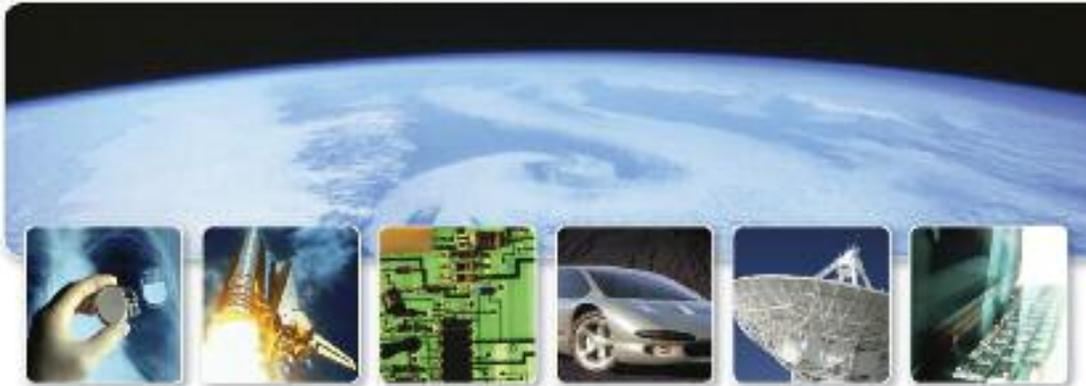




Vacuum Insulated Pipe

Global Supplier of Vacuum Insulated Pipe Solutions



SYSTEM DESIGN | MANUFACTURING | TRAINING | INSTALLATION | CONSULTING

Vacuum Insulated Pipe



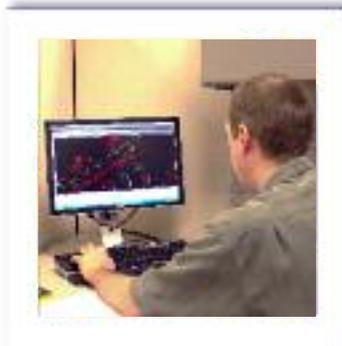
Production Facility
New Prague, MN

Innovation. Experience. Performance. ®

Superiority through Experience

Chart is the world's leading designer, manufacturer, and installer of standard and custom vacuum insulated pipe systems. Our industry-leading 35 years of experience cover the spectrum of traditional industrial applications, from heat-leak sensitive helium lines to tightly specified aerospace applications. Our vacuum insulated pipe systems are built in an ISO 9001 approved manufacturing facility in New Prague, MN along with an ASME U-Stamp. The large facility shares manufacturing with our bulk tank product line, giving us the resources and flexibility to adjust our pipe manufacturing capacity to market demands. This enables us to keep our lead times and costs down while maintaining superior product quality. Our wide product line of pipe and accessories allows us to engineer the optimum **system solution** for any liquid application.

From small to large jobs, we can supply the entire system from the liquid tank to the application equipment.



Engineering Design

Our site survey crew will document your system specifications and our engineering team will propose the most efficient and economical solution that meets the system's performance requirements.



Quality Manufacturing

Our experience and **ISO 9001** certification ensures that your job is completed to high quality standards and on schedule.

