-90 minutes.

b. Before introducing chemical into the system, all joints and connections must be checked for leakage. Make sure that the flexible connector is attached to the gas discharge valve on the chemical container. Note: It is recommended that, if used, the vacuum ejector be operating as a precaution to evacuate gas in case of a major leak.

1. Leakage test method with dry air or nitrogen:

   aa. Close the manual vent valve (See Figure 6) and pressure test the liquid piping and vaporizing chamber to 150 psig (1035 kPa/10 bar), with dry air or nitrogen.

       Caution: Nitrogen cylinders are pressurized in excess of 2000 psig (13970 kPa/139 bar). Use regulator to assure proper pressure.

       Apply soapy water to the outside of the joints to detect leaks. If there are no apparent leaks, open the manual vent valve to relieve nitrogen pressure and then close.

   bb. Open and immediately close the chemical container gas outlet valve, introducing just enough gas to pressurize the chemical system. Test for leaks by filling a squeeze bottle 1/4 full of household ammonia. Hold the squeeze bottle near the suspected points and squeeze the fumes. If gas is leaking, a dense white smoke will appear. Repair all leaks and retest. Reference Chlorine Institute Chlorine Manual and Pamphlet #6.
3.3.2 Abnormally High Chemical Supply Pressure

**CAUTION:** Vaporizer performance will be restricted if ton containers and tank cars produce abnormally high liquid pressure. Normal ton container pressure ranges (unpadded) are 85-100 psig (586-690 kPa). Liquid pressure in a padded tank car is normally 125 psig (862 kPa). Vaporizer capacity is reduced by padding and very low liquid chemical temperature.

**Restricted Performance Example**

Assume that the liquid chlorine being fed from the tank car is 60°F (15.6°C) and that the vaporizer water bath temperature is 180°F (82.2°C). The vapor pressure of the liquid chlorine at 60°F (15.6°C) is approximately 70 psig without any padding, and the thermal difference through the vaporizer chamber wall between the heated water and the liquid chlorine will be 120°F (49°C). With this temperature difference, the vaporizer can transfer heat and thereby vaporize the liquid chlorine to gaseous chlorine.

The Chlorine Institute Pamphlet #54 permits maximum allowable padding pressure to be 190 psig (1310 kPa) for liquid chlorine at 60°F (15.6°C). In this case, the liquid pressure in the vaporizer tank then becomes 190 psig (1310 kPa), instead of 70 psig (483 kPa), because of the padding.

From the vapor pressure curve of chlorine, a 190 psig (1310 kPa) vapor pressure is equivalent to 120°F (49°C) so that the vaporizer must heat the liquid chlorine to 120°F (49°C) prior to vaporization. With the vaporizer water bath at 180°F (82.2°C), a 60°F (15.6°C) change in temperature is available to vaporize the chlorine instead of a change in temperature of 120°F (49°C) without padding. The increased heat required to raise the liquid chlorine temperature 120°F (49°C) reduces the vaporizer capacity and superheat.

To reduce abnormally high liquid chlorine pressure induced by heat (ton containers) or induced by padding pressure (tank cars), operate on the gas phase of the source (top container valve) until the pressure drops to approximately 70 psig (483 kPa). The chlorinator can operate to its maximum capacity at 20 psig (138 kPa) gas pressure at the inlet to the vacuum regulator but 40 psig (276 kPa) is preferred. Padding of a tank car will only be required when the liquid chlorine temperature is below 30°F (-1.1°C), and then only a small amount of padding is required.

If padding is used and pressure is maintained above 80 psig (552 kPa), chlorine liquid carry-over can occur, and must be prevented for proper performance.

