



Product Manual

Liquid Cylinders

Dura-Cyl® Liquid Cylinders

120LP, 160MP/HP, 180LP/MP/HP, 200LP/MP/HP, 230LP/MP/HP, 265MP/HP

Cryo-Cyl™ 80HP Liquid Cylinders



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Revision Log

Revision Level	Date	Description
K	05/01/1998	Addition of new Dura-Cyl HP LCCM module
L	10/07/2008	Updated exploded views of Dura-Cyl and Cryo-Cyl Tanks
M	07/13/2016	Reformat and update information, add 7 year vacuum warranty info.



Preface

General

The Dura-Cyl® Liquid Cylinder series is a premium transportable liquid cylinder for cryogenic service. The patented internal support system design and quality construction makes the Dura-Cyl series the most efficient yet rugged cylinder on the market today. Along with the patented Liquid Cylinder Control Manifold (LCCM) and our wide choice of caster base / foot ring options, the Dura-Cyl series is also the most user-friendly cylinder available. Add in our industry-leading five-year vacuum warranty and you get the lowest cost of ownership - making the Dura-Cyl series the preferred choice in transportable liquid cylinders.

Like the Dura-Cyl models, the Cryo-Cyl™ 80 HP Liquid Cylinder is designed and built to meet the rugged demands of the liquid cylinder market. However, in contrast, this model is designed specifically for liquid and low to medium gas flow applications. By specifically targeting these applications, we are able to offer this model at an economical value over our premium Dura-Cyl series.

Product Highlights

- Ideal for liquid nitrogen, oxygen, argon, CO₂ or nitrous oxide
- Different sizes, pressures, and features to meet your needs
- Stainless steel bottle construction
- Thick, dent-resistant outer shell
- Patented durable, inner-vessel support system
- Heavy duty foot ring and/or large diameter handling ring with four supports
- Optional Micrometer Controlled Regulator (MCR) or Liquid Cylinder Control Manifold (LCCM)
- Roto-Tel™ Liquid Level Gauge
- Seven-year vacuum warranty (as of 1/1/2016)
- Cryo-Cyl liquid cylinders have the vent and gas use valves combined for simple and safe operation

Product Manual

The Liquid Cylinder Product Manual is designed to be used in conjunction with Dura-Cyl Series Liquid Cylinders and Cryo-Cyl 80 HP Liquid Cylinders. It should be thoroughly read and understood by anyone that operates, or is exposed to this equipment. If there are any questions regarding the operation of the tank, contact Chart's Technical Service division at 1-800-400-4683.

The Safety section discusses the safety requirements needed to operate any of the Dura-Cyl series liquid cylinders and the Cryo-Cyl 80 HP liquid cylinders. Additional safety information on cryogenics or the gases carried can be obtained from the Compressed Gas Association.

The Introduction section discusses the general features of the liquid cylinders, safe handling procedures and the theory of operation.

Reference the Operations section for actual operations of the various liquid cylinder models including filling weight tables. This section can be used as a quick reference guide and will provide the specific information needed to operate each model.

In the Maintenance section you will find general maintenance information along with a Troubleshooting guide and common repair descriptions.

The Specifications section will provide cylinder capacity information, drawings and part numbers.

Terms

Throughout this manual safety precautions will be designated as follows:



Warning! *Description of a condition that can result in personal injury or death.*



Caution! *Description of a condition that can result in equipment or component damage.*



Note: *A statement that contains information that is important enough to emphasize or repeat.*

Acronyms / Abbreviations

The following acronyms / abbreviations are used throughout this manual:

BAR	Pressure (Metric)
BARG	Pressure (Metric) Gauge
BTU	British Thermal Unit
CGA	Compressed Gas Association
CO ₂	Carbon Dioxide
DOT	Department of Transportation
HP	High Pressure
LCCM	Liquid Cylinder Control Manifold
LP	Low Pressure
MAWP	Maximum Allowable Working Pressure
MCR	Micrometer Controlled Regulator
MP	Medium Pressure
N ₂ O	Nitrous Oxide
PB	Pressure Builder
PN	Part Number
PSI	Pounds per Square Inch
PSIG	Pounds per Square Inch (Gauge)
RV	Relief Valve



Safety

General

Chart has conducted a rigid test program for liquid cylinders, both internally and through an independent testing laboratory, to verify the safety of Chart equipment. Dura-Cyl® and Cryo-Cyl™ Liquid Cylinders are safely designed with the following features:

- An exclusive all stainless steel support system designed to withstand many years of rugged service.
- A stainless steel neck tube that is designed not to break in case of a minor accident, such as a liquid cylinder being inadvertently tipped over.
- A vacuum maintenance system specifically designed to provide long life and safety provisions.
- Safety relief devices to protect the pressure vessel and vacuum casing, sized and selected in accordance with CGA Pamphlet S-1.1 "Safety Relief Devices for Cylinders."

While Chart equipment is designed and built to rigid standards, no piece of mechanical equipment can ever be made 100% safe. Strict compliance with proper safety and handling practices are necessary when using a liquid cylinder or other compressed gas equipment. We recommend that all of our customers reemphasize safety and safe handling practices to all their employees and customers. While safety features have been designed into the unit and safe operations are anticipated, it is essential that the user of these liquid cylinders carefully read to fully understand all WARNINGS and CAUTIONS listed in this safety section and enumerated below. Also read to fully understand the information provided in the Safety Summary below.

Safety Summary

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



Warning! *In oxygen enriched atmospheres flammable items burn vigorously and could explode. 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.



Warning! *DO NOT permit smoking or open flames in any area where oxygen is stored, handled, or used. Failure to comply with this warning may result in serious personal injury.*



Warning! *The Dura-Cyl Series and Cryo-Cyl 80HP cylinder, with their stainless steel support system, are designed, manufactured, and tested to function normally for many years of service. Chart does not suggest or warrant that it is ever safe to drop a liquid cylinder or let it fall over in oxygen or any other cryogenic service.*



Caution! *Only use replacement equipment which is compatible with liquid oxygen and has been cleaned for oxygen use. Do not use regulators, fittings, hoses, etc., which have been previously used in compressed air service. Similarly, do not use oxygen equipment for compressed air. Failure to comply with these instructions may result in serious damage to the liquid cylinder.*

In the event a liquid cylinder is inadvertently dropped, tipped over, or abused, slowly raise it to its normal vertical position. Immediately open the vent valve to release any excess pressure in a safe manner. As soon as possible, remove the liquid product from the vessel in a safe manner. If the vessel has been used in oxygen service, purge it with an inert gas (nitrogen). If damage is evident or suspected, return to Chart prominently marked "LIQUID CYLINDER DROPPED, INSPECT FOR DAMAGE."



Caution! *Before removing cylinder parts or loosening fittings, completely empty the liquid cylinder of liquid and release the entire vapor pressure in a safe manner. External valves and fittings can become extremely cold and may cause painful burns to personnel unless properly protected.*

Safety Bulletin

Portions of the following information is extracted from Safety Bulletin SB-2 from the Compressed Gas Association, Inc. Additional information on oxygen, nitrogen, argon, and cryogenics is available from the CGA.

Cryogenic containers, stationary or portable, are from time to time subjected to assorted environmental conditions of an unforeseen nature. This safety bulletin is intended to call attention to the fact that whenever a cryogenic container is involved in any incident whereby the container or its safety devices are damaged, good safety practices must be followed. The same holds true whenever the integrity or function of a container is suspected of abnormal operation.

Good safety practices dictate the contents of a damaged or suspect container be carefully emptied as soon as possible. Under no circumstances should a damaged container be left with product in it for an extended period of time. Further, a damaged or suspect container should not be refilled unless the unit has been repaired and recertified.

Incidents which require that such practices be followed include: highway accidents, immersion of a container in water, exposure to extreme heat or fire, and exposure to most adverse weather conditions (earthquake, tornadoes, etc.) As a rule of thumb, whenever a container is suspected of abnormal operation, or has sustained actual damage, good safety practices must be followed.

In the event of known or suspected container vacuum problems (even if an extraordinary circumstance such as those noted above has not occurred), do not continue to use the unit. Continued use of a cryogenic container that has a vacuum problem can lead to embrittlement and cracking. Further, the carbon steel jacket could possibly rupture if the unit is exposed to inordinate stress conditions caused by an internal liquid leak.

Prior to reusing a damaged container, the unit must be tested, evaluated, and repaired as necessary. It is highly recommended that any damaged container be returned to Chart for repair and recertification.

The remainder of this safety bulletin addresses those adverse environments that may be encountered when a cryogenic container has been severely damaged. These are oxygen deficient atmospheres, oxygen enriched atmospheres, and exposure to inert gases.

Oxygen Deficient Atmospheres



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.

The normal oxygen content of air is approximately 21%. Depletion of the oxygen content in air, either by combustion or by displacement with inert gas, is a potential hazard and 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 about 15% to 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 because 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 essentially helpless. This can occur if the condition is reached by an 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 the unconscious partner unless equipped with a portable air supply. Best protection is obtained by equipping all individuals with a portable supply of respirable air. Life lines are acceptable only if the area is essentially free of obstructions and individuals can assist one another without constraint.

If an 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 nonflammable, 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 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 proven 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 alloy) 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 asphyxiates. 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 narcosis 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 worker's skin or eyes, the affected tissue should be flooded or soaked with tepid water (105-115°F or 41-46°C). DO NOT USE HOT WATER. Cryogenic burns that result in blistering or deeper tissue freezing should be examined promptly by a physician.