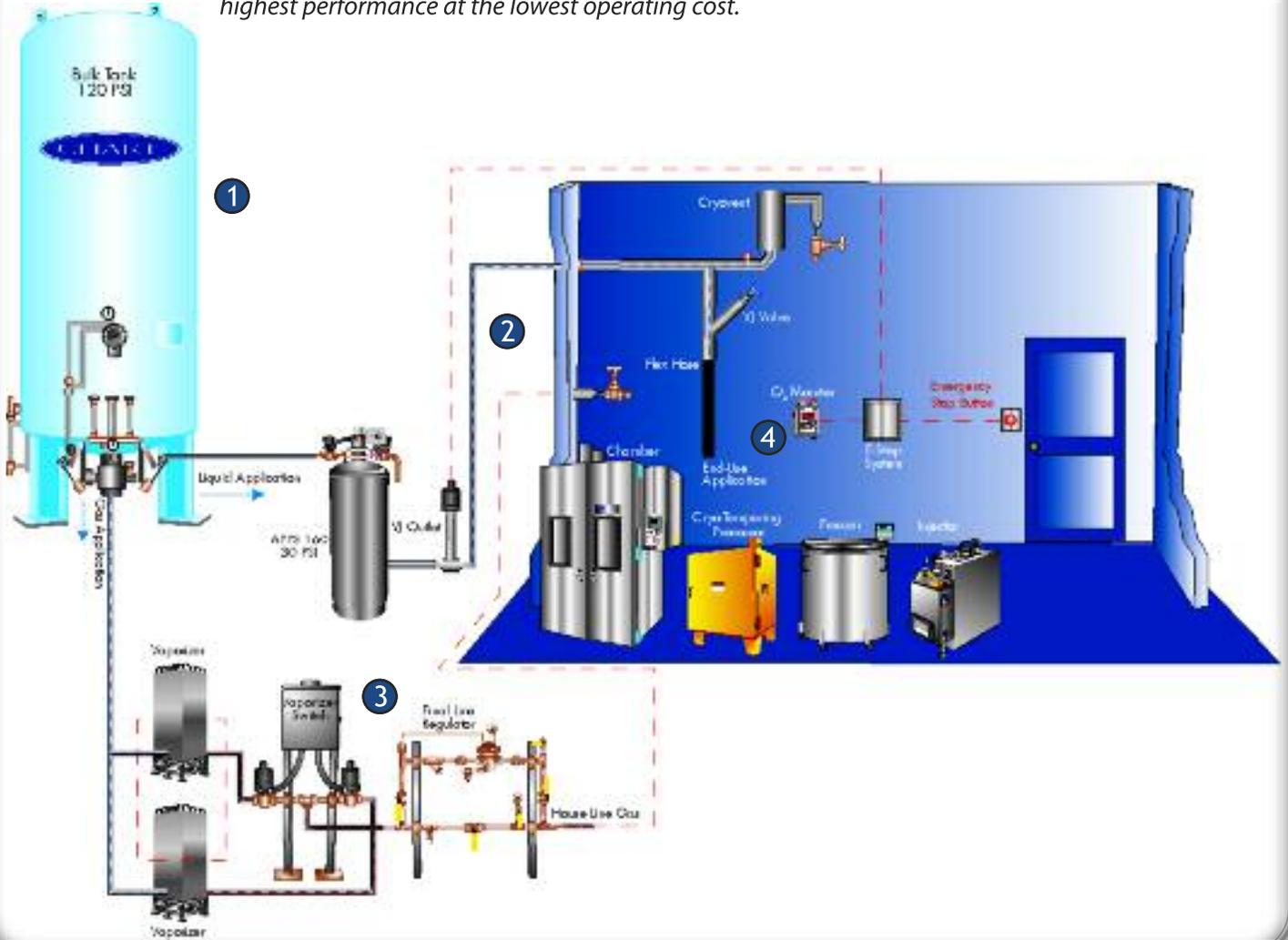


Installation & Startup

Certified technicians provide installation and training to assure long-term trouble-free operation.

Chart designs, manufactures, installs and services the complete integrated system.

*Chart's vacuum insulated pipe systems are custom engineered to meet your application's specifications. Chart's complete **system solution** package ensures quality liquid to keep your processes operating at their peak efficiency. Built for long-term integrity and industry-leading efficiency, these systems give you the highest performance at the lowest operating cost.*



1 Liquefied gases are stored at ultra-cold temperatures in a vacuum insulated tank. Controls on the tank keep the pressure of the liquid at optimum levels to assure proper liquid delivery to the application.

2 Vacuum insulated pipe connects the tank's liquid withdrawal to the application equipment. The pipe is the foundation for the system's heat-loss efficiency and long-term integrity. It must be engineered to work with the associated controls and accessories.

3 Chart manufactures equipment that controls and provides gas to other applications within the facility. Our engineers can help provide proper sizing for vaporizers, control manifolds, etc. to serve both a liquid and gas application from a single bulk tank liquid source.

4 The application equipment is designed to utilize liquid at specific properties. The system design must take careful consideration of the application and equipment requirements and specifications.

Vacuum Insulated Pipe

VIP to Meet the Needs of Any Application



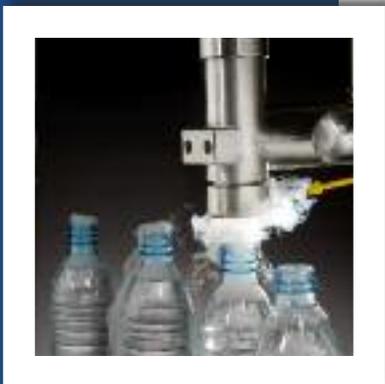
Biological Storage and Research

An efficient supply of high-quality liquid nitrogen is needed to keep valuable biological samples stored indefinitely. Today's top medical research facilities depend on a reliable liquid nitrogen supply to find cures for tomorrow's diseases. Any interruption in supply can result in the loss of many years of research. Chart's experience in the biological container market makes us the first choice in vacuum insulated pipe systems for these applications.