3.3.3 Shutdown

The vaporizer can be shut down using two methods:

**Caution:** Liquid chemical must not remain trapped in the vaporizing chamber when the liquid inlet shutoff valve and gas discharge valve or process equipment is shut off. If liquid is trapped in the heated vaporizer, the pressure will rise, causing the rupture disc to burst and the pressure relief valve to open.

a. **Method A (preferred)**
   Shut off the container liquid supply inlet valve at the vaporizer while maintaining the water bath temperature. The remaining liquid will vaporize and discharge to the process.
   **Note:** The process equipment must be operating. When the gas pressure gauge indicates the rapid drop in pressure, all the liquid is vaporized. The manual gas discharge valves and the process equipment may then be shut off.

b. **Method B**
   Shut off the manual gas discharge valves to the process while maintaining the water bath temperature. The pressure buildup in the vaporizing chamber will cause the liquid chemical to return to its source. Shut down the process equipment, then shut off the container liquid supply valve at the vaporizer.
After completing Method A or B, residual pressurized chemical gas may still be in the vaporizer chamber. Before disconnecting any pipes, open the manual vent valve to make sure all gas is vented.

3.4 Calibration

3.4.1 Cathodic Protection Current Adjustment

The current level required to prevent electrolytic degradation of the tank and chamber is between 25 and 30 milliamps as read on the instrument panel ammeter. This should be read and adjusted weekly using the potentiometer knob directly below the ammeter. A zero reading at all potentiometer settings indicates replacement of anodes is required. Refer to Service Section.

3.4.2 Relief Valve Calibration

The relief valve will need recalibration upon disassembly for cleaning following an over-pressure condition. Refer to Bulletin 115.6020.
4  SERVICE

4.1  Changing Chemical Supply

4.1.1  With the process equipment operating, shut off the chemical container liquid outlet valve.

4.1.2  Shut off the isolating valve on the flexible connection at the chemical container.

4.1.3  Disconnect the flexible connection from the empty chemical container liquid outlet valve and reconnect to a full chemical container. Promptly apply the outlet cap and valve protection hood to the empty container valve.

4.1.4  Slowly open, then immediately close the liquid outlet valve on the full container.

4.1.5  Check for leaks as described in the Startup Section.

4.1.6  Reopen both valves if no leaks are found.

4.2  Cleaning

The vaporizer requires periodic cleaning for safe and efficient operation. The frequency varies with usage and quality of the chemical used. Clean the unit every six months or less, if loss of capacity or superheat is experienced.

4.2.1  Chamber Cleaning

Refer to Figures 5 and 9 and proceed as follows:

a. Shut down the vaporizer system. Refer to Shutdown Section.
b. Turn off the electrical power to the heater and control circuits.
c. Open the 1" drain valve and drain the water from the water bath tank. Close the valve when the tank is empty.
d. Open the manual bypass (vent) valve to make sure the pressure is at zero and leave open.

4. Disconnect the 1" union in the chemical liquid pipe at the vaporizer after the chemical liquid valve.

f. Pass dry air into the vaporizer through the chemical liquid inlet at the disconnected union to purge the vaporizing chamber.
g. Disconnect the 1" union at the chemical gas outlet. Plug the open port left at the union to the discharge piping.
h. Remove the gas temperature and pressure sensors from their protective wells in the chamber.
i. Remove the two anodes, see Cathodic Protection Section.
j. Remove twelve 3/4" bolts on the chamber flange.
k. Remove the chamber flange vertically from the vaporizing chamber. The baffles and dip pipe are connected to the underside of this cover.
l. Remove the large lead gasket in the chamber groove.
m. Remove the eight bolts around the top plate.
n. With the use of lifting equipment, vertically withdraw the chamber from the water bath tank.

Caution: Lift out the chamber using the two (2) lifting points welded to the chamber.
o. Clean the inside of the chamber, chamber flange and internal parts with hot water and steam until the wash water is clean and free of odor.
p. Thoroughly dry all parts.
q. Examine both anodes and replace if necessary. Refer to Service Section.
r. Clean the inside of the water bath tank if needed.
s. Examine the water bath tank, chamber, heaters and other internal parts for corrosion. Remove any white buildup on the heaters to prevent premature failure. Replace parts as required. Refer to Service Section.

l. Install the chamber into the water bath tank in proper orientation and fasten in place with the eight bolts around the top plate. Replace the rubber gasket if required.

u. Insert a new lead gasket into the groove in the chamber flange.

v. Install the chamber flange into the chamber.

w. Insert the twelve 3/4" bolts into the chamber flange and apply 110 FOOT-POUNDS TORQUE. Make sure to torque opposite bolts sequentially.

x. Reconnect wiring to anodes and ammeter. Refer to Cathodic Protection Section VIII.

y. Insert gas temperature and pressure sensors into their protective wells.

z. Prepare the vaporizer for startup. Refer to Pre-startup Section.

aa. Start up the vaporizer. Refer to Startup Section.

