



**VACUUM INSULATED PIPE - VIP  
SERVICE AND INSTALLATION MANUAL**

# Introduction

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Thank you for your purchase of Chart Inc. (Chart) Vacuum Insulated Pipe (VIP). Chart has designed and fabricated your pipe system with attention to detail and utilizing the leading cryogenic technologies to ensure a highly efficient and reliable pipe system.

## Service

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Chart's Vacuum Insulated Pipe has been designed for years of safe and dependable operation. In the event service is required, please contact Chart at:

Chart Inc.  
407 7th Street NW  
New Prague, MN 56071 USA  
www.chart-ind.com  
Phone: 1-888-877-3093

## Manufacturer

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The vacuum insulated pipe system is designed and manufactured by:

Chart Inc.  
407 7th Street NW  
New Prague, MN 56071 USA  
www.chart-ind.com  
Phone: 1-888-877-3093

## Design Modification

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**DO NOT** use this product in any manner not consistent with the instructions outlined in this manual!

**NEVER** alter the design, or perform service that is not consistent with the instructions outlined in this manual, without the prior written approval of Chart!

**ALWAYS** refer to the manual supplied by the component manufacturer for the most accurate and current information regarding that item and its particular use since each vacuum insulated pipe system may use different components (such as valves) based on the required performance of the system, and different brands of components may be used for various purposes. Any information in the component manufacturer's manual shall take precedence over information contained in this manual.

## Additional Copies

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Additional copies of this manual are available by contacting Chart in New Prague, MN (address listed above) or by going to Chart's website ([http://www.chart-ind.com/app\\_csd\\_vip\\_designs.cfm](http://www.chart-ind.com/app_csd_vip_designs.cfm)).

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- This manual is intended for use by Chart Vacuum Insulated Pipe customers. It is important to read and understand the information in this manual before installing or operating the pipe system. This manual is provided by Chart to its customers as a courtesy and, except as expressly provided in this manual, **CHART MAKES NO WARRANTIES, EXPRESS OR IMPLIED, REGARDING THE CONTENTS IN THIS MANUAL. CHART ASSUMES NO RESPONSIBILITY FOR ANY OUTCOMES AS A RESULT OF USING THIS MANUAL.**
- The staff and employees of Chart thank you for choosing our product. Please don't hesitate to call us with any questions or comments that you may have. If after reading this manual you are not confident in carrying out any task, please call Chart's Technical Service team at 1-888-877-3093.
- Any information contained in other manuals for equipment supplied by third party manufacturers (including, but not limited to valves, actuators, relief valves, etc.) shall take precedence over information contained within this manual with respect to that third party equipment.

## SAFETY FIRST!

Liquid Nitrogen must be handled properly. Without proper handling, severe frost bite, cryogenic burning and/or oxygen deprivation can result.

During this process, you will need:

- Safety glasses with side shields and/or protective face shield
- Insulated gloves for cryogenic service
- Hearing protection
- Leather working gloves
- Steel toed shoes

Symbols and statements used throughout this text and their meaning are as follows:

 Text following this symbol needs extra attention.

**NOTE:** Text like this is extra information helpful to the situation

**CAUTION:** Text like this is information to help avoid personal injury and/or property damage.

 **WARNING!:** Text like this is information to help avoid serious personal injury or death and/or property damage.

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## Safety

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**⚠ WARNING!:** Vacuum insulated pipe systems are designed to contain pressurized, ultra-cold cryogenic liquids and/or extremely cold gas. These systems should only be worked on by trained personnel to avoid serious injuries such as freezing, oxygen deficient atmosphere and extremely high pressures.

**⚠ WARNING!:** Any configuration which allows a trapped volume of cryogenic liquid or cold gas must be protected by a pressure relief valve. As the cold liquid/gas gains heat, the contents will expand and increase in pressure. A section not protected by an over-pressure relief valve will experience extremely high pressures and significant safety concerns.

**⚠ WARNING!:** Before working on any section of a vacuum insulated pipe system, it is critical to positively confirm the section or entire system is depressurized and drained of all liquid. Even a section with residual cold gas will warm up and develop positive pressure in a short period of time. One must never assume that a section contains no pressure.

**⚠ WARNING!:** If you are at all unsure of how to safely work on this system, STOP and contact Chart immediately.

CAUTION: As with any cryogenic system, it should be observed that any non-insulated piping can get extremely cold and should not be touched by exposed skin. If the system requires maintenance, it should be shutdown and allowed to warm up.

**Strict compliance with proper safety and handling practices is necessary when using a cryogenic system.** We recommend that all our customers re-emphasize safety and safe handling practices to all their employees and customers. While every possible safety feature has been designed into the system and safe operations are anticipated, it is essential that the user of the cryogenic system carefully read to fully understand all WARNINGS and CAUTION notes listed in this safety summary and enumerated below. Also read the information provided in the Safety Bulletin for Oxygen and Inert Gases following this Safety Summary. Periodic review of the Safety Summary is recommended.

**⚠ WARNING!:** In oxygen enriched atmosphere, flammable items burn vigorously and could explode.

Excess accumulation of oxygen creates an oxygen-enriched atmosphere (defined by the Compressed Gas Association as an oxygen concentration above 23%). Certain items

considered non-combustible in air may burn rapidly in such an environment. Keep all organic materials and other flammable substances away from possible contact with oxygen; particularly oil, grease, kerosene, cloth, wood, paint, tar, coal, dust, and dirt which may contain oil or grease. Do not permit smoking or open flame in any area where oxygen is stored, handled, or used. Failure to comply with this warning may result in serious personal injury or death.