Molecular Beam Epitaxy

MBE is a method of laying down layers of materials with atomic thicknesses on a substrate (epitaxial growth). This is done by creating a "molecular beam" of a material which impinges on the substrate in a high-quality vacuum. A cryogenic screening around the substrate minimizes fluxes of atoms from the walls of the chamber. During this process, it is imperative that the supply of liquid nitrogen be uninterrupted and of good quality (the right pressure and temperature) to prevent contamination of the substrate or interruption of the process.



Food and Beverage Packaging

Using nitrogen to create positive pressure for a rigid container and displace oxygen for a longer shelf-life requires a consistent flow of quality liquid nitrogen to the injector. With Chart's engineered system solutions from the bulk tank to the injector, you get a reliable supply of liquid nitrogen that keeps your equipment operating at peak efficiency for maximum productivity.



Aerospace

Chart's vacuum insulated pipe is used on launch pads delivering extremely high flow rates of liquid hydrogen and oxygen to fuel today's demanding space programs. Aerospace applications are extremely precise, requiring larger diameters, higher pressures and intense analysis of engineering stress and heat leak. Additionally, Chart is able to meet the precision clean requirements common to these applications.



Food Freezing

Total system cost and efficiency is crucial in food freezing applications. Chart's superior insulation technology delivers liquid nitrogen with more cooling capacity, using less nitrogen per pound of frozen product. With our experience and capabilities in providing complete pipe system solutions, we help maintain the lowest total cost of ownership with the most efficient system.



Electronic Manufacturing and Testing

Silicone manufacturing and cleaning applications require extremely tight tolerances on the control of liquid nitrogen flow. It is critical that the vacuum insulated pipe system deliver the proper amount of liquid at the proper temperature to maximize wafer yield. For electronic component testing, Chart works with today's leading equipment manufacturers to design and manufacture pipe systems that supply the flows demanded by today's thermal stress environmental test chambers. As the leading manufacturer of LN₂ cooled chambers, Chart gets your pipe system right the first time.

Vacuum Insulated Pipe

Engineered Vacuum Insulated Pipe

ENGINEERED VIP



Vacuum insulated pipe systems provide the most efficient method of transferring quality cryogenic liquid, allowing you to focus on operations rather than the liquid supply. Once the system is installed, its maintenance-free design will provide you with many years of trouble-free service.

Serving a variety of markets and usage requirements, Chart's vacuum insulated pipe systems meet the unique demands of every customer. With our industry-leading experience we can help you select the pipe system that best suits your application and installation.

Product Advantages

- **Stationary, static vacuum system**
100% stainless steel and/or invar construction for a maintenance-free long service life
- **Sized to match usage needs**
Available in a variety of styles and sizes to meet the unique demands of your application
- **Maximize limited space**
The smallest diameter outer with the largest diameter inner available today
- **Built to industry standards**
Qualified to ASME Code, Section B31.1, Chemical Plant and Petroleum Refining



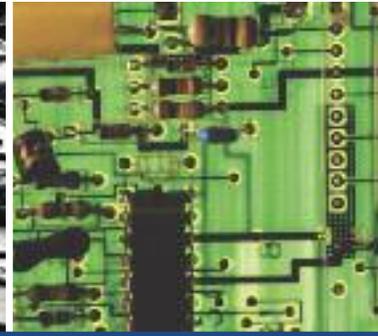
	Invar	Internal Bellows	External Bellows	Helium
FEATURES				
Heat Leak	★★★★	★★★★	★★★★	★★★★
Pressure Drop	★★★★	★★★	★★★★	★★★★
External Durability	★★★★	★★★★	★★★	★★★★
Installation Flexibility	★★★★	★★★★	★★★	★★★
Section Connections	Bayonets or Field Joints			
MATERIALS				
Inner pipe	Invar36	T304 Stainless Steel		
Outer jacket	T304 Stainless Steel; Bright Annealed ⁽¹⁾			
DESIGN CODE	Built in accordance with ASME, Section B31.3 ⁽²⁾			
MAWP ⁽³⁾	150 psig			
NOMINAL PIPE SIZES				
1/2" Inner	2" Nominal Pipe Size			
1" Inner	3" Nominal Pipe Size			
1-1/2" Inner	3-1/2" Nominal Pipe Size			
2" Inner	3-1/2" Nominal Pipe Size			
3" Inner	N/A	5" Nominal Pipe Size		
4" Inner	N/A	6" Nominal Pipe Size		
Larger	N/A	Larger sizes are available - consult factory for details		

(1) Outer jacket for 3-inch inner and larger is not bright annealed
 (2) Code required X-ray or pneumatic pressure tests are optional
 (3) MAWP = Maximum allowable working pressure

★Poor ★★Good ★★★Better ★★★★Best



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Invar



The ultimate solution for the most demanding applications. Special Invar material is used for the inner pipe, eliminating the need for flexible bellows. Chart's pipe is qualified in all respects to ASME Code, Section B31.3, chemical plant and petroleum refining piping for 150 psi. Invar's extremely low thermal contraction eliminates the need for bellows or convoluted flex hose. All-rigid construction means design simplicity and long-term integrity; no extra weld fatigue from adding items for construction; less stress during over-the-road shipments; and minimal damage during installation. Bayonet or field weld connections.