4.2.2 Replacement Criteria

After the chamber has been cleaned both inside and outside of all deposits and ferric chloride, the chamber should be weighed and inspected for excessive corrosion pitting to determine if it is still safe for continued use.

When new, the chamber weighs 200 pounds (90.7 kilograms) and has an inside diameter of 5.761" (146.3 mm). The chamber should be replaced if it exhibits a loss over 15 pounds (6.8 kilograms), or if any pitting deeper than 0.125" (3.17 mm) can be measured.

Any vaporizer chamber which does not exceed these losses can be considered safe for continued use.

a. Gas Filter

While the vaporizer is shutdown for chamber cleaning, it is advisable that the filter (Y-strainer or cartridge) in the gas line between the vaporizer and the pressure reducing valve be disassembled and cleaned. Refer to the manufacturer's instructions.

1. Loosen fasteners housing the strainer or cartridge.
2. Wash the strainer in hot soapy water. Discard the cartridge.
3. Dry the strainer completely.
4. Reinstall cleaned strainer or new cartridge using a new lead gasket.

4.3 Heater Replacement

If the vaporizer requires longer than normal warm-up times or, if the full vaporization capacity cannot be achieved, one or more heating elements may have failed.

Before inspecting the heaters, check the fuses in the power supply for failure.

To inspect the heater elements, FIRST TURN ELECTRICAL POWER OFF to the vaporizer heater and control circuit. Then open the door on the heater enclosure. Disconnect the two wires to each heater element and, using an ohmmeter, measure the resistance across the terminals. Infinite resistance indicates a faulty heater. Refer to Figure 10 and proceed as follows to replace the heater element.

4.3.1 Shut off the manual gas discharge valves downstream of the vaporizer and shut down the process equipment.

4.3.2 Open the 1" drain valve and drain the water from the water bath tank. Close the valve when the tank is empty.

4.3.3 Close the manual filling valve.

4.3.4 Open the heater enclosure door and disconnect the two wires to the bad heater element.

4.3.5 Using a 1-1/2" socket wrench, unscrew the heater element. Remove the element and gasket.

4.3.6 Install the new heater element and gasket. Be sure the new element is the same electrical rating as the old one, per the markings on both parts.
NOTE: The heater elements must be aligned vertically for proper operation. Note the “UP” molded in the face of the heater at installation.

4.3.7 Connect the two wires to the new element terminals and close the heater enclosure door.

4.3.8 Fill the water bath tank to the proper level by opening the manual filling valve and by energizing the automatic fill solenoid valve. Visually check for water leaks before activating the electrical power to the control circuit.

4.3.9 After the tank is filled, activate the electrical power to the heater circuit.

4.3.10 Allow the water bath temperature to stabilize. This may take 60 to 90 minutes.

4.3.11 Slowly open the manual gas discharge valves downstream of the vaporizer and start up the process equipment.

4.4 Water Filling

If the loss of water indication (a cutoff of power to the heaters), does not actuate the fill solenoid valve, refer to Section V.

4.5 Low Water Level Alarm, Water Level Control, and Low Water Level Cutoff Switches (float switches) Refer to Figures 3 and 4

If any of the final control elements are not functioning properly, the cause may be a malfunctioning water level switch or water temperature control switch. Refer to the wiring diagram to determine which switches affect the operation of the malfunctioning control element, then using a voltmeter, follow the circuit to determine if a switch is at fault.

4.5.1 Check for loss of voltage or blown fuses.

4.5.2 Check all devices that are actuated by these switches for proper operation.

4.5.3 If testing indicates that a switch is the cause, refer to Shutdown Section before proceeding.

4.5.4 Disconnect wiring and remove the switch from the tank. Note position and wire connections.

4.5.5 Check for flooded float. With an ohmmeter on the float terminals, manually actuate float. ON should indicate zero resistance. OFF should indicated infinite resistance.