Personal Protective Equipment (PPE)

The following personal protective equipment is recommended when working around cryogenic liquid:

- Safety glasses with side shields to prevent cryogenic liquid from splashing into the eyes
- Chemical / Liquid resistant gloves to prevent cryogenic burns on exposed hands
- Long sleeve shirts to protect the arms
- Cuffless trousers worn over closed shoes

Introduction

General

The Dura-Cyl® and Cryo-Cyl™ Liquid Cylinders are double walled, vacuum and multi-layer insulated cylinders designed for the transportation and storage of liquefied gases. All of the Dura-Cyl series and Cryo-Cyl 80 HP cylinders can be used for liquid argon, liquid nitrogen, and liquid oxygen. The Dura-Cyl HP series and the Cryo-Cyl 80 HP cylinders can also be used for transporting liquid carbon dioxide (CO₂) or liquid nitrous oxide (N₂O).

Dura-Cyl series liquid cylinders have model distinctions for low pressure liquid and gas withdrawal cylinders (LP), medium pressure liquid and gas withdrawal cylinders (MP), and high pressure liquid and gas withdrawal (HP). Cryo-Cyl liquid cylinders are only offered in 80HP. The various cylinder models also have capacity distinctions; the number after their name that designates net capacity in liters (i.e. Dura-Cyl 180 indicates 180 liter capacity).

Cylinder Design

The Dura-Cyl/Cryo-Cyl liquid cylinders are designed, manufactured and tested to the requirements of US DOT 4L and Transport Canada specifications. They are specifically authorized by the US Department of Transportation for transporting of liquid nitrogen, oxygen, argon, carbon dioxide, and nitrous oxide. They are specifically authorized by Transport Canada for the transporting of liquid nitrogen, oxygen and argon. They are authorized by Transport Canada for the transporting of carbon dioxide and nitrous oxide with an exemption.

The inner pressure vessel is constructed of stainless steel and supported within an outer stainless steel vacuum jacket. The support system is an all stainless steel internal support designed for low heat leak and high strength.

The illustration in Figure 1 shows the major components of the Dura-Cyl/Cryo-Cyl cylinders. The space between the inner and outer vessel makes up the insulation system. Multiple-layer insulation and high vacuum assures long holding time. The insulation system is designed for long term vacuum retention and is permanently sealed at the factory. The vacuum space is protected from over pressurization by the pump-out, based on the requirement of CGA 5-1.1-2003. The pump-out also functions as the vacuum port.

The outer vacuum jacket of the liquid cylinder contains an internal vaporizer which converts the cold liquid to gas. The internal pressure building system allows for immediate use of the cylinder by automatically building pressure to the preset operating pressure and maintaining it there during gas withdrawal.

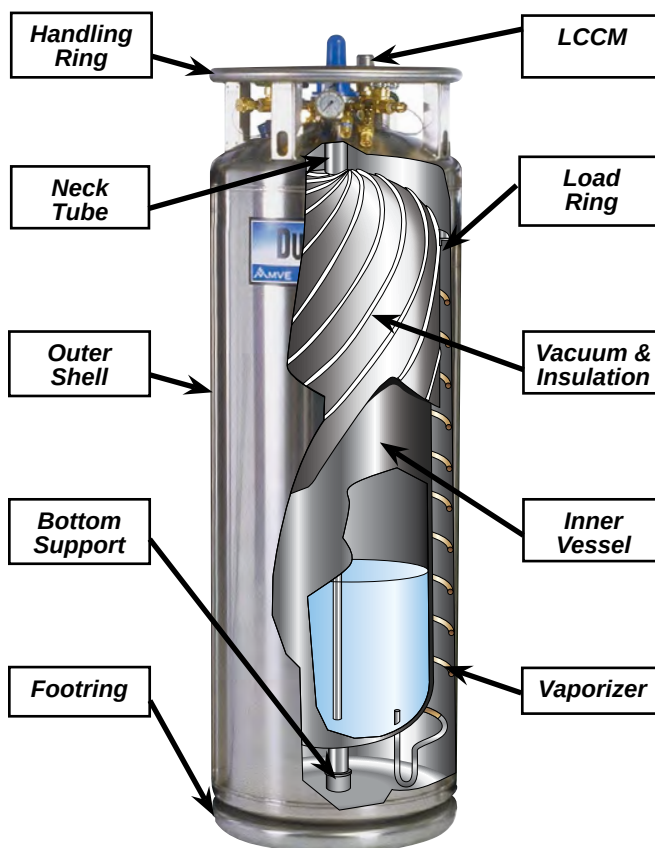


Figure 1

Each liquid cylinder is equipped with a stainless steel ring to protect the plumbing components. The ring on the Cryo-Cyl cylinder is connected to the cylinder with two handling posts; the Dura-Cyl cylinders use four handling posts. The posts have slots for ease in handling with a hand truck or an overhead hoist.

The Dura-Cyl/Cryo-Cyl liquid cylinders are constructed with all operating controls situated at the top of the cylinder for ease in gas withdrawal and liquid dispensing operations. In a stand-alone operating environment the units enable the user, through the use of the vent, liquid, pressure building and pressure relief devices, to completely control the liquid cylinder's operation.

To protect the inner pressure vessel from over pressurization, the units include a safety pressure relief valve. The liquid cylinders are further protected from over pressurization by a bursting disc that acts as a secondary relief device. These devices meet the requirements of CGA Pamphlet S-1.1 "Pressure Relief Device Standard - Part 1 - Cylinders for Compressed Gases."

A back control regulator is used to build and maintain operator pressure while assuring a no-loss operation under normal usage during gas withdrawal service. The no loss

portion of the regulator (referred to as the economizer) allows gas withdrawal directly from the vapor space of the cylinder until liquid cylinder head pressure is reduced to the normal operating range. This important feature is useful whenever a liquid cylinder has been inactive for a period of several days or whenever normal heat leak may have created an increase in head pressure.

For precise regulation of the outlet gas, add a final line gas regulator at the gas use connection. The operating pressure can be increased to the pressure control valve setting (if necessary) by changing the regulator.

These liquid cylinders provide a complete self-contained liquid or gas supply system for industrial, laboratory, or hospital use.

Cylinder Identification / Safety Devices

There are many different Dura-Cyl® Liquid Cylinders described in this manual. They vary in size, capacity, pressure, gas service and various plumbing features. It is important that these liquid cylinders can be easily identified. The Cryo-Cyl™ Liquid Cylinders are available in 80HP only.

The following table shows each model by type and indicates its capacity and pressure rating. The sight gauge protector color is an easy way to determine the pressure rating of a liquid cylinder.

Model Suffix	Model Color	Service Pressure (psig)	Maximum Relief Valve (psig)	Industry Standard Relief Setting (psig)	Maximum Rupture Disk (psig)
LP	Yellow	100	110	22	200
MP	Blue	200	235	230	300
HP	Orange	292	350	350	584

The data plate (Figure 2) is permanently attached to the handling post of the liquid cylinder. The data plate shows the serial number and pressure rating for that cylinder. Do not remove or alter the data plate in any way.



Figure 2

One of the most important requirements in the 4L code is the marking and calculation of the safety devices used to protect the inner pressure vessel. Manufacturers use these guidelines to design and select the appropriate safety devices based on calculations derived from the Compressed Gas Association (CGA) code, pamphlet S1.1 (CFR49 section 173.316). These safety devices are marked and sized accordingly to meet the minimum requirements for the capacity, liquid service and maximum operating pressure of the liquid cylinder on which they are installed. Confirming this requirement during the procurement of replacement relief valves and rupture disks from a reputable supplier will help ensure device compliance.

Based on the liquid cylinder stamping data, calculating the pressure settings on both of these safety devices is actually relatively simple. On a DOT - 4L coded cylinder, you can find the service pressure on the cylinder data plate. The service pressure (psig) is noted directly after the DOT marking: DOT - 4L SP. This will be a three-digit numeric value that dictates the design of the inner vessel thickness and the maximum allowable operating pressure calculation from the manufacturer.

To calculate the maximum allowable operating pressure or maximum relief valve setting, the following equation is used:

$$1.25 \times \text{Service Pressure} - 15 \text{ psi (for vacuum)} \\ = \text{Maximum Relief Valve}$$

Safe Handling

This section describes and illustrates proper cylinder handling procedures. Major considerations for liquid cylinder handling are summarized as follows:

- Dura-Cyl and Cryo-Cyl liquid cylinders should only be moved by utilizing an appropriate cylinder cart, roller base, or overhead hoist.
- Do not roll a liquid cylinder by the handling ring.
- Liquid cylinders should always be stored and operated in a vertical position.
- Never lay, store, or ship a cylinder on its side.
- When loading (or unloading) a cylinder onto a truck, use a power lift gate, crane, or an inclined ramp. Never attempt to manually lift or slide a liquid cylinder on or off of a truck bed.

Dura-Cyl and Cryo-Cyl liquid cylinders can be safely handled by using a cylinder cart, roller base, or an overhead hoist. When moving the unit, keep the unit upright at all times except for those instances when it is slightly tipped for loading or unloading.

Dura-Cyl and Cryo-Cyl liquid cylinders are durable and designed to withstand common handling; however, abusing a unit may damage the liquid cylinder to the extent that it must be returned to the factory for repair.