Internal Bellows



Our most common solution for many industrial applications. Internal bellows eliminate contraction of the outer pipe and give it a clean look. This industrial/commercial grade product is built to the same rigid requirements as ASME piping. The material is very corrosion resistant. Bayonet or field weld connections.

External Bellows



External bellows are a good choice for our customers who need higher pressure ratings or reduced pressure drop, as the flexible bellows material is moved to the outer jacket. This product is qualified in all respects to ASME Code, Section B31.3, chemical plant and petroleum refining piping for 150 psi. The material is very corrosion resistant. Bayonet or field weld connections.

Helium Lines



The solution for helium piping starts with 2 1/2 times more insulation for super-low heat leak. Field joints are also 67% more efficient than standard piping. Chart's helium lines are qualified in all respects to ASME Code, Section B31.3, chemical plant and petroleum refining piping for 150 psi.

Vacuum Insulated Pipe

Modular Vacuum Insulated Pipe (MVIP™)

MVIP™

MVIP™

Chart's latest pipe innovation, Modular Vacuum Insulated Pipe (MVIP™), is a pre-fabricated interlocking system for cryogenic liquid service. Piping modules are connected with vacuum insulated bayonets for a simple and flexible system installation. Standard modules allow for quick delivery and are reusable during application equipment upgrades or facility layout changes.

Chart's MVIP™ eliminates sweating and frosting problems that lead to wasted energy and potential safety issues. So start installing MVIP™ and upgrade your customers to today's technology.

Are you still installing old pipe technology?



Get with MVIP™

- ▶ Thermal efficiency 10 times better than foam insulated pipe
- ▶ Proven MVE bayonet technology and vacuum integrity
- ▶ No cutting, welding, brazing or foaming during installation
- ▶ Standard module designs for short lead-times
- ▶ Available in ½", 1" and 2" inner pipe sizes

Modular Vacuum Insulated Piping



Foam Insulated Piping (X-50)



Materials

Inner pipe	T304 Stainless Steel
Outer jacket	T304 Stainless Steel
Design Code	Built in accordance with ASME, Section B31.3 ⁽¹⁾
MAWP⁽²⁾	150 psig
Service	LN ₂ , LAR

Nominal Pipe Sizes

½" Inner	2" Outer Jacket
1" Inner	3" Outer Jacket
2" Inner	3½" Outer Jacket

(1) Code required X-ray not available. Pneumatic pressure tests are optional.
(2) MAWP = Maximum Allowable Working Pressure.

MVIP™ Modulator Application

Design your own MVIP™ System



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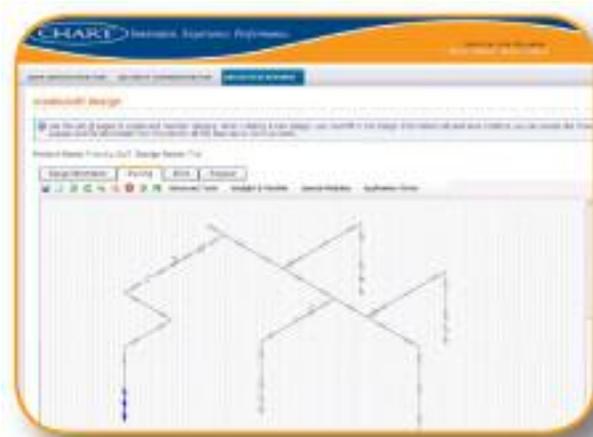
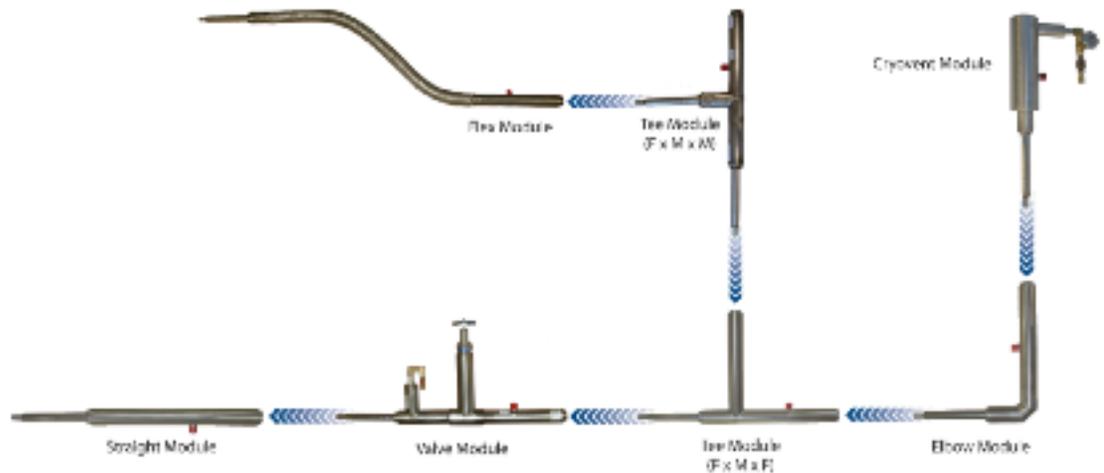