**⚠ WARNING!: Nitrogen and argon vapors in air may dilute the concentration of oxygen necessary to support or sustain life.**

Exposure to such an oxygen deficient atmosphere can lead to unconsciousness and serious injury, including death.

**CAUTION:** Before removing parts or loosening fittings, empty the cryogenic piping system of liquid and release any vapor pressure in a safe manner.

External valves and fittings can become extremely cold and may cause painful burns to personnel unless properly protected. Personnel must wear protective gloves and eye protection whenever removing parts or loosening fittings. Failure to do so may result in personal injury due to the extreme cold and pressure in the system.

**⚠ WARNING!: Accidental contact of liquid gases with skin or eyes may cause a freezing injury similar to a burn.**

Handle liquid so that it will not splash or spill. Protect your eyes and cover skin where the possibility of contact with liquid, cold pipes and equipment, or cold gas exists. Safety goggles or a face shield should be worn if liquid ejection or splashing may occur or cold gas may issue forcefully from equipment. Clean, insulated gloves that can be easily removed, and long sleeves are recommended for arm and hand protection. Cuffless trousers should be worn over the shoes to shed spilled liquid.

**⚠ WARNING!: If clothing is splashed with liquid oxygen it will become highly flammable and easily ignited while concentrated oxygen remains.**

Such clothing must be aired out immediately, removing the clothing if possible, and should not be considered safe for at least 30 minutes.

**⚠ WARNING!: If the pipe system is going to be used in oxygen service now, or at any time in the future, use only replacement parts that are compatible with liquid oxygen and have been cleaned for oxygen use.**

Do not use regulators, fittings, hoses, etc., which have been previously used in a

compressed air environment. Similarly, do not use oxygen equipment for compressed air. Failure to comply with these instructions may result in serious damage to the equipment.

**CAUTION:** Before locating oxygen equipment, become familiar with the relevant EU Directives or National Fire Protection Association (NFPA) standard No. 50, “Bulk Oxygen Systems at Customer Sites”, and with all local safety codes.

The NFPA standard covers general principles recommended for installing bulk oxygen systems on industrial and institutional consumer premises.

### ***Safety Bulletin***

Portions of the following information are extracted from Safety Bulletin SB-2 from the Compressed Gas Association, Inc. (CGA). For the full text of Safety Bulletin SB-2 and for more information about oxygen atmospheres, refer to Safety Bulletin SB-2 from the Compressed Gas Association, Inc. (CGA) at <http://www.cganet.com>. Additional information on nitrogen and argon and liquid cylinders is available in CGA Pamphlet P-9. Write to the Compressed Gas Association, Inc., 1235 Jefferson Davis Highway, Arlington, VA 22202 or visit their website at <http://www.cganet.com>.

### **Oxygen Deficient Atmospheres**

The normal oxygen content of air is approximately 21%. Depletion of oxygen content in air, either by combustion or by displacement with inert gas, is a potential hazard. Users should exercise suitable precautions.

One aspect of this possible hazard is the response of humans when exposed to an atmosphere containing only 8 to 12% oxygen. In this environment, unconsciousness can be immediate with virtually no warning.

When the oxygen content of air is reduced to approximately 15 or 16%, the flame of ordinary combustible materials, including those commonly used as fuel for heat or light, may be extinguished. Somewhat below this concentration, an individual breathing the air is mentally incapable of diagnosing the situation. The onset of symptoms such as sleepiness, fatigue, lassitude, loss of coordination, errors in judgment and confusion can be masked by a state of "euphoria," leaving the victim with a false sense of security and well being.

Human exposure to atmosphere containing 12% or less oxygen leads to rapid unconsciousness. Unconsciousness can occur so rapidly that the user is rendered helpless. This can occur if the condition is reached by immediate change of environment, or through the gradual depletion of oxygen.

Most individuals working in or around oxygen deficient atmospheres rely on the "buddy system" for protection - obviously, the "buddy" is equally susceptible to asphyxiation if he or she enters the area to assist an unconscious partner unless equipped with a portable air supply. Best protection is obtainable by equipping all individuals with a portable supply of respiratory air. Lifelines are acceptable only if the area is essentially free of obstructions and individuals can assist one another without constraint.

If oxygen deficient atmosphere is suspected or known to exist:

1. Use the "buddy system." Use more than one "buddy" if necessary to move a fellow worker in an emergency.
2. Both the worker and "buddy" should be equipped with self-contained or airline breathing equipment.

### **Oxygen Enriched Atmospheres**

An oxygen-enriched atmosphere occurs whenever the normal oxygen content of air is allowed to rise above 23%. While oxygen is non-flammable, ignition of combustible materials can occur more readily in an oxygen-rich atmosphere than in air; and combustion proceeds at a faster rate although no more total heat is released.

It is important to locate an oxygen system in a well-ventilated location since oxygen-rich atmospheres may collect temporarily in confined areas during the functioning of a safety relief device or leakage from the system.

Oxygen system components, including but not limited to, containers, valves, valve seats, lubricants, fittings, gaskets and interconnecting equipment including hoses, shall have adequate compatibility with oxygen under the conditions of temperature and pressure to which the components may be exposed in the containment and use of oxygen. Easily ignitable materials shall be avoided unless they are parts of equipment or systems that are approved, listed, or proved suitable by tests or by past experience.

Compatibility involves both combustibility and ease of ignition. Materials that burn in air may burn violently in pure oxygen at normal pressure, and explosively in pressurized oxygen. In addition, many materials that do not burn in air may do so in pure oxygen, particularly when under pressure. Metals for containers and piping must be carefully selected, depending on service conditions. The various steels are acceptable for many applications, but some service conditions may call for other materials (usually copper or its alloys) because of their greater resistance to ignition and lower rate of combustion.