Preferred Lifting Procedure

To lift a Dura-Cyl®/Cryo-Cyl™ Liquid Cylinder attach the properly sized hooks and chains into both of the holes and lift vertically. Figure 3 shows how a chain system can be used to lift the liquid cylinder. The spreading bar is the preferred method, but the double chain system is acceptable.

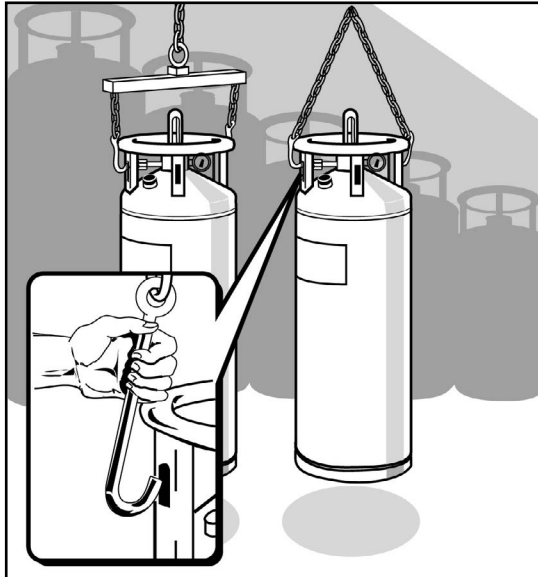


Figure 3

Preferred Handling Procedures

Figure 4 illustrates the preferred cylinder handling procedures. It shows the proper way to approach a cylinder when using a pneumatic-tire hand truck. It shows how to engage the pickup hook in the post slot and illustrates proper engagement. It then illustrates how to tilt the cylinder back once the pickup hook and post slot are engaged. The approximate tilt position of the cart should be maintained when transporting a cylinder.

Alternate Procedures

The use of a four wheel roller base that has been designed expressly for transporting a liquid cylinder is acceptable. This method is used when frequent and short distance moves of a liquid cylinder are required. Before utilizing this method of transportation, make sure the area over which the liquid cylinder is to be moved is flat and smooth.

The hard rubber-tire hand truck (or a hand truck having swivel rear wheels) can be used in place of a pneumatic-tire hand truck. As with the roller base, use of these methods should be limited to facilities having relatively smooth floors.

A semi-permanent handling carriage can be used which locks the Dura-Cyl/Cryo-Cyl liquid cylinder to the base for transporting cylinders. This arrangement is ideal for those users having the capability of filling their own liquid cylinders.

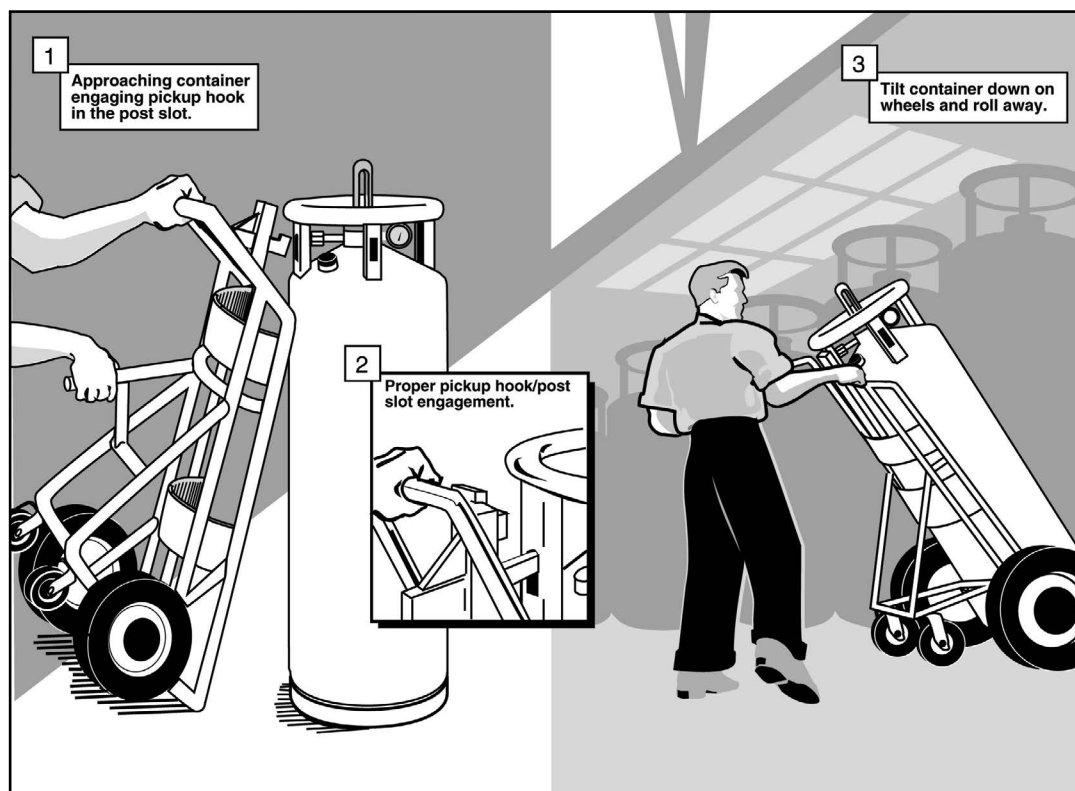


Figure 4

Transporting Procedures

The Dura-Cyl®/Cryo-Cyl™ Liquid Cylinders are designed to withstand the normal handling associated with transportation by truck.

Figure 5 illustrates how a cylinder should be secured in a truck for transportation. Nylon or other suitable straps should be used. The use of a strap prevents scratching on the surface and provides a reliable tie down arrangement. Never use a chain type binder or chains as that will scratch the finish and could crush or dent the vacuum jacket.

Figure 5 also shows the proper method of unloading a cylinder from a truck.



Note: The pneumatic-tire hand truck is being used and the cart and liquid cylinder are lowered to the ground by use of a power lift gate.

Responsibilities of Distributor and Fillers of Liquid Cylinders

Chart is stating below the responsibilities of the filler of any cryogenic liquid cylinder:

1. The cylinder must be in a safe condition.

The filler is responsible for confirming that any cylinder to be filled is in its proper working condition. This includes:

- It has an acceptable vacuum
- The relief system is in place and functioning
- There is no structural damage to the cylinder
- All warning labels are in place and legible

2. Do not overfill the cylinder

The cylinders are not to be filled beyond the recommended filling weight for the liquid being dispensed.

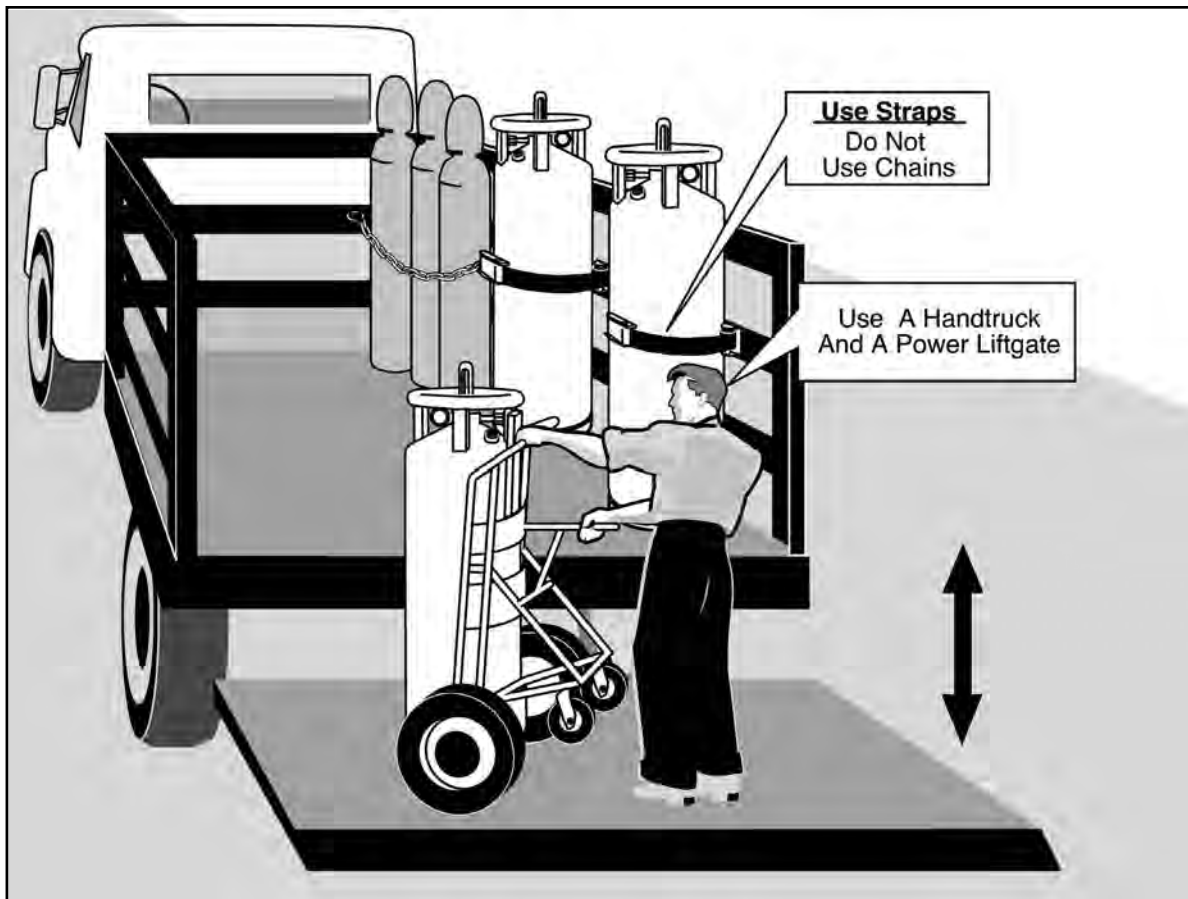


Figure 5

3. Dispense only to knowledgeable users.

The filler must determine that the user is knowledgeable about the general characteristics of the product and the proper safety precautions for its use. Do not allow customers to fill their own cylinders.