Chart's new **MVIP Modulator** website allows you to design your own VIP system using our Modular Vacuum Insulated Pipe (MVIP™) components. The Modulator takes the mystery out of designing a vacuum insulated pipe system.

- Easily builds an MVIP system in 3D with standard components
- Automatically calculates pressure drop in pipe to optimize pipe size
- Accurate drawings show layout dimensions that can be used as an installation guide
- Full parts list with complete proposal simplifies ordering process
- Fast, accurate and available 24/7
- Manage your projects and designs on-line from any computer, at any time
- On-line help videos demonstrate the MVIP Modulator's many features
- Combine engineered piping with MVIP – consult factory

Modules Available

- Straight lengths of 2' - 6', 10', 15', 20', 30'
- Vacuum Insulated Flexible modules
- Vacuum Insulated Valve module
- Drop module with Internal Liquid Trap
- Cryovent module
- Elbow module
- (2) Tee modules (F x M x M) and (F x M x F)
- Bayonet adapters to adapt to MVE VIP design, or MPT



Design your own system on-line at
www.chart-ind.com/mvipmodulator

Vacuum Insulated Pipe

Python Pipe

Python®



Python®

Python® products provide thermal performance that far exceeds conventional foam insulation materials, take only a fraction as much space, and require no additional protection against moisture or vapors. Python piping is adaptable, reusable and easy to install.

Installed costs are comparable to most conventional mechanical insulation systems. Typical delivery on small projects is next day from stock. Installation service can be provided from one of our many locations worldwide.

Python piping is designed for temperatures down to -350° F and pressures up to 400 psig. Python systems can be modified and adapted to many applications from liquid nitrogen to chilled water. Python piping is ideal for highly temperature-sensitive piping systems found in the petrochemical, energy, manufacturing, and food and beverage industries around the world. It is an excellent selection for liquid CO₂ applications.

Physical Characteristics

➤ Composition

- Inner and outer stainless steel pipe
- Custom flex expansion/contraction transition joint
- Combination evacuation/relief valve
- Insulation: MLI laminar radiation shielding, vacuum, gettering system

➤ Construction

- Heli-arc (TIG) welding
- MAWP 400 psig

➤ Design Code

- ASME B31.3
- MIL-Q-9858A
- MIL-1-45208A

➤ QA/QC Compliance

- ISO 9001

➤ Dimensions

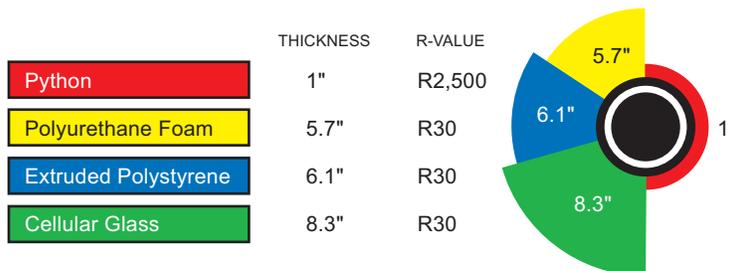
- 2' - 20' straight standard sections of 1" and 2" (shipped from inventory) and 3" NPS diameter
- Flexible sections available to accommodate various system design needs

➤ Joints

- Factory cleaned and protected for field welding (consult manufacturer for available joint configuration and insulation options)



Thermal Efficiency Comparison



Insulation thickness and associated R-value
(ambient air= 80°F — pipe= -100°F)



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Bayonets

Chart's bayonet fittings are the fastest way to install a vacuum insulated pipe system and are designed to provide a very reliable connection that is leak resistant and thermally efficient. It is as easy as engaging the male bayonet into the female bayonet until the flanges contact the O-ring, then tightening a V-band clamp around the bayonet flange!