Similarly, materials that can be ignited in air have lower ignition energies in oxygen. Many such materials may be ignited by friction at a valve seat or stem packing, or by adiabatic compression produced when oxygen at high pressure is rapidly introduced into a system initially at low pressure.

## **Nitrogen and Argon**

Nitrogen and argon (inert gases) are simple asphyxiants. Neither gas will support or sustain life and can produce immediate hazardous conditions through the displacement of oxygen. Under high pressure these gases may produce unconsciousness even though an adequate oxygen supply, sufficient for life, is present.

Nitrogen and argon vapors in air dilute the concentration of oxygen necessary to support or sustain life. Inhalation of high concentrations of these gases can cause anoxia, resulting in dizziness, nausea, vomiting, or unconsciousness and possibly death. Individuals should be prohibited from entering areas where the oxygen content is below 19% unless equipped with a self-contained breathing apparatus. Unconsciousness and death may occur with virtually no warning if the oxygen concentration is below approximately 8%. Contact with cold nitrogen or argon gas or liquid can cause cryogenic (extreme low temperature) burns and freeze body tissue.

Persons suffering from lack of oxygen should be immediately moved to areas with normal atmospheres. **SELF CONTAINED BREATHING APPARATUS MAY BE REQUIRED TO PREVENT ASPHYXIATION OF RESCUE WORKERS.** Assisted respiration and supplemental oxygen should be given if the victim is not breathing. If cryogenic liquid or cold boil-off gas contacts a worker's skin or eyes, the affected tissues should be promptly flooded or soaked with tepid water (105-115°F; 41-46°C). **DO NOT USE HOT WATER.** Cryogenic burns, which result in blistering or deeper tissue freezing, should be examined promptly by a physician.

## Unpacking the Pipe

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Upon arrival of the pipe system, it is advised to immediately inspect for any signs of damage. If any damage occurred in shipping, claims must be filed with the shipping carrier immediately. It is suggested to inspect the pipe before it is removed from the truck. If damage is found, alert the driver and document with pictures and proper description before the driver leaves the premises. Please contact Chart immediately to determine if the damage is severe enough that the pipe will need re-work or repair.

Things to check for upon arrival include:

- ✓ Dents in the outer jacket of the pipe
- ✓ Damaged vacuum gauge tube
- ✓ Male bayonets should have protective sleeves over them.
- ✓ Female bayonets should have protective caps over them.
- ✓ Count the number of sections and compare to the number of sections shown on the drawing to be sure you have received a complete shipment.
- ✓ Proper number of bayonet clamps/flanges and O-rings.
- ✓ Proper number of cryovents
- ✓ Any other components that were defined to ship loose

When unpacking the pipe, caution should be used to ensure the pipe is not damaged by hammers, pry bars, screwdrivers, saws, or any other tools that may be used for the packaging or securing of the pipe for shipment.

When removing the pipe from the truck, one should take note of the section of pipe and its total geometry. Watch for items such as valves, pressure relief risers, vacuum pump-out ports or flexible pieces that may stick out in other directions and be prone to damage as it's lifted off the truck and set aside.

**CAUTION:** When removing the pipe from the truck, gently set it on the ground. Do not drop the pipe off the truck! When transporting the pipe through the job site, be sure to carry with care. Take care to not run into walls or drag the pipe on the ground or floor.

Do not remove any of the bayonet protective pieces until the actual installation. This will help ensure damage is not done inadvertently between the time of unloading and installation.

Prior to installation, the pipe sections should be stored in a location that will prevent dirt, water or other debris from getting inside the pipe. Similarly, it should be stored in a place that is generally out of the way of frequent traffic to reduce the risk of damage. Chart recommends not storing the pipe in direct sunlight when not in service.

## Preparing for Installation

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Before beginning the installation, the technicians should ensure they have the proper tools and equipment available. The following serves as a basic list of the most commonly needed tools and equipment. Each installation is different and some may require additional tools.

- ❑ Pipe hangers
- ❑ Threaded rod
- ❑ Beam clamps
- ❑ Halocarbon grease
- ❑ Combination box-end wrench set
- ❑ Screwdrivers
- ❑ Man-lift
- ❑ Ladders
- ❑ Nitrogen gas source for purge and/or pressure test
- ❑ Proper safety equipment

The installation technicians should survey the site and walk the intended route of the pipe system to be sure there is nothing prohibiting them from doing the installation. If the installation requires a shutdown of a section of an existing pipe system (or the whole system), the technicians should make sure that all affected parties are made aware of the shut-down and the expected duration of the shut-down prior to starting the work.

## Installation

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### ***Supporting the Pipe***

When supporting the pipe system, a few things need to be considered. The first is the proper support span (distance between supports) and the weight of the pipe that is being supported. The following table gives approximate weights per foot of the pipe, depending on the size. Please note these weights are only approximate and can vary due to the presence and number of valves, actuators, etc.