4. Dispose of cylinders properly.

To eliminate the risk of injury from the improper reuse of cryogenic (vacuum jacketed) cylinders, before disposal, destroy the cylinder's pressure retaining capability.

We recommend:

- Purging the cylinder's contents.
- Drilling multiple holes through the cylinder and its vacuum casing or otherwise puncture the tank.

Do it yourself! Don't assume it will be done by the scrap dealer.

Performance

The performance of a liquid cylinder can be shown in its ability to hold cryogenic liquid and dispense it as a gas.

The normal evaporation rate (NER) is an indication of how well the insulation system performs its ability to hold cryogenic liquid. Figure 6 indicates how the insulation performance affects the holding time for CO₂ and N₂O.

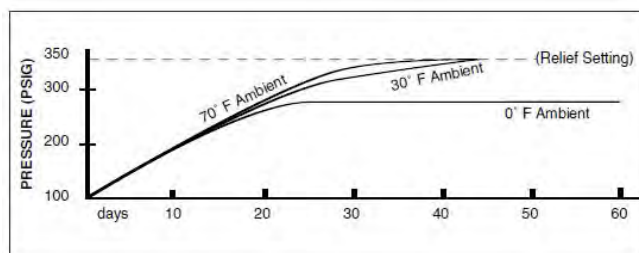


Figure 6

The pressure building system can be measured by how fast it can increase pressure in the liquid cylinder (Figure 7) and how well it maintains pressure while gas is being withdrawn from the cylinder (Figures 8 & 9).

Performance data provided in the illustrations represents typical values. Actual values may vary depending on ambient conditions and/or the condition of the liquids.

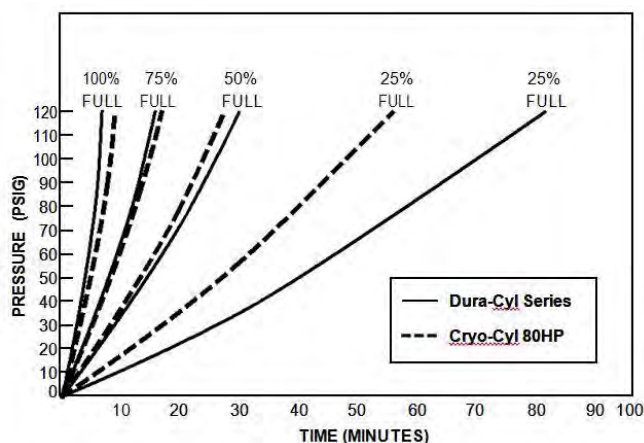
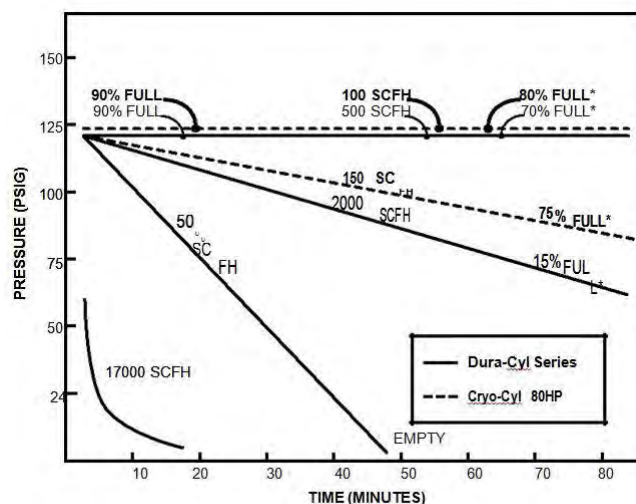


Figure 7



* Amount of liquid left at conclusion of test

Figure 8

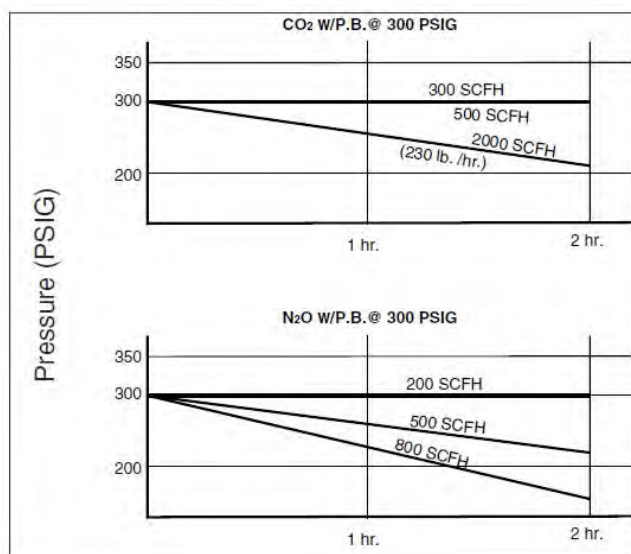


Figure 9

Principle of Operation

The various Dura-Cyl®/Cryo-Cyl™ Liquid Cylinders have the same general operating characteristics. Each model of liquid cylinder has the ability to be filled with a cryogenic product, build pressure inside the vessel, and deliver either liquid or gas for a specific application.

The following section will discuss the theory behind these operations. Later sections of this manual will give step-by-step procedures for the operation on each of the specific models of liquid cylinders.

Liquid cylinder operation is done completely with the control valves located on the top of the tank. The valves are labeled and color coded for easy identification: Fill/Liquid Valve - blue; Gas Use Valve - green; Vent Valve - silver; Pressure Building Valve - Green.

Filling Procedures

The following recommendations should be used to optimize liquid cylinder filling:

- Keep the transfer lines as short as possible. Long uninsulated transfer lines will result in higher fill losses and longer fill times.
- Any time liquid can be entrapped in a line between two valves, the line must be equipped with a safety relief device.
- Conduct the filling operation in as short a time as possible.
- Do not over fill. Fill only to the weight allowable by the specification.
- Use a minimum number of bends, valves and reducers.
- Use the largest transfer line possible - at least 1/2" ID.

The liquid cylinder should be visually inspected before every fill for possible damage, cleanliness and suitability for its intended gas service. If damage is detected (e.g. serious dents, loose fittings, etc.) remove it from service and repair the unit as soon as possible.

All Chart liquid cylinders are tested for performance with low-purity liquid nitrogen. For this reason liquid cylinders intended for use in another service should be thoroughly purged with the applicable gas prior to filling.

When filling a liquid cylinder with a cryogenic liquid, the transfer may be made with a centrifugal pump or through a pressure transfer operation.

Pressure Transfer

Liquid will always flow from a vessel of higher pressure to one with low pressure. This method is commonly used to fill liquid cylinders by connecting a transfer line between the delivery source and the Fill/Liquid valve of the liquid cylinder. The transfer takes place as the vent valve of the liquid cylinder is opened. This allows gas to escape and lowers the pressure in the liquid cylinder. This method should always be used for liquid only vessels. Figure 10 shows the pressure transfer method of filling.

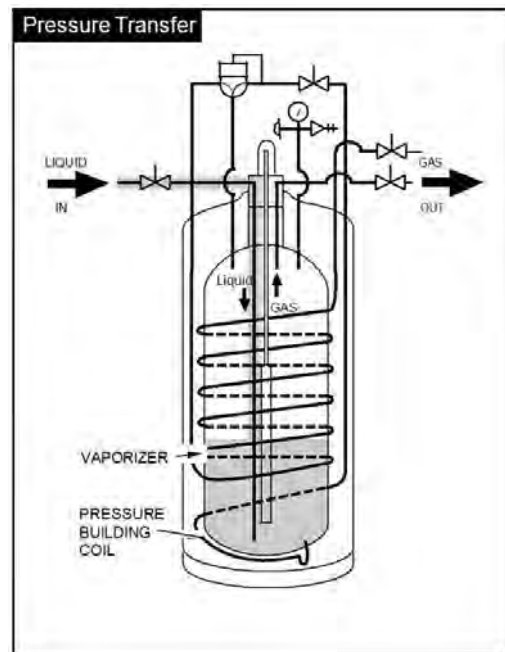


Figure 10

Pump Transfer

The pump transfer method lowers the product losses associated with filling. Liquid may be pumped into the cylinder so that venting is not necessary. The vent valve on the liquid cylinder has a spray header that will splash the incoming cold liquid onto the somewhat warmer gas in the tank. The cold liquid will actually collapse the vessel pressure while being sprayed into the warmer gas. This method of filling works well with vessels that are used regularly and do not warm up between fills. Figure 11 shows the pump transfer method.