- Easy to install
- Leak resistant
- Thermally efficient



Male and Female Bayonets



Bayonet, shown with V-band Clamp

Product Advantages

Field Joints

For the most demanding applications where higher pressures and thermal efficiency are of great importance, field joints connections are available.

- High pressure applications
- Increased thermal efficiency
- Engineered vacuum insulated pipe or Python



Field Joints for VIP



Field Joints for Python, shown with cover

Product Advantages

Vacuum Insulated Pipe

Flex Pipe



Many cryogenic pipe systems require flexible vacuum insulated lines. These applications include connection points to the bulk tank or the application equipment such as food freezers, test chambers, cryo-biological freezers or nitrogen dosers. Flexible sections may also be used to make installations in tight, confined spaces easier to manage.

DynaFlex™

DynaFlex™ is an all stainless steel coaxial vacuum insulated pipe that utilizes an external vacuum pump to maintain the system vacuum. Modular by design, DynaFlex spools are joined together with close tolerance bayonet connections. Jumper hoses are used to connect the vacuum annulus of each section of pipe.

Cryotech/Chart offers a complete line of components including in-line venting devices, phase separators, gas traps, tees, and elbows to maximize the system performance and design.

Product Features

- Continuous On-Site Vacuum Pumping Required
- Vacuum Jumper Hoses Required for Multiple Sections
- Triax Compatible
- Modular Design
- Three Year Warranty
- Close Tolerance Bayonets
- Minimal Cool Down Losses



DynaFlex™	D625	D1250
Inner Diameter (ID)	0.625"	1.25"
Outer Diameter (OD)	1.8"	2.6"
Steady State Heat Loss	1 btu/hr/ft	2 btu/hr/ft
Bayonet Heat Loss	6 btu/hr	12 btu/hr
Max. Operating Pressure	200 psi	125 psi
Weight	0.9 lbs/ft	1.4 lbs/ft
Min. Bend Radius	18"	30"
Max. Length (Single Spool)	60 ft	
Pipe Construction	All SST 300 Construction	
Protective Outer Cover	Braided Flex	
Standard Testing	He Mass Spectrometer, Vacuum Retention, LN ₂ Cold Shock (AQL Lot Sampling)	
Optional Testing	Certificate of Conformance, Leak Test Certification, Vacuum Certification, Material Certificate, 100% LN ₂ Cold Shock, Pressure Testing, X-Ray, O ₂ Cleaning	



Innovation. Experience. Performance.®



StatiFlex™

StatiFlex™ is an all stainless coaxial vacuum insulated pipe pumped down and sealed at the factory. Modular by design, StatiFlex spools are joined together with close tolerance bayonet connections.

Cryotech/Chart offers a complete line of components including in-line venting devices, phase separators, gas traps, tees, and elbows to maximize the system performance and design.

Product Features

- Pre-evacuated and Sealed Vacuum
- Triax Compatible
- Modular Design
- Three Year Warranty
- Close Tolerance Bayonets
- Minimal Cool Down Losses



StatiFlex™	S625	S1250
Inner Diameter (ID)	0.625"	1.25"
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Optional Testing	Certificate of Conformance, Leak Test Certification, Vacuum Certification, Material Certificate, 100% LN ₂ Cold Shock, Pressure Testing, X-Ray, O ₂ Cleaning	

Vacuum Insulated Pipe

Flex Pipe



Innovation. Experience. Performance.™



CryotechFlex™

CryotechFlex™ is a super flexible vacuum insulated liquid nitrogen transfer hose. The coaxial bellowed construction allows for optimal flexibility. The use of lightweight stainless steel reduces cool-down loss to an absolute minimum.

CryotechFlex hoses are protected by a stainless steel spiral wrap or braided outer cover. These hoses are used in a wide variety of applications including tool connections and custom OEM applications.

Cryotech/Chart offers a complete line of components including in-line venting devices, phase separators, gas traps, tees, and elbows to maximize the system performance and design.

Product Features

- Custom Manifolds
- High Pressure Requirements
- Pre-evacuated and Sealed Vacuum
- One Year Warranty
- Minimal Cool Down Losses
- Minimal Steady State Losses



CryotechFlex™ Hose	04S	06S	08S	08B
Inner Diameter (ID)	1/4"	3/8"	1/2"	1/2"
Outer Diameter (OD)	1.25"	1.65"	1.90"	1.80"
Min. Flexible Bend Radius	7"	8"	10"	10"
Min. Static Bend Radius	5"	6"	8"	7"
Max. Operating Pressure	150 psi	150 psi	150 psi	150 psi

S: Spiral wrap outer covering **B:** Braided outer covering

CryotechFlex hoses are available in standard or custom lengths up to 60 feet.