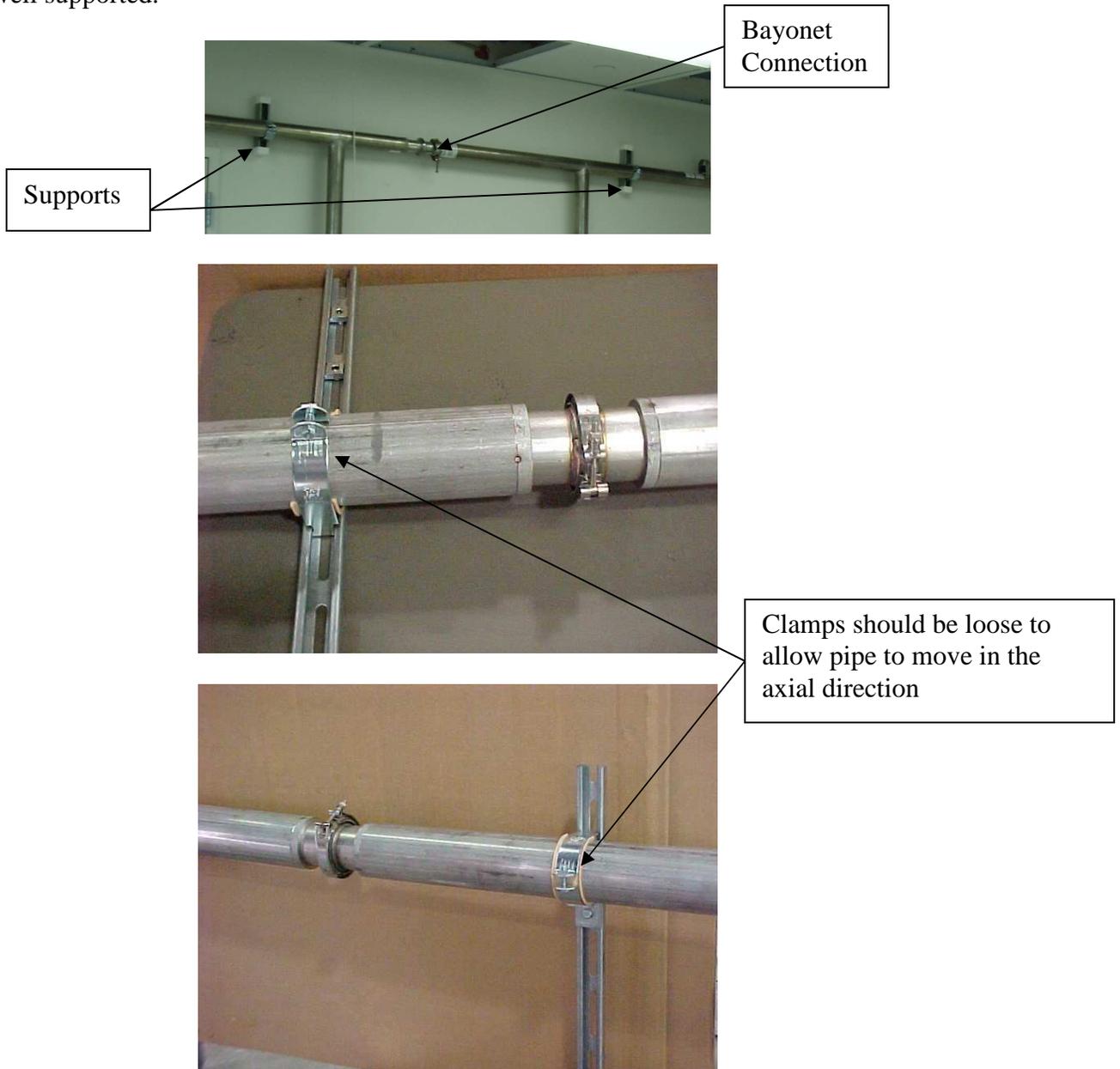
| Pipe Size                       | Approximate Weight per Foot With Liquid Nitrogen <sup>1</sup> |
|---------------------------------|---|
| ½" inner line (2" outer jacket) | 3 ¼ lb/ft   |
| 1" inner line (3" outer jacket) | 5 lb/ft   |
| 2" inner line (4" outer jacket) | 7 ½ lb/ft   |
| 3" inner line (5" outer jacket) | 14 ¼ lb/ft  |
| 4" inner line (6" outer jacket) | 17 ½ lb/ft  |
| Larger than 4" inner line       | Consult Chart   |

Supports should be placed close enough to handle the above weight loads, depending on the load capacity of the support system being used. Furthermore, Chart recommends that each section of pipe have a minimum of two supports to relieve any stress on the

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<sup>1</sup> Consult Chart for weights of pipe with any other liquid.

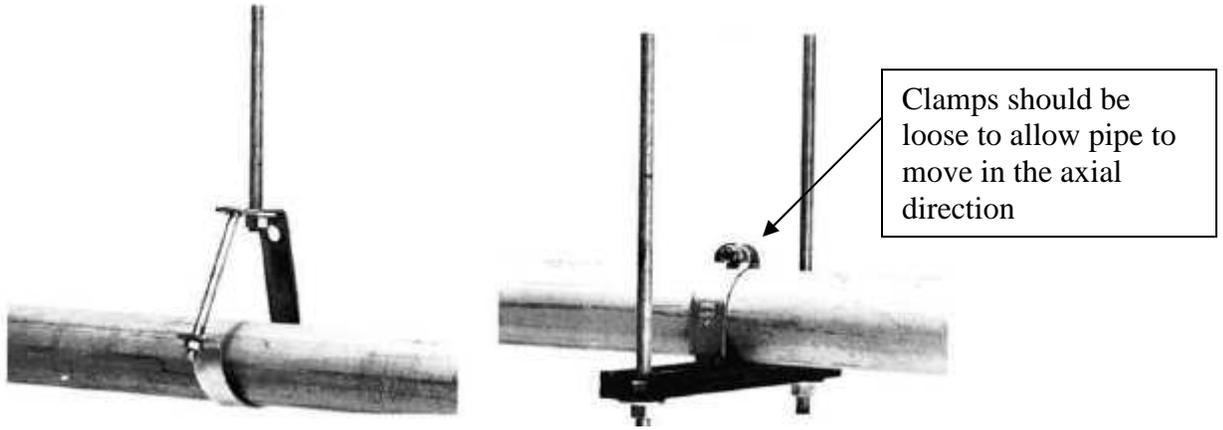
bayonets. Supports should be placed in such a way to eliminate any bowing or flexing at bayonet locations. The pictures below show installations where the bayonet connection is well supported.