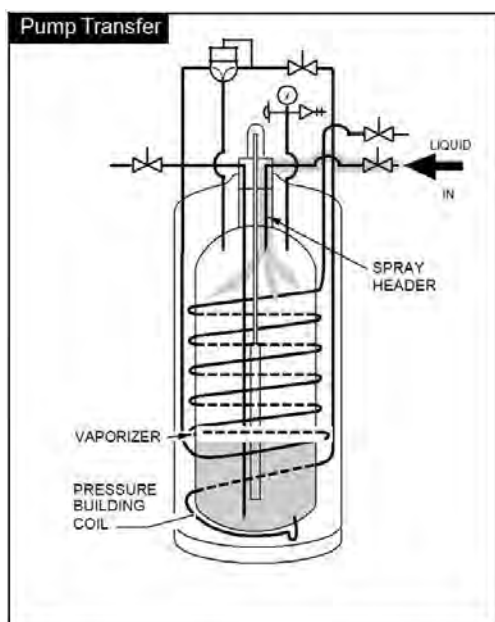


Figure 11

Gas Withdrawal

When a Dura-Cyl® LP or MP Liquid Cylinder is used for gas withdrawal, the normal operating pressure range is from approximately 75 to 175 psig and the pressure relief valve has a set pressure of 230 psig. When a Dura-Cyl HP liquid cylinder is used for gas withdrawal, the normal operating pressure range is from approximately 100 to 350 psig and the pressure relief valve has a set pressure of 350 psig. On both liquid cylinders the economizer portion of the control regulator is automatically set approximately 15 psig higher than the pressure building portion of the control regulator.



Warning! Before conducting a gas (or liquid) withdrawal operation, make sure protective eyeglasses and gloves are being used.

The supply of gaseous product is the primary operation of the liquid cylinder. An additional regulator must be added to the gas use valve to step down the pressure to the application. The liquid cylinder is usually at a high pressure after the filling and delivery operation. When it is connected to the gas application and the gas use valve and pressure building valves are opened, it will automatically deliver gas.

The Dura-Cyl® MP Liquid Cylinder model with a 230 psi relief valve operates between the pressure building setting (125 psig) and the economizer setting (140 psig). When the operating pressure is above the economizer setting (140 psi) the regulator will open (Figure 12). The gas that is

being supplied to the application will be pulled out of the vapor space in the top of the tank. It will travel through the regulator and then the vaporizer coils. It will be warmed before it reaches the final line regulator. The action of removing gas from the tank reduces the tank's pressure.

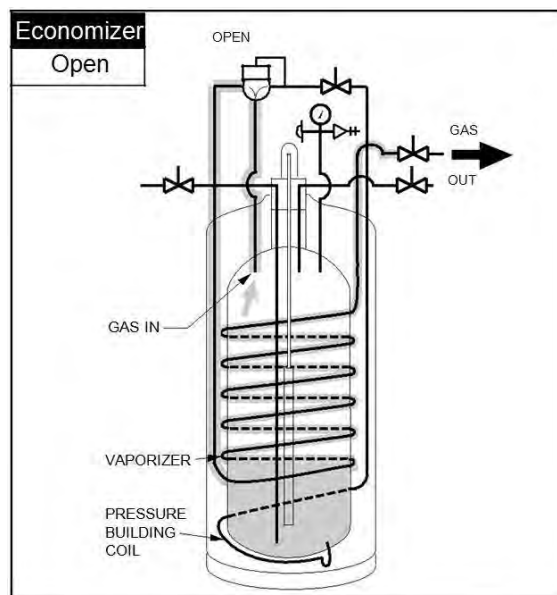


Figure 12

When the operating pressure is reduced to the economizer setting (140 psi), the regulator will close (Figure 13). Gas is still required by the application and will pull liquid up the dip tube and into the vaporizer. This will turn the liquid into gas and warm it before it is delivered to the final line regulator. The pressure decay will be much slower since a small amount of liquid can be vaporized into a large amount of gas.

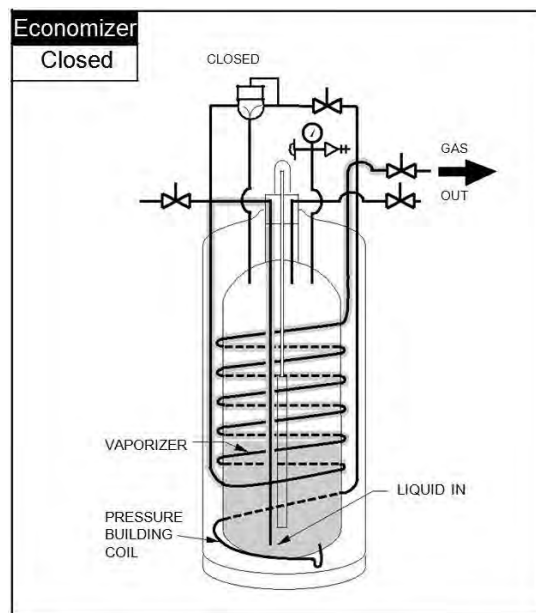


Figure 13

When the pressure falls below the pressure building regulator setting (125 psig), the regulator will open (Figure 14). This will allow liquid to run into the pressure builder vaporizer located at the bottom of the tank. The liquid will turn into gas and be delivered back into the top vapor space of the tank. The results of this operation are a rise in pressure in the tank.

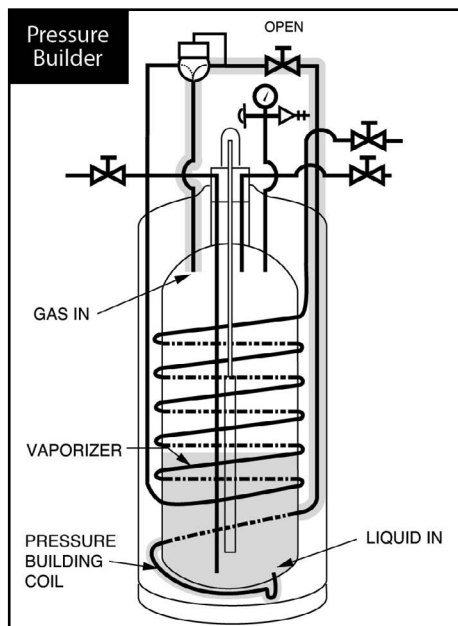


Figure 14

Liquid Withdrawal

If the liquid cylinder is to be placed in permanent liquid withdrawal service, it is recommended that the cylinder be fitted with a 22 psig relief valve to minimize loss due to flash-off.



Note: In the Dura-Cyl® HP/Cryo-Cyl™ HP Liquid Cylinders the pressure must be kept above 70 psig for CO₂ to prevent solidifying the CO₂.



Caution! Before making a liquid transfer, be sure that protective eye glasses and gloves are being worn.

To withdraw liquid from a liquid cylinder, connect a transfer line from the liquid valve fitting to the user's receiving vessel (Figure 15). Open the liquid valve to obtain the preferred rate of flow. Close the liquid valve when the user's vessel has been filled. To prevent contamination, when the cylinder has been emptied, all valves should be closed. To minimize flash-off and spillage, use a phase separator on the end of the transfer line. Normal liquid withdrawal operations are performed at lower pressure (approximately 22 psig) to

reduce flash-off losses and splashing. For this reason, the pressure building valve is customarily closed during liquid withdrawals. Transfer of liquid at higher pressure can lead to excessive splashing of the cryogenic liquid which could result in burns to the operator and/or nearby personnel. All personnel should be fully instructed in the cautions associated with handling cryogenic fluids and the proper clothing and protective gear to be used.

If a higher operating pressure is desired (other than that available through normal heat leak), the pressure building valve may be opened for a short time until the preferred pressure has been obtained. If automatic pressure building for liquid service is necessary, a low pressure building regulator may be installed to replace the pressure building regulator supplied with the unit.

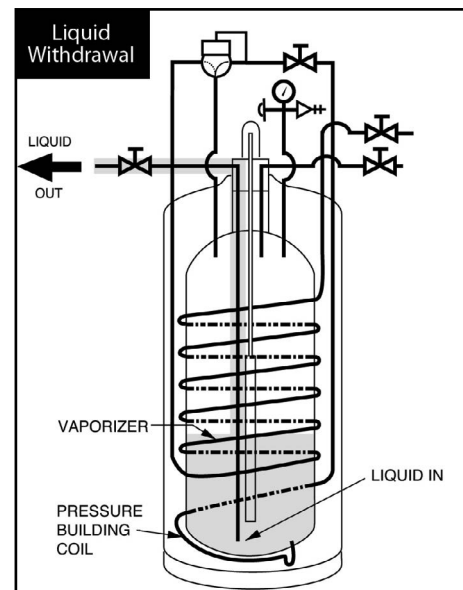


Figure 15

If a higher operating pressure is desired (other than that available through normal heat leak), the pressure building valve may be opened for a short time until the preferred pressure has been obtained. If automatic pressure building for liquid service is necessary, a low pressure building regulator may be installed to replace the pressure building regulator supplied with the unit.

Liquid carbon dioxide, used for freezing or cooling can be completely withdrawn from a Dura-Cyl HP/Cryo-Cyl HP liquid cylinder, leaving just 2% residual gaseous product. Connect a transfer line from the liquid fitting of the liquid cylinder to the receiving vessel. Open the liquid valve to obtain the desired rate of flow.