4.5.6 Clean and replace float as necessary, using Teflon base pipe dope or Teflon tape on the threads.

4.5.7 Refer to Startup Section.

Figure 9 - Disassembly and Cleaning of Chamber Components
4.6 Water Temperature Control Thermostat (Refer to Bulletins 115.3020 and 115.3021)

4.6.1 Check power source and fuse to actuate magnetic contactor coil.
4.6.2 Check power source and fuse to heater circuit.
4.6.3 Check power source and 100 mA sloblow fuse to the temperature control.

**WARNING:** Improper voltage will destroy the switch.

4.6.4 Check contactor for malfunction. Refer to manufacturer’s instructions.
4.6.5 Check low water level cutoff. Section 4.5.
4.6.6 Check high water temperature alarm, Section 4.7.
4.6.7 Manually check water temperature to confirm failure of thermostat to actuate.
4.6.8 Refer to Shutdown Section before proceeding.
4.6.9 Disconnect wiring and remove control thermostat.
4.6.10 Refer to Startup Section.

4.7 High and Low Water Temperature Alarm Switch

4.7.1 Check power source and fuse.
4.7.2 Inspect the actuated component for proper operation. Refer to manufacturer’s instructions.
4.7.3 Manually check water temperature to confirm failure of switch to actuate.
4.7.4 Refer to Shutdown Section.
4.7.5 Disconnect wiring and remove switch.
4.7.6 Replace using a Teflon based pipe dope or Teflon tape on the threads.
4.7.7 Refer to Startup Section.

The temperature controls are factory set as follows:

- Control Thermostat - 180°F (82°C)
- Low Temperature Alarm Switch - 170°F (77°C)
- High Temperature Alarm Switch - 190°F (88°C)

4.8 Cathodic Protection - Anode Replacement

The water wetted surfaces of the vaporizer are protected against corrosion by two sacrificial anodes. The anodes being the most active metal in the vaporizer will suffer corrosion and supply the electrical current needed to protect the structure.

The anodes should be replaced as a set after they are consumed. This is indicated by zero current flow at all potentiometer settings. Refer to Figure 8 and proceed as follows to replace or remove the anodes. Note: It is not necessary to shutdown the system for this procedure, but caution must be exercised to prevent burns from the hot water in the tank.

4.8.1 To replace the anode, disconnect the wire from the screw at the top of the anode. See Figure 8. Using a screwdriver, hold the position of the screw and loosen the nut with a box wrench.

4.8.2 Unscrew the two 10-24 screws at the top plate and withdraw the anode insulator vertically from the vaporizer.

4.8.3 Insert a new anode and fasten into position.

4.8.4 Connect wires as before. The screw at the top of the anode must be tight and in good electrical contact.

4.9 Recommended Torque Values

The following bolt/nut torque values are used at the factory when assembling the equipment. These values are recommended guidelines for re-assembly of a repaired unit:

<table>
<thead>
<tr>
<th>Part</th>
<th>Torque Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flange Bolt</td>
<td>110 foot pounds</td>
</tr>
<tr>
<td>Thermowell</td>
<td>75 foot pounds</td>
</tr>
</tbody>
</table>
## TROUBLESHOOTING CHART