Supplement your vacuum insulated pipe system with Chart's engineered accessories. Our accessories have been field-tested for reliability and durability to give years of trouble-free service.

Phase Separator

Phase Separators are stainless steel, vacuum insulated vessels designed to store liquid nitrogen under atmospheric pressure. They are used in specialized applications requiring extremely high quality, low pressure liquid nitrogen on demand.

The level of liquid nitrogen is automatically controlled to provide a consistent volume of liquid in the phase separator. The reservoir is vented to atmosphere at all times ensuring that the pressure inside is equal to atmosphere. This results in a volume of pure saturated liquid nitrogen.

Product Advantages

- ▶ **Low Pressure LN₂** - stored at atmospheric pressure to gravity feed LN₂
- ▶ **Pure LN₂ Delivery** - LN₂ at atmospheric pressure guarantees the highest quality of liquid for the application
- ▶ **Closed Loop System** - re-circulate and re-use LN₂ through the Phase Separator and custom designed triax pipe
- ▶ **On Demand LN₂** - LN₂ is stored in the Phase Separator for immediate, on demand consumption



Materials	Stainless Steel 300
Controller Dimensions	14"H x 6.5"D x 2.5"W
Number of Outlets	2 to 10 (even increments)
Capacity/Operational Volume	2 & 4 outlets: 4.63 gallons 6, 8, & 10 outlets: 12.19 gallons
Weight	Empty Condition: 60 - 85 lbs Full Condition: 100 - 163 lbs
System Utilities	Electricity: 110 - 220VAC, 50 - 60Hz Gaseous Nitrogen: Minimum 50 psi, Maximum 100 psi Liquid Nitrogen: Maximum 125 psi, 80 psi optimal
Certifications	NEMA 4X, CE
Options	Custom sizes, ASME coded pressure vessels, backpressure regulator (10 psi max)

Vacuum Insulated Pipe

VIP Accessories



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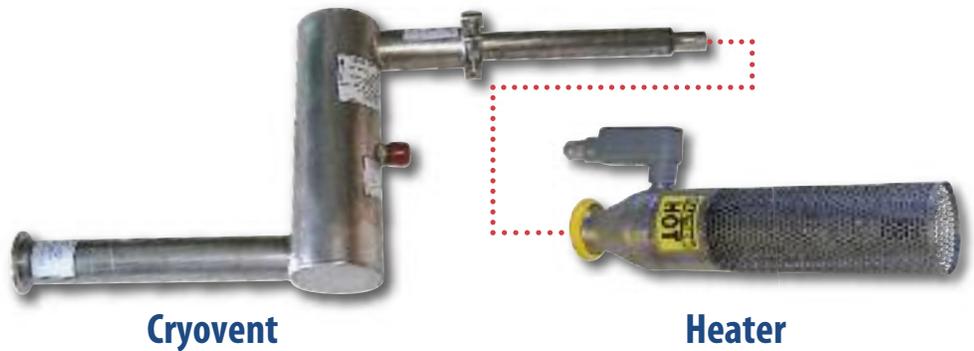


Cryovents and Heaters

Chart's cryovents are installed to enhance the performance of the pipe system. In normal operation, some liquid is boiled to vapor from the small amount of heat leak into the pipe, and the cryovent allows this gas to escape. Applications requiring continuous up-time of liquid in the piping system must have a cryovent installed to ensure the availability of quality liquid. The result is more efficient operation of the liquid supply.

Product Advantages

- Available in a wide variety of sizes and configurations, including vacuum insulated exhaust connection to reduce ice build-up from the cold gas
- Electric heater options also available as another solution to eliminate exhaust ice build-up
- Available with pipe thread or bayonet inlets and outlets for system installation flexibility



Cryovent

Heater

Vacuum Jacketed (VJ) Valves

Cryogenic pipe systems often require valves to properly control the liquid flow to the application. Strategically located valves control flow to a branch of the system or into a use-point drop. A vacuum insulated valve has the benefit of extremely low heat leak for minimum gas boil-off, and it eliminates ice build-up and dripping water.

Product Advantages

- Available in many sizes and styles such as T or Y pattern
- The more compact Y-pattern valve is generally used in vertical drops for easier operation, better reliability and higher flow rates.
- Actuators can be installed on valves for control from a remote location or signal. Standard pneumatic actuators are often used to control flow rate or open and close valves based on the state of a switch, control system, or oxygen system E-stop switch.
- Un-insulated economical brass valves are also available for applications that have infrequent use. It is highly recommended to locate the internal liquid trap accessory above the valve to create a gas trap.