The Dura-Cyl HP/Cryo-Cyl HP liquid cylinder will deliver a continuous flow of liquid CO₂ at rates of 1,000 pounds/hour or greater, having a refrigeration content of 119 BTU/pound at 350 psig. Leave the pressure building valve open for high withdrawal rates.

Operations

This section provides the filling procedures, operating pressure information and liquid withdrawal procedures for Dura-Cyl® and Cryo-Cyl™ Liquid Cylinders. The low pressure (LP), medium pressure (MP) and high pressure (HP) cylinders have their own sections as procedures differ based on pressure rating. Filling weight tables are also provided at the end of each pressure section.

Dura-Cyl® LP Liquid Cylinders

The Dura-Cyl LP liquid cylinders are designed to transport, store and dispense liquid oxygen, nitrogen or argon in their liquid states only. Liquid product is generally used at ambient or very low pressures. These liquid cylinders have a working pressure of 22 psig (1.5 barg) to allow for transfer into vented cryogenic dewars or equipment. The pressure is maintained in the liquid cylinder through its normal heat leak of the cylinder. The pressure will rise in the closed cylinder as its liquid contents boil off. It is normal for the pressure to reach the relief valve setting of 22 psi (1.5 bar) and vent slowly into the atmosphere. The transportation of the cryogenic products in these liquid cylinders is not regulated by the DOT/TC since the pressure is normally below 25 psi (1.7 bar).

Pressure Building (Option)

The LP cylinders are equipped with an internal pressure building coil and plumbing stubs for the optional PB valve and regulator. The following procedure should be used for maintaining pressure during liquid withdrawal if the pressure building option is part of the Dura-Cyl LP cylinder.

1. Open the PB isolation valve prior to liquid withdrawal.
2. Allow the pressure to rise in the cylinder until the regulator shuts off the PB circuit.
3. Transfer liquid as described in the Filling Procedure below.
4. Close the PB valve when liquid transfer is complete.

Filling Procedure

The Dura-Cyl LP liquid cylinders are equipped with liquid and vent valves that are used for filling. Use a pressure transfer fill as the proper filling method for this style of cylinder. The delivery tank pressure should be as low as practical for the transfer to be efficient. Follow these steps for filling LP liquid cylinders:



Caution! Before making a liquid transfer be sure that protective eyeglasses and gloves are being worn.

1. Sample the residual gas that is in the cylinder. Purge the cylinder if necessary to ensure the proper purity.
2. Place the cylinder on the filling scale. Record the weight. Compare this weight to the registered tare weight on the data plate. The difference is the weight of the residual gas.
3. Connect the transfer hose to the liquid valve. Record the new weight. The difference between this weight and the initial weight is the weight of the transfer hose.
4. To determine the total filling weight add the tare weight of the cylinder, the hose weight and the proper filling weight from the filling table (i.e. Dura-Cyl 120 LP for oxygen at 22 psi / 1.5 bar has a product weight of 285 pounds / 129 kg).
5. Open the cylinder vent and liquid valves. Open the transfer line shut-off valve to begin the flow of product.
6. When the scale reads the calculated total filling weight turn off the liquid valve on the cylinder. Close the vent valve.
7. Close the transfer line shut-off valve and relieve the pressure in the transfer line. Remove the transfer line. Remove the cylinder from the scale.



Caution! The transfer hose will have pressure in it that must be relieved before the hose is completely removed.

Operating Pressure

The Dura-Cyl LP liquid cylinder will maintain a normal operating pressure of 22 psig (1.5 barg). Normal liquid withdrawal operations are performed at lower pressure to reduce flash-off losses and splashing. Transfer of liquid at higher pressure can lead to excessive splashing of the cryogenic liquid which could result in burns to the operator and/or nearby personnel. All personnel should be fully instructed in the cautions associated with handling cryogenic fluids and the proper clothing and protective gear to be used.

Liquid Withdrawal

Cryogenic liquid can be pressure transferred from the liquid cylinder to other cryogenic equipment that operates at a lower pressure than the liquid cylinder. To make a liquid transfer follow this procedure:



Caution! Before making a liquid transfer be sure that protective eyeglasses and gloves are being worn. If the transfer is being made to an open top vessel, the transfer pressure should be as low as possible and a phase separator should be used to eliminate splashing and hose whip.

1. Connect the transfer hose to the liquid valve of the cylinder.
2. Connect or place the other end of the hose onto the inlet of the cryogenic equipment that will receive liquid. Atmospheric dewars are filled with a phase separator mounted to the open end of the hose.
3. Refer to the receiving equipment manual for procedures to open the fill valve and vent valve of the receiving equipment.
4. Open the liquid valve on the liquid cylinder. This valve can be adjusted to obtain the proper liquid flow rate.
5. When the transfer is complete, close the receiving equipment's valve. Close the liquid valve on the cylinder and relieve pressure from the hose.
6. Disconnect or remove the hose from the receiving equipment.

Dura-Cyl® LP Liquid Cylinder Filling Weight Table

Model	Argon		Nitrogen		Oxygen	
	LBS	Kg	LBS	Kg	LBS	Kg
Dura-Cyl 120 LP*	351	159	201	91	285	129
Dura-Cyl 180 LP*	573	260	327	148	465	211
Dura-Cyl 200 LP*	611	277	349	158	496	225
Dura-Cyl 230 LP*	702	318	401	182	570	258

* Relief valve setting at 22 psig (1.5 barg).



Note: It is important to fill all liquid cylinders by their published fill weights to comply with the DOT - 4L regulations. There is however, one exception to the filling regulation (CFR49 section 173.320): If you are operating under the 25.3 psig (40 psia) relief valve setting (22 psig is typically used in liquid service), you are not required to fill by weight so the operator can fill the liquid cylinder to "vent full". This is allowed because the liquid will not have a chance to grow as the relief valve is set very low and hence there is minimal risk of liquid dispensing out the safety relief valve.

Dura-Cyl® MCR MP Liquid Cylinders

The Dura-Cyl MCR MP liquid cylinders are functionally the same and only vary in capacity. They are designed to transport, store and deliver liquid oxygen, nitrogen or argon as a cryogenic liquid or gas. The common application for these liquid cylinders is to provide gas at a pressure around 100 psi (6.9 bar). The liquid cylinder will build and maintain pressure at the pressure control regulator setting of 125 psi (8.6 bar). If the pressure exceeds 140 psi (9.7 bar) the economizer portion of the regulator will supply gas to the receiving equipment to reduce the cylinder pressure. A continuous gas flow can be automatically provided from these cylinders. Liquid can be withdrawn from these liquid cylinders in the same manner that was described in the Dura-Cyl LP liquid cylinder section.

Filling Procedures

The Dura-Cyl MCR MP liquid cylinders are regulated by the DOT/Transport Canada for transporting liquid oxygen, nitrogen or argon. The filling of these liquid cylinders must be done by product weight. This will allow enough gas space above the liquid to keep the liquid cylinder from becoming liquid full if its pressure rises to the relief valve setting. The filling weight table indicates the correct product weight for the various relief valve settings. The standard relief valve setting is 230 psig (15.9 barg). The filling procedure will explain the proper way to use the filling weight table.

The liquid cylinder is equipped with liquid and vent valves that are used during the filling procedure. The liquid valve is equipped with a dip tube that extends into the inner vessel of the cylinder and reaches to the bottom. The vent valve has a vent tube attached to it that also extends into the inner vessel of the cylinder. This vent tube is designed to spray the liquid into the top of the vessel so that pump filling through the vent valve will keep head pressure down in the cylinder.

Filling can be accomplished by either pressure transfer or pump fill. Follow these steps for filling Dura-Cyl MCR MP liquid cylinders:

1. Sample the residual gas that is in the cylinder. Purge the cylinder if necessary to ensure the proper purity.
2. Place the cylinder on the filling scale. Record the weight. Compare this weight to the registered tare weight on the data plate. The difference is the weight of the residual gas.
3. Connect the transfer hose to the liquid valve. Record the new weight. The difference between this weight and the initial weight is the weight of the transfer hose.
4. To determine the total filling weight add the tare weight of the cylinder, the hose weight and the proper filling weight from the filling table (i.e. Dura-Cyl 160 MP for oxygen at 230 psi / 16 bar has a product weight of 379 pounds / 172 kg).
5. Open the cylinder vent and liquid valves. Open the transfer line shut-off valve to begin the flow of product.
6. When the scale reads the calculated total filling weight turn off the liquid valve on the cylinder. Close the vent valve.
7. Close the transfer line shut-off valve and relieve the pressure in the transfer line. Remove the transfer line. Remove the cylinder from the scale.

Operating Pressure

The Dura-Cyl MCR MP liquid cylinder will automatically maintain a normal operating pressure between the pressure building portion of the regulator (125 psi / 8.6 bar) and the economizer portion of the regulator (140 psi / 9.7 bar). The operating pressure can be set up or down by simply adjusting the regulator while watching the pressure gauge. The adjustment range of the regulators is between 50 and 175 psi (3.4 and 12.1 bar).

The gas delivery pressure should not be confused with the vessel operating pressure. The gas delivery pressure should be adjusted with a separate regulator that is attached to the gas withdrawal fitting.