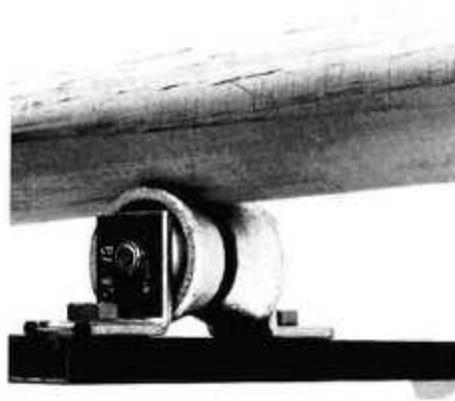
In addition to weight loads, the support system used must account for the possibility of movement of the system. For example, pipe installed on the top of a roof will get very warm in hot climates on sunny days. As the outer jacket warms up, it will expand along the length of the pipe. The installation should provide a support means that accommodates this movement as well as provisions to account for this movement at the point the pipe penetrates down into the building.

Similarly, for external bellows pipe systems, the relative movement between the inner and outer jackets is taken up in the outer jacket. As such, the outer jacket will move by design. A support system (such as rollers, hangers, etc.) must be used to allow this movement and prevent damage of the pipe<sup>2</sup>. Examples of roller and hanger supports are below.

### Example Pipe Supports



Hanger Supports



Roller Support

**CAUTION:** External bellows pipe systems must use a support system that allows for the outer jacket to move. If this is not done, damage to the bayonets could occur.

<sup>2</sup> On average, a pipe system may move approximately 1 inch per 28 feet of linear length. However, each pipe system should be evaluated independently for proper movement and support.

NOTE: There should not be any welding to the outer jacket. Doing so will void the warranty of the pipe.

### Assembling the Bayonets

CAUTION: Assembly of bayonets should not require much force. If there is any resistance, STOP and consult Chart to avoid any damage to the bayonets.

When properly installed, Chart's bayonet fittings are designed to provide a very reliable connection that is extremely leak resistant and thermally efficient. Please use the following procedure for the assembly of the bayonets:

1. Confirm the bayonet pair (male/female) being installed is correct.

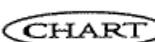


Male Bayonet

Female Bayonet

2. Consult the Chart-supplied system drawing to determine which section (noted by VS-#) is intended to connect to which other section. The VS-# that is shown on the system drawing refers to the VS-# that appears on the label on the pipe. An example of this label is shown below:

Example label on each pipe section. Each section of pipe will have it's own VS number.

|  |          |             |        |
|--|----------|-------------|--------|
|          |          |             |        |
| CHART INDUSTRIES<br>VACUUM INSULATED PIPE<br>NEW PRAGUE, MN. MADE IN USA<br>PH. 888-877-3093 |          |             |        |
| P/N  | 1XXXXXXX | SVCE        | LN2    |
| MAWP   | 150      | MFG DATE    | Jan-07 |
| VS-  | 10       | JKT. RELIEF | 5 PSI  |
| CUSTOMER / PROJECT NAME  |          |             |        |

- **Note** – If MVE design bayonets are used, once the bayonets are installed and get cold, the pipe will require 24 hours to warm up before the bayonets can be pulled apart. Assembling the wrong bayonets could result in significant installation delays!

3. Remove the bayonet protective sleeve (on male bayonet) and cap (on female bayonet). Inspect the inner and outer surfaces for any signs of damage, dirt, water or debris. If any such problem is found, clean the bayonets with water. Be sure the bayonets are completely (inside and out) dry before installing. If there is other physical damage, consult the factory before attempting installation.
4. Prior to engaging a bayonet set, ensure that the male and female halves are exactly in alignment.

**CAUTION:** If bayonets are not properly aligned, the installation will be much more difficult and could ultimately result in damage to the bayonets.

5. Apply a thin film of halocarbon grease to the supplied o-ring.  
 NOTE: The proper halocarbon grease and o-rings can be purchased at [www.chartparts.com](http://www.chartparts.com). The Chart part number for the grease is 10684611. The following table lists the proper part numbers for o-rings based on the bayonet size.

| Bayonet Size      | O-Ring Part Number |
|-------------------|--------------------|
| MVE Design        |                    |
| MVE 1/2" x 1-1/2" | 2322231            |
| MVE 1" x 2-1/2"   | 2322291            |
| MVE 1-1/2" x 3"   | 2322341            |
| MVE 2" x 3-1/2"   | 2300321            |
| CVI Design        |                    |
| CVI 1" x 2-1/2"   | 30-0000-15231      |
| CVI 1-1/2" x 3"   | 30-0000-15238      |
| CVI 2" x 4"       | 30-0000-15246      |
| CVI 3" x 5"       | 30-0000-15254      |
| CVI 4" x 6"       | 30-0000-15261      |



**CAUTION:** Do not use hydrocarbon (auto) grease.  
**CAUTION:** Do not apply a grease of any kind to the bayonet itself.

6. Install o-ring into the groove that is machined into the male bayonet flange.  
**NOTE:** CVI design bayonets have the O-ring groove machined into the female bayonet flange rather than the male bayonet flange.



7. Connect the bayonet halves together until the female bayonet flange contacts the O-ring.



**CAUTION:** Do not twist the bayonets to get them to engage.

**CAUTION:** Do not force the bayonets together with a chain, hammer, come-along, or any other means. If the bayonets do not go together easily, stop and call the factory for assistance.