<table>
<thead>
<tr>
<th>TROUBLE</th>
<th>PROBABLE CAUSE</th>
<th>CORRECTIVE ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. High temperature cutoff switch actuates.</td>
<td>a. Malfunctioning control thermostat or high temperature cutoff switch.</td>
<td>a. Inspect and/or replace thermostat and high temperature cutoff. See Service Section.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>a. 1) Check power source. 2) Check fuse and replace as necessary. 3) Check safety switch to see that it has actuated. 4) Check magnetic contactor for proper operation. Refer to manufacturer’s instructions.</td>
</tr>
<tr>
<td></td>
<td>b. Low water level cutoff actuated.</td>
<td>b. 1) Check water level and refill. Service Section. 2) Check proper operation of cutoff switch. See Service Section.</td>
</tr>
<tr>
<td></td>
<td>c. Faulty heater(s).</td>
<td>c. Inspect and replace. See Service Section.</td>
</tr>
<tr>
<td></td>
<td>d. Malfunction of control thermostat</td>
<td>d. Check and adjust thermostat as required. See Operation Section.</td>
</tr>
<tr>
<td></td>
<td>e. Faulty high water temperature alarm switch.</td>
<td>e. 1) Inspect and replace thermostat. Service Section. 2) Inspect and replace switch. See Service Section.</td>
</tr>
<tr>
<td>2. Low temperature alarm switch actuated.</td>
<td>a. Loss of power to heaters.</td>
<td>a. Fill tank to level midrange on sight glass.</td>
</tr>
<tr>
<td></td>
<td>b. Low water level cutoff actuated.</td>
<td>b. Check power and fuse. correct or replace as required.</td>
</tr>
<tr>
<td></td>
<td>c. Faulty heater(s).</td>
<td>c. Check and replace solenoid valve. Use ohmmeter to check for open or short.</td>
</tr>
<tr>
<td></td>
<td>d. Malfunction of control thermostat</td>
<td>d. Inspect and replace water level control switch. See Service Section.</td>
</tr>
<tr>
<td></td>
<td>b. No power to automatic fill solenoid valve.</td>
<td>b. Inspect and clean and/or replace switch. See Service Section.</td>
</tr>
<tr>
<td></td>
<td>c. Auto fill valve solenoid inoperative.</td>
<td>c. Inspect, clean or replace solenoid. Use ohmmeter to check for open or short.</td>
</tr>
<tr>
<td></td>
<td>d. Malfunctioning water level control switch (automatic fill only).</td>
<td>d. Inspect and replace water level control switch. See Service Section.</td>
</tr>
<tr>
<td></td>
<td>b. Water level control switch malfunctioning (automatic fill only)</td>
<td>b. Clean chamber. See Service Section.</td>
</tr>
<tr>
<td></td>
<td>c. Automatic fill valve solenoid not closing properly.</td>
<td>c. Clean and open valves.</td>
</tr>
<tr>
<td>5. Insufficient vaporization capacity.</td>
<td>a. Faulty heater(s).</td>
<td>a. Check and correct source pressure.</td>
</tr>
<tr>
<td></td>
<td>c. Gas or liquid shutoff valves not completely open.</td>
<td>c. Check and correct pressure reducing valve. See Section 3.2.</td>
</tr>
<tr>
<td></td>
<td>d. Low source pressure.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>e. Clogged gas filter(s).</td>
<td></td>
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<tr>
<td></td>
<td>f. Faulty pressure reducing valve.</td>
<td>g. See Section 3.3.</td>
</tr>
<tr>
<td>TROUBLE</td>
<td>PROBABLE CAUSE</td>
<td>CORRECTIVE ACTION</td>
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<tr>
<td>----------------------------------------------</td>
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<td>--------------------------------------------------------</td>
</tr>
<tr>
<td>6. Cathode current drops to zero at all settings.</td>
<td>a. Anodes are consumed.</td>
<td>a. Replace anodes. See Service Section 4.8.</td>
</tr>
<tr>
<td>7. Reliquefaction of gas downstream.</td>
<td>a. Faulty heater(s)</td>
<td>a. Inspect, replace heater(s). See Service Section.</td>
</tr>
<tr>
<td></td>
<td>b. Excessive container pressure.</td>
<td>b. Reduce pressure. See Startup Section.</td>
</tr>
<tr>
<td></td>
<td>c. Dirty chamber.</td>
<td>c. Clean chamber and gas filter. See Service Section.</td>
</tr>
<tr>
<td></td>
<td>d. Feed rate higher than vaporizer capacity.</td>
<td>d. Do not exceed vaporization capacity.</td>
</tr>
<tr>
<td></td>
<td>e. Pressure reducing valve malfunction (no pressure drop).</td>
<td>e. Check pressure reducing valve for proper operation. See Section 3.2.</td>
</tr>
<tr>
<td></td>
<td>g. Inadequate insulation of gas pressure piping.</td>
<td>g. Add insulation to gas pressure piping.</td>
</tr>
</tbody>
</table>