Gas Withdrawal

The Dura-Cyl MCR MP liquid cylinder will deliver gas at various flow rates and temperatures for different applications. The flow rate is controlled by the equipment that is being supplied gas from the liquid cylinder. The continuous flow rate indicates the flow rate that will normally provide gas at a reasonable temperature and should not be exceeded. Higher flow rates may provide very cold gas that could damage the equipment that they are attached to. To supply gaseous product follow this procedure:

1. Connect the proper regulator to the liquid cylinder's gas use outlet.
2. Connect the proper hose between the final line regulator and the receiving equipment.
3. Open the pressure building valve.
4. Allow pressure to build to the operating pressure of 140 psi (9.7 bar).
5. Open the gas use valve.
6. Adjust the gas use regulator for the proper delivery pressure.
7. When the gas delivery is completed, close all liquid cylinder valves.



Caution! *The liquid and vent valves on an empty liquid cylinder should always be kept closed to protect the inner vessel and plumbing from being contaminated.*

Dura-Cyl® LCCM MP Liquid Cylinders

The Dura-Cyl LCCM MP liquid cylinders have the unique feature of a combination pressure building and economizer regulator (Liquid Cylinder Control Manifold). The LCCM eliminates the need to adjust two regulators when the operating pressure needs to be changed. The liquid cylinder is designed to transport, store and deliver liquid oxygen, nitrogen or argon as a cryogenic liquid or gas. The common application for this liquid cylinder is to provide gas at pressures around 100 psi (6.9 bar).

The liquid cylinder will build and maintain pressure at the regulator setting of 125 psi (8.6 bar) the regulator will supply gas from the tank vapor space (economizer function) to the receiving equipment which will reduce the cylinder pressure. A continuous gas flow can be automatically provided from this cylinder.

Liquid can be withdrawn from this liquid cylinder in the same manner that was described in the Dura-Cyl LP liquid cylinder section.

Filling Procedures

The Dura-Cyl® LCCM MP liquid cylinders are regulated by the DOT/Transport Canada for transporting liquid oxygen, nitrogen or argon. The filling of these liquid cylinders must be done by product weight. This will allow enough gas space above the liquid to keep the liquid cylinder from becoming liquid full if its pressure rises to the relief valve setting. The filling weight table indicates the correct product weight for the various relief valve settings. The standard relief valve setting is 230 psig (15.9 barg). The filling procedure will explain the proper way to use the filling weight table.

The liquid cylinder is equipped with liquid and vent valves that are used during the filling procedure. The liquid valve is equipped with a dip tube that extends into the inner vessel of the cylinder and reaches to the bottom. The vent valve has a dip tube attached to it that also extends into the inner vessel of the cylinder. This vent tube is designed to spray the liquid into the top of the vessel so that pump filling through the vent valve will keep head pressure down in the cylinder.

Filling can be accomplished by either pressure transfer or pump fill. Follow these steps for filling Dura-Cyl LCCM MP liquid cylinders:

1. Sample the residual gas that is in the cylinder. Purge the cylinder if necessary to ensure the proper purity.
2. Place the cylinder on the filling scale. Record the weight. Compare this weight to the registered tare weight on the data plate. The difference is the weight of the residual gas.
3. Connect the transfer hose to the liquid valve. Record the new weight. The difference between this weight and the initial weight is the weight of the transfer hose.
4. To determine the total filling weight add the tare weight of the cylinder, the hose weight and the proper filling weight from the filling table (i.e. Dura-Cyl 160 MP for oxygen at 230 psi/16 bar has a product weight of 379 lbs/172 kg).
5. Open the cylinder vent and liquid valves. Open the transfer line shut-off valve to begin the flow of product.
6. When the scale reads the calculated total filling weight turn off the liquid valve on the cylinder. Close the vent valve.
7. Close the transfer line shut-off valve and relieve the pressure in the transfer line. Remove the transfer line. Remove the cylinder from the scale.

Operating Pressure

The liquid cylinder will automatically maintain a normal operating pressure between the pressure building portion of the LCCM (125 psi/8.6 bar) and the economizer portion of the LCCM (140 psi/9.7 bar). The operating pressure can be set up or down by simply adjusting the LCCM control knob while watching the pressure gauge. The adjustment range of the regulators is between 40 and 160 psi (2.8 and 11.0 bar).

The gas delivery pressure should not be confused with the vessel operating pressure. The delivery pressure should be adjusted with a separate regulator that is attached to the gas withdrawal fitting.

Gas Withdrawal

The liquid cylinder will deliver gas at various flow rates and temperatures for different applications. The flow rate is controlled by the equipment that is being supplied from the liquid cylinder. The continuous flow rate indicates the flow rate that will normally provide gas at a reasonable temperature and should not be exceeded. Higher flow rates may provide very cold gas that could damage the equipment attached to them.

To supply gaseous product follow this procedure:

1. Connect the proper fill line regulator to the liquid cylinder's gas use outlet.
2. Connect the proper hose between the final line regulator and the receiving equipment.
3. Open the pressure building valve.
4. Allow pressure to build to the operating pressure (125 psi / 8.6 bar).
5. Open the gas use valve.
6. Adjust the gas use regulator for the proper delivery pressure.
7. When the gas delivery is completed, close all liquid cylinder valves.



Caution! *The liquid and vent valves on an empty liquid cylinder should always be kept closed to protect the inner vessel and plumbing from being contaminated.*

Service and Maintenance

Refer to the Maintenance section of this manual to troubleshoot problems and service these liquid cylinders.

Dura-Cyl® MP Liquid Cylinder Filling Weight Table

Relief Valve Setting psig/barg	Argon				Nitrogen				Oxygen			
	LBS	Kg	SCF	Nm ³	LBS	Kg	SCF	Nm ³	LBS	Kg	SCF	Nm ³
Dura-Cyl 160 MP (235 psig max. RV) (16 barg max. RV) Gross Cap - 176 liters												
0-45 psig / 0-3.1 barg	514	233	4971	130	294	133	4058	106	418	190	5048	133
46-75 psig / 3.2-5.2 barg	503	288	4864	161	286	130	3947	104	406	184	4903	129
76-105 psig / 5.3-7.2 barg	491	223	4748	125	278	126	3837	101	398	180	4807	126
106-170 psig / 7.3 to 11.7 barg	472	214	4564	120	271	123	3740	98	387	176	4674	123
**171-230 psig / 11.8-15.9 barg	460	209	4448	117	267	121	3685	97	379	172	4577	120
231-235 psig / 16.0-20.3 barg	445	202	4303	113	263	119	3630	95	371	168	4480	117
Dura-Cyl 180 MP (235 psig max. RV) (16 barg max. RV) Gross Cap - 196 liters												
0-45 psig / 0-3.1 barg	573	260	5541	146	327	148	4513	118	465	211	5616	148
46-75 psig / 3.2-5.2 barg	560	254	5415	142	319	145	4403	116	452	205	5459	143
76-105 psig / 5.3-7.2 barg	547	248	5290	139	310	141	4278	113	444	201	5362	141
106-170 psig / 7.3 to 11.7 barg	526	239	5086	134	301	137	4154	109	431	195	5205	136
**171-230 psig / 11.8-15.9 barg	513	233	4961	130	297	135	4099	108	422	191	5096	134
231-235 psig / 16.0-20.3 barg	495	224	4787	125	293	133	4044	106	413	187	4988	131
Dura-Cyl 200 MP (235 psig max. RV) (16 barg max. RV) Gross Cap - 209 liters												
0-45 psig / 0-3.1 barg	611	277	5908	155	349	158	4817	126	496	225	5990	157
46-75 psig / 3.2-5.2 barg	597	271	5773	152	340	154	4693	123	482	219	5821	153
76-105 psig / 5.3-7.2 barg	583	264	5638	148	331	150	4568	120	473	215	5712	150
106-170 psig / 7.3 to 11.7 barg	560	254	5415	142	321	146	4430	117	459	208	5543	145
**171-230 psig / 11.8-15.9 barg	547	248	5290	139	317	144	4375	115	450	204	5435	143
231-235 psig / 16.0-20.3 barg	528	239	5106	134	312	141	4306	113	441	200	5326	140
Dura-Cyl 230 MP (235 psig max. RV) (16 barg max. RV) Gross Cap - 240 liters												
0-45 psig / 0-3.1 barg	702	318	6789	178	401	182	5535	149	570	258	6884	180
46-75 psig / 3.2-5.2 barg	686	311	6634	174	390	177	5383	141	554	251	6691	176
76-105 psig / 5.3-7.2 barg	670	304	6479	170	380	172	5245	137	543	246	6558	172
106-170 psig / 7.3 to 11.7 barg	644	292	6228	164	369	167	5093	133	528	239	6377	167
**171-230 psig / 11.8-15.9 barg	628	285	6073	160	364	165	5024	132	517	234	6244	164
231-235 psig / 16.0-20.3 barg	607	275	5870	154	359	163	4955	130	506	229	6111	160
Dura-Cyl 265 MP (235 psig max. RV) (16 barg max. RV) Gross Cap - 276 liters												
0-45 psig / 0-3.1 barg	807	366	7804	205	461	209	6363	167	655	297	7911	208
46-75 psig / 3.2-5.2 barg	789	358	7630	201	449	204	6197	163	637	289	7693	202
76-105 psig / 5.3-7.2 barg	771	350	7456	196	437	198	6031	158	625	283	7548	198
106-170 psig / 7.3 to 11.7 barg	740	336	7156	188	425	193	5866	154	607	275	7331	192
**171-230 psig / 11.8-15.9 barg	722	327	6982	183	418	190	5769	152	595	270	7186	189
231-235 psig / 16.0-20.3 barg	698	317	6750	178	412	187	5686	149	582	264	7029	185

**Normal Factory Setting



Note: It is important to fill all liquid cylinders by their published fill weights to comply with the DOT - 4L regulations. There is however, one exception to the filling regulation (CFR49 section 173.320): If you are operating under the 25.3 psig (40 psia) relief valve setting (22 psig is typically used in liquid service), you are not required to fill by weight so the operator can fill the liquid cylinder to "vent full". This is allowed because the liquid will not have a chance to grow as the relief valve is set very low and hence there is minimal risk of liquid dispensing out the safety relief valve.