8. Spread open the V-band clamp and put it around the bayonet flange set as shown in the following picture:



9. Insert the T-bolt through the round receiving end and tighten the nut to secure.



10. While tightening the nut, lightly tap around the V-band clamp with a small rubber mallet. This will help ensure that the V-band clamp tightly secures and pulls the bayonet flanges together.



11. Tighten nut to the following torque values:

| Inner Pipe Size | Torque Value (in-lbs) |
|-----------------|-----------------------|
| 1/2"            | 50                    |
| 1"              | 50                    |
| 1-1/2"          | 50                    |
| 2"              | 75                    |

12. The flanges should engage until there is a very small gap between the male and female flanges.



After all of the bayonets have been connected and the support hangers are secure, install any non-vacuum insulated components such as brass valves, etc<sup>3</sup>. Note that any small leaks in the threaded plumbing connections, or through the end use equipment valves, etc can cause frost and/or ice to form on the threaded connections. It is very important to make sure these connections are confirmed to be leak free.

### ***Bend Radius Limits of Flexible Pipe***

Flexible pipe is often used in pipe systems to facilitate installation and connection to the bulk tank or end use equipment. In some cases, flexible pipe may have been used to help go around an obstruction in the path of the pipe such as a support column or existing electrical or HVAC equipment. In other cases, flexible pipe may have been used to help make small adjustments in the pipe as well as bend 90 degrees rather than using a rigid elbow. It is important to not over-bend the flexible pipe. If the flexible pipe is bent beyond its bend radius, it is likely to cause a thermal short or develop a leak. The following table shows the minimum bend radius for the different size pipes. If a smaller bend radius is required, a rigid 90-degree elbow should be used in the design.

<sup>3</sup> It is recommended to use a Teflon tape, properly installed, on any threaded connections.

| <b>Inner Flex Size</b>           | <b>Minimum Bend Radius</b> |
|----------------------------------|----------------------------|
| 3/8" ID x 1" ID<br>Transfer hose | 8"                         |
| 1/2" Pipe Size                   | 12"                        |
| 1" Pipe Size                     | 16"                        |
| 1-1/2" Pipe Size                 | 20"                        |
| 2" Pipe Size                     | 20"                        |

### ***Relief Valve Discharge***

It should be recognized that the automatic pressure relief valves could discharge at any time. Care should be taken to consider the orientation of the relief valve discharge so that it does not spray extremely cold gas and/or cryogenic liquid on sensitive surfaces or onto personnel. Automatic pressure relief valves that are installed outdoors should be done so in a manner that prohibits rain, dirt, snow or ice to accumulate on the end of the valve. **It is the responsibility of the customer to check these relief valves and ensure that they are pointed in the proper direction.** Although Chart installs the relief valves during manufacturing of the pipe, we have no way of knowing the surrounding atmosphere at installation to be able to modify the installation orientation.

**⚠️ WARNING!:** The automatic pressure relief valve can discharge extremely cold gas and/or cryogenic liquid at any time. The discharge of these valves **MUST** be oriented in a way so as not to spray on any personnel.

The line pressure relief valves installed by Chart are intended to be used in a manner that they discharge freely to atmosphere. Adding plumbing to the exit of a relief valve can reduce the over-all relieving capacity.

### ***Slope of Pipe System***

The performance of the pipe system can be greatly affected by the slope of the pipe sections. If the pipe system has a cryovent, the pipe should be installed such that the pipe slopes vertically up to the cryovent to allow the gas bubbles to naturally rise up to the cryovent. The amount of slope recommended is 1-inch per 10-foot span (~0.5°). This slope is usually achieved by adjustment of the support and/or hanger system.

## Start-Up/Commissioning

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Following a proper start-up procedure is very important to minimize the chances of pressure spikes within the system, as well as reduce the probability of getting impurities or debris introduced into the system, lodged in valve seats, etc. Once the system has been fully installed, the following general procedure should be followed to start the system up. The exact procedure will vary depending on the specific system, equipment involved, etc.

**CAUTION:** System start-up should only be performed by properly trained technicians who fully understand cryogenics and pressure and who follow strict safety guidelines.

The general start-up procedure is as follows:

1. Ensure a properly sized pressure relief valve<sup>4</sup> is installed between any and all locations where liquid can become trapped.
2. If the system has any cryovents, close the isolation valve on the outlet side to prohibit flow through the cryovent during the initial start-up process.
3. Close all use point valves throughout the system.
4. **Slowly** open the system supply valve ½ turn and allow pressure to fill the pipe system slowly. Closely monitor the pressure in the system for any signs of pressure above the MAWP<sup>5</sup> of the pipe.
  - If product does not start flowing into the pipe system after ½ turn of the valve, open another ¼ turn. If again, no product is flowing, open the valve another ¼ turn, etc.
  - If the valve is opened completely and no product is flowing, ensure the main supply valve is open and contact Chart.
5. When product has stopped flowing into the pipe and the system is at supply pressure, walk the system and check for any leaks.
6. If no leaks are found, slowly open a use point valve at the location farthest from the supply.

**⚠ WARNING!:** Ensure there are no personnel in the vicinity of the venting gas/liquid stream. Also ensure there is proper ventilation so as not to produce an oxygen deficient atmosphere.

7. When a continuous stream of liquid exits at the farthest use point, close that use point valve and open the next use point valve upstream.

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<sup>4</sup> Each section of pipe has an identification label that documents the MAWP (Maximum Allowable Working Pressure) of the pipe. The pressure relief valve should be set at a pressure equal to or less than the MAWP of the pipe.

<sup>5</sup> The MAWP is indicated on the label of each section of pipe.

8. Continue sequentially opening use point valves until all use points have been purged through and a liquid stream is present.
9. Open the cryovent isolation valve approximately ½ way.
10. Allow the cryovent to cool down for one hour.
11. Fully open the cryovent isolation valve.