T-Pattern Vacuum Insulated Globe Valve

Y-Pattern Vacuum Insulated Globe Valve

T-Pattern Non-Insulated Extended Stem Globe Valve



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Vacuum Insulated Withdrawal

One of the most important options for any vacuum insulated pipe system is the vacuum insulated withdrawal on the liquid storage vessel. Because this option is part of the vessel vacuum system, it must be specified with the tank order. Chart's engineers can help make sure the tank and pipe connections are correct for proper integration in the field.

Chart's Vacuum Insulated Liquid Withdrawal option is designed for applications that require the transfer of higher quality, cold low-pressure liquid from bulk or MicroBulk storage.

Providing quality low-pressure liquid at the point of use requires minimal heat leak throughout the entire piping system, including key plumbing components. The system begins with the bulk tank. Chart has developed the most efficient storage tank design for liquid applications using state-of-the-art vacuum insulation.

Product Advantages

- Eliminates ice build-up and dripping water at tank connection
- Reduces liquid consumption from boil-off
- Available on bulk tanks and Perma-Cyl® units
- Specify end connection and isolation valve style with tank order



Bulk tank with vacuum insulated liquid withdrawal



Perma-Cyl tank with vacuum insulated liquid withdrawal

Vacuum Insulated Pipe

VIP Accessories



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Liquid Flow Meter

For applications that require accurate cryogenic metering, the liquid flow meter is the solution. Based on the field-tested Orca flow meter, this meter system is a proven product without any moving parts to service. It accurately measures the pressure drop through a fixed orifice and reads the actual temperature of the liquid to calculate the liquid flow.

Product Advantages

- Accuracy capability: +/- 1.5%
- Approvals: National Institute of Standards and Testing (NIST) and California Weights and Measures
- Computer interface: RS-232
- Electronic display module to view current flow rate as well as totalized flow
- Readouts: pounds, kilograms, imperial gallons, US gallons and liters of liquid; cubic feet and cubic meters of gas
- Meter section is permanently encased in a vacuum insulated pipe section for thermal efficiency and meter accuracy



Liquid Flow Meter

Adjustable Pressure Phase Separator (APPS)

The APPS-160 provides a convenient method of providing low-pressure liquid to an installation that is supplied from a bulk tank at higher pressure. The APPS provides a lower cost solution to supplying liquid at different pressures than installing two bulk tanks.

Product Advantages

- Provides tighter pressure control for the lower pressure liquid application
- Adjustable outlet pressure ranges of either 10-50 psig or 40-85 psig
- Working capacity: 160 liters
- Bayonet outlet connection is standard



APPS-160

End-Use Equipment and Pipe Size Chart



www.cryotechinternational.com

Liquid Nitrogen Dosing Systems

Extend food shelf life and improve package integrity with our liquid nitrogen (LN₂) dosing equipment. Designed for easy interchangeability to various packaging lines, our injectors provide continuous operation at high fill speeds. Engineered options are available to meet your packaging specifications.



www.chartchambers.com

Reliability Test Chamber

Using the extreme cooling capabilities of liquid nitrogen, our REAL series HALT/HASS reliability test chambers can reach the lowest temperatures at the fastest rates possible for maximum thermal stress testing and screening of your components. The REAL series product line offers a wide range of features, from vibration tables to user-friendly touch screen controls.



www.chartbiomed.com

Biological Freezers

Chart/MVE Biological Systems is the leading supplier of products for freezing, long-term storage and distribution of biological materials with liquid nitrogen. Our XLC series offers a wide range of models with electronic controls to match your application and storage process.

LN₂ Flow vs. Pipe Size

The following table can be used as an initial estimate of required pipe size. It is strongly suggested that a detailed analysis of the actual expected pressure drop be considered with respect to the allowable pressure drop for the process of interest.

Length Equivalent	1/2" PS	1" PS	1-1/2" PS	2" PS	3" PS
100'	4 GPM	20 GPM	56 GPM	110 GPM	325 GPM
200'	3 GPM	14 GPM	40 GPM	78 GPM	225 GPM
300'	2 GPM	11 GPM	32 GPM	63 GPM	185 GPM
400'	2 GPM	10 GPM	28 GPM	54 GPM	160 GPM
500'	1 GPM	8 GPM	25 GPM	48 GPM	140 GPM

Notes: 1. This table is intended to be used as a guide only and should not be substituted for a complete analysis.

2. Length equivalent is length of pipe plus fitting factors
3. Valve = 40 feet / Elbow or tee = 20 feet / 1 foot flex = 3 feet
4. One foot vertical rise = 0.35 psi pressure drop for nitrogen service
5. Suggested sizes assume an allowable pressure drop of 5 psi.



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