## Components

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Each vacuum insulated pipe system may use different components based on the required performance of the system. In addition, different brands of components (such as valves) may be used for various purposes. Please refer to the manual supplied by the component manufacturer for the most accurate and current information regarding that item. Any information in the manufacturer's manual shall take precedence over information contained in this manual.

### Cryovents

Cryovents are designed to help remove residual gas from the pipe system, keeping it full of liquid during periods of no use. When properly installed, cryovents will greatly reduce the amount of time required to get quality liquid at the point of use.



The cryovent is a vacuum insulated mechanical float device.

**Figure 1 - Cryovent with Vacuum Insulated inlet and outlet**

As vapor accumulates in the cryovent, the float drops and allows the gas to vent out of the Cryovent. When all of the gas has vented out, liquid fills the Cryovent reservoir, lifting the float and closing the valve.

In normal operation, the Cryovent will open and close in a cyclical manner to keep the pipe system full of liquid. The frequency of the opening and closing will be determined by the length of the pipe system, the slope of the pipes, the amount of liquid being used by the system, the amount of non-vacuum insulated pipe in the system and ambient conditions. It is normal for a Cryovent to vent more or less frequently on some days than it does on other days.

The vapor coming out of the Cryovent is extremely cold. Unless a Chart Cryovent Heater or insulated pipe is used on the exhaust of the Cryovent, it should be expected to have frost and/or ice accumulate on the exit of the Cryovent.

**NOTE:** The cryovent is not designed to operate at or near 150 psi.

**CAUTION:** Care should be taken to evaluate where the Cryovent exhaust is located. Extremely cold vapor will come out of the Cryovent. Should the Cryovent fail for any reason, there is a chance that cryogenic liquid could come out of the Cryovent exhaust. The exhaust should be designed in such a way so that there is no risk of personnel injury or property damage should such a failure occur.

**⚠️ WARNING!:** The Cryovent is not a pressure relief device. It will not protect the pipe system from over-pressure conditions. Only automatic pressure relief valves should be used as pressure relief devices.

**⚠️ WARNING!:** The Cryovent will vent various amounts of vapor. Care should be taken to make sure the room is properly ventilated so as not to produce an oxygen deficient (in nitrogen or argon service) or an oxygen enriched (in oxygen service) atmosphere.

### ***Vacuum Gauge Tubes***

Vacuum gauge tubes are used to allow checking the condition of the vacuum space at any time. The standard vacuum gauge tube Chart uses is a Hastings DV-6 (shown in the picture with a protective blue vinyl cap beneath the protective stainless steel strap). To check the vacuum, simply remove the vinyl cap and connect the appropriate meter to the gauge tube and check the reading.



The gauge tube is a sensitive instrument that should not be tampered with. Any abuse to the gauge tube may cause a loss of vacuum in that section. If the gauge tube should ever need to be replaced, it should be replaced only by a Chart technician as it involves dropping the vacuum on the section. If the vacuum is not dropped properly, the insulation space can become contaminated and thus permanently damage the section of pipe.

### ***Vacuum Insulated Valves***

Some pipe systems include vacuum insulated valves. These valves are manufactured by a third party. Contact Chart to obtain any detailed information regarding the valves used in your system.

### ***Pneumatic Actuators***

Some pipe systems include pneumatic actuated valves. These actuators are manufactured by a third party. Depending on the brand and model of pneumatic actuator, it may require low (~30 psi) or high (~80 psi) control pressure to operate. Contact Chart to obtain any detailed information regarding the actuators used in your system.

### ***Pressure Relief Valves***

Automatic pressure relief valves are installed in the system for safety purposes to prevent an over-pressure condition. If the pressure in the pipe system exceeds the setting on the relief valve, the relief valve will open and discharge vapor and/or liquid to reduce the pressure in the pipe system. When the pressure in the pipe system drops back below the setting of the relief valve, the relief valve will close. If the pressure in the pipe system has dropped well below the setting of the relief valve and the relief valve has not stopped discharging vapor and/or liquid, it may be necessary to change the relief valve. It is a good idea to have a few spare relief valves on site as spare parts. Be sure to only use cryogenic rated pressure relief valves. Relief valves can be purchased online by visiting [www.chartparts.com](http://www.chartparts.com).



**NOTE:** Any liquid carbon dioxide (LCO<sub>2</sub>) systems require special relief valves. Consult the factory for the proper valves for LCO<sub>2</sub> service.

**⚠️ WARNING!:** Maintenance to any cryogenic piping system should only be performed by trained and qualified professionals. These pipe systems may be pressurized, contain liquid or gaseous nitrogen and seriously injure personnel if not handled with proper safety precautions.

# Maintenance

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The vacuum insulated pipe system is designed to provide many years of performance with regular inspection and minimal maintenance.

**⚠️ WARNING!:** Maintenance to any cryogenic piping system should only be performed by trained and qualified professionals. These pipe systems may be pressurized, contain liquid or gaseous nitrogen and seriously injure personnel if not handled with proper safety precautions.

## ***System Inspection***

It is a good idea to walk along the entire length of the pipe system, from the storage tank to the end-use equipment at least once per year. When inspecting the system, one should look for any of the following:

- Frost or ice spots  
Note that frost on any vacuum insulated components may be normal. If frost, ice or condensation appear, that location should be monitored along with the ambient temperature and humidity for the next few weeks. If a vacuum meter is available, it would be good to take vacuum readings as well. Frost, sweat or ice can occur for various reasons such as:
  - At any uninsulated connections
  - At bayonet flanges, given certain ambient temperature and humidity conditions
  - On pipe sections, given certain ambient temperature and humidity conditions
- Evidence that the relief valves have been tampered with in any way
- Signs of a leak
- External damage such as dents

## ***Check and/or replace Relief Valves***

The relief valves should be visually inspected at least once per year. When inspecting the valves, check for any signs of the following:

- Relief valve removed
- Pressure setting of relief valve higher than the MAWP of the pipe
- A plug in the exit of the relief valve
- Dirt or debris in the exit of the relief valve
- Gas leaking out of the relief valve, or out of the threaded connection at the bottom of the relief valve

If the relief valve needs to be replaced, please use the following procedure:

1. Identify a use point or other connection downstream from the relief valve that can be opened to discharge pressure to atmosphere.
2. Open the point identified in #1 slightly so that some vapor is being discharged to atmosphere.
3. Close an isolation valve upstream from the relief valve location.
4. Wait until vapor is no longer discharging from the location identified in step #1.
5. When the vapor has stopped discharging, open that location fully to confirm there is no pressure in the system. Leave this location open during the removal of the defective relief valve.
6. Using the proper sized wrench, remove the defective relief valve by turning the wrench counter-clock-wise.
7. Remove any obvious strands of Teflon tape from the pipe threads on the pipe system.
8. Verify the set pressure of the new relief valve is appropriate for this system.
9. Apply new Teflon tape to the threads of the new relief valve<sup>6</sup>.
10. Tighten the new relief valve into the port on the pipe system.
11. Close the valve or location identified in step #1.
12. Slowly re-open the isolation valve closed in step #3.
13. Check for any leaks at the new relief valve.

### ***Disassembly of Bayonets***

If the bayonets need to be disassembled, please use the following procedure:

1. Drain the system of liquid nitrogen and allow to warm-up for approximately 24 hours.
2. Before attempting to remove a bayonet, open the pipe system to atmosphere at a convenient use point to ensure there is no residual pressure in the line at the point where the bayonet is going to be disassembled.
3. Make sure no person is directly in front of the bayonet being removed.

**⚠️ WARNING!:** Never stand, nor put any body part directly in-line with any pipe system component when it is being disassembled.

4. Slowly loosen the nut on the bayonet V-band retainer clamp.

**⚠️ WARNING!:** Stop and listen and feel for any evidence of gas leaking through the bayonets. If any is detected, stop immediately and remove all pressure from the system!

5. Remove the nut from the V-band clamp bolt.
6. Remove the V-band clamp from the bayonet flanges.

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<sup>6</sup> It is recommended to not have Teflon tape on the first thread of the relief valve.

7. Slowly pull the two bayonet halves apart.

**CAUTION:** The bayonets should come apart easily. If they are difficult to remove, wait another 4 hours to allow the parts to further warm-up and try again. If, after 30 hours of no liquid in the pipe system it is still very difficult to get the bayonets apart, stop and call Chart.

**CAUTION:** Do not twist the bayonets to get them apart.

8. Take care to not lose the O-ring when bayonets are apart.
  - It is recommended to replace the used O-ring with a new O-ring when the bayonets are re-installed. The O-ring part numbers are given on page 10 and 11 of this manual and can be purchased on-line at [www.chartparts.com](http://www.chartparts.com).
9. Place a protective cover over both of the bayonet halves to avoid any damage to the parts, or getting any dirt, debris or water inside the bayonets and pipes.

# Warranty

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All sales of Vacuum Insulated Pipe from Chart Inc. ("Chart") to the purchaser are subject to all applicable Chart standard terms and conditions in effect at the time of sale, unless otherwise agreed in writing by an authorized representative of Chart. In addition to the warranty stated in Chart's Standard Terms and Conditions of Sale, Chart warrants to the original purchaser of Chart manufactured Vacuum Insulated Pipe (VIP) that for ninety (90) days after invoice date said Chart manufactured VIP (exclusive of Python and MVIP™) shall be free from any defects in workmanship and materials, and that for one (1) year after the date of shipment to the original purchaser said Chart manufactured VIP will maintain all vacuum and performance standards for said VIP as published by Chart on the date of invoice.

Purchaser agrees that as a pre-condition to any Chart warranty obligation hereunder, purchaser shall fully inspect the VIP immediately upon delivery to purchaser and shall give Chart written notice of any claim or purported defect within ten (10) days after receipt of the VIP. As a further pre-condition to any Chart warranty obligation hereunder, purchaser shall return said purportedly defective VIP, freight prepaid, to the plant of the manufacturer within thirty (30) days after receipt of the VIP. Chart shall inspect all returned VIP, and, if said VIP is found defective, shall, at Chart's option as purchaser's sole and exclusive remedy, either (i) repair or replace such VIP or any defective component or part thereof which proves to be defective, or (ii) refund the net purchase price paid by the original purchaser. Alterations or repairs by others or operation of such VIP in a manner inconsistent with Chart accepted practices and all operating instructions, unless preauthorized in writing by Chart, shall void this warranty. This warranty does not extend to defects caused by the effects of normal wear and tear, erosion, corrosion, fire, or explosion.

Chart's sole and exclusive liability under this Warranty is to the original purchaser and shall not exceed the lesser of the cost of repair, cost of replacement, or refund of the net purchase price paid of the VIP by the original purchaser. Chart is not liable for any other losses, damages, or costs of delays, including incidental or consequential damages. CHART SPECIFICALLY MAKES NO WARRANTIES OR GUARANTEES, EXPRESS OR IMPLIED, INCLUDING THE WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR USE, OTHER THAN OR WHICH EXTEND THOSE WARRANTIES EXPRESSED HEREIN. The original purchaser shall indemnify, defend and hold Chart harmless from any third party claims as a result of the use, sale, or lease of the VIP.