Dura-Cyl® MCR HP Liquid Cylinders

The Dura-Cyl MCR HP liquid cylinders are functionally the same and only vary in capacity. They are designed to transport, store and deliver liquid oxygen, nitrogen, argon, carbon dioxide, or nitrous oxide as a cryogenic liquid or gas. They can be used to transport liquid carbon dioxide or nitrous oxide in Canada with the exemption Chart has received from Transport Canada. The common application for these high pressure liquid cylinders is to provide gas at pressures around 300 psi or deliver liquid CO₂. The high pressure liquid cylinder will build and maintain pressure at the pressure control regulator setting of 300 psi (20.7 bar). If the pressure exceeds 325 psi (22.4 bar) the control regulator will supply gas from the tank vapor space to the receiving equipment which will reduce the cylinder pressure. A continuous gas flow can be automatically provided from these cylinders.

Filling Procedures

The Dura-Cyl MCR HP liquid cylinders are regulated by the DOT/Transport Canada for transporting liquid oxygen, nitrogen, argon, carbon dioxide, or nitrous oxide. The filling of these liquid cylinders must be done by product weight. This will allow enough gas space above the liquid to keep the liquid cylinder from becoming liquid full if its pressure rises to the relief valve setting. The filling weight table indicates the correct product weight for the various relief valve settings. The standard relief valve setting is 350 psig (24.1 barg). The filling procedure will explain the proper way to use the filling weight table.

The high pressure liquid cylinder is equipped with a liquid and vent valve that is used during the filling procedure. The liquid valve is equipped with a dip tube that extends into the inner vessel of the cylinder and reaches to the bottom. The vent valve has a dip tube attached to it that also extends into the inner vessel of the cylinder. This vent tube is designed to spray the liquid into the top of the vessel so that pump filling through the vent valve will keep head pressure down in the cylinder.

Filling can be accomplished by either pressure transfer or pump fill. Follow these steps for filling Dura-Cyl HP liquid cylinders:

1. Sample the residual gas that is in the cylinder. Purge the cylinder if necessary to ensure the proper purity.
2. Place the cylinder on the filling scale. Record the weight. Compare this weight to the registered tare weight on the data plate. The difference is the weight of the residual gas.
3. Connect the transfer hose to the liquid valve. Record the new weight. The difference between this weight and the initial weight is the weight of the transfer hose.
4. To determine the total filling weight add the tare weight of the cylinder, the hose weight and the proper filling

weight from the filling table (i.e. Dura-Cyl 160 HP for carbon dioxide at 350 psi / 24.8 bar has a product weight of 387 pounds / 176 kg).

5. Open the cylinder vent and liquid valves. Open the transfer line shut-off valve to begin the flow of product.
6. When the scale reads the calculated total filling weight turn off the liquid valve on the cylinder. Close the vent valve.
7. Close the transfer line shut-off valve and relieve the pressure in the transfer line. Remove the transfer line. Remove the cylinder from the scale.

Operating Pressure

The Dura-Cyl MCR HP liquid cylinder will automatically maintain a normal operating pressure between the pressure building portion of the regulator (300 psi / 20.7 bar) and the economizer portion of the regulator (325 psi / 22.4 bar). The operating pressure can be set up or down by simply adjusting the regulator while watching the pressure gauge. The adjustment range of the regulators is between 150 and 350 psi (10.6 and 24.1 bar).

The gas delivery pressure should not be confused with the vessel operating pressure. The delivery pressure should be adjusted with a separate regulator that is attached to the gas withdrawal fitting.

Liquid CO₂ Withdrawal

Liquid can be withdrawn from these liquid cylinders in the same manner that was described in the Dura-Cyl LP Liquid Cylinder section. However, the transfer of liquid carbon dioxide is slightly different and should follow these steps:

1. Connect the transfer hose to the liquid valve fitting of the high pressure liquid cylinder.
2. Connect the other end of the hose to the receiving equipment.
3. Open the pressure building valve and wait for the pressure gauge to reach the operating pressure (300 psi / 20.7 bar).
4. Refer to the receiving equipment manual for procedures to open the fill valve and vent valve of the receiving equipment.
5. Open the liquid valve on the liquid cylinder. This valve can be adjusted to obtain the proper liquid flow rate and delivery pressure.
6. Adjust the receiving equipment vent valve and the fill valve to maintain pressure in the fill hose. The equipment and the hose must maintain pressure above 70 psi (4.8 bar) during the transfer. Liquid CO₂ will turn into dry ice at lower pressures.

- When the transfer is complete close the receiving equipment's valve. Close the liquid valve on the cylinder and relieve pressure from the hose.
- Disconnect or remove the hose from the receiving equipment.



Caution! *The liquid and vent valves on liquid cylinders should always be kept closed to protect the inner vessel and plumbing from being contaminated.*

Gas Withdrawal

The high pressure liquid cylinder will deliver gas at various flow rates and temperatures for different applications. The flow rate is controlled by the equipment that is being supplied gas by the liquid cylinder. The continuous flow rate indicates the flow rate that will normally provide gas at a reasonable temperature and should not be exceeded. Higher flow rates may provide very cold gas that could damage the equipment attached to them.

To supply gaseous product follow this step-by-step procedure:

- Connect the proper regulator to the liquid cylinder's gas use outlet.
- Connect the proper hose between the liquid cylinder gas use regulator and the receiving equipment.
- Open the pressure building valve.
- Allow pressure to build to the operating pressure.
- Open the gas use valve.
- Adjust the gas use regulator for the proper delivery pressure.
- When the gas delivery is completed, close all liquid cylinder valves.



Caution! *The liquid and vent valves on an empty liquid cylinder should always be kept closed to protect the inner vessel and plumbing from being contaminated.*



Caution! *In the Dura-Cyl HP/Cryo-Cyl HP liquid cylinders the pressure must be kept above 70 psig for CO₂ to prevent solidifying the CO₂.*

Service and Maintenance

Refer to the Maintenance section of this manual to troubleshoot problems and service these liquid cylinders.

Dura-Cyl® LCCM HP Liquid Cylinders

The Dura-Cyl LCCM HP liquid cylinder models are functionally the same and only vary in capacity. They are designed to transport, store and deliver liquid oxygen, nitrogen, argon, carbon dioxide, or nitrous oxide as a cryogenic liquid or gas. They can be used to transport liquid carbon dioxide or nitrous oxide in Canada with the exemption Chart has received from Transport Canada. The common application for these high pressure liquid cylinders is to provide gas at pressures up to 350 psi (24.1 bar) or deliver liquid CO₂. The high pressure liquid cylinder will build and maintain pressure with a pressure control manifold. The pressure building portion of the regulator has a setting of 300 psi (20.7 bar). If the pressure exceeds 325 psi (22.4 bar) the economizer portion of the regulator will supply gas from the tank vapor space to the receiving equipment which will reduce the cylinder pressure. A continuous gas flow can be automatically provided from these cylinders.

Filling Procedures

The high pressure liquid cylinder is regulated by the DOT/Transport Canada for transporting liquid oxygen, nitrogen, argon, carbon dioxide, or nitrous oxide. The filling of these high pressure liquid cylinders must be done by product weight. This will allow enough gas space above the liquid to keep the cylinder from becoming liquid full if its pressure rises to the relief valve settings. The standard relief valve setting is 350 psig (24.1 bar). The filling procedure will explain the proper way to use the filling weight table.

The high pressure liquid cylinder is equipped with liquid and vent valves that are used during the filling procedure. The liquid valve is equipped with a dip tube that extends into the inner vessel of the cylinder and reaches to the bottom. The vent valve has a dip tube attached to it that also extends into the inner vessel of the cylinder. This vent tube is designed to spray the liquid into the top of the vessel so that pump filling through the vent valve will keep head pressure down in the cylinder.

Filling can be accomplished by either pressure transfer or pump fill. The following procedure should be used for pressure transfer fillings.

- Sample the residual gas that is in the cylinder. Purge the cylinder if necessary to ensure the proper purity.
- Place the cylinder on the filling scale. Record the weight. Compare this weight to the registered tare weight on the data plate. The difference is the weight of the residual gas.
- Connect the transfer hose to the fill valve. Record the new weight. The difference between this weight and the initial weight is the weight of the transfer hose.
- To determine the total filling weight add the tare weight of the cylinder, the hose weight and the proper filling weight from the filling table (i.e. Dura-Cyl 160 HP

for carbon dioxide at 350 psi / 24.8 bar has a product weight of 387 pounds / 176 kg).

5. Open the cylinder's vent and liquid valves. Open the transfer line shut-off valve to bring the flow of product.
6. If filling CO₂, adjust the cylinder's vent valve to maintain pressure in the cylinder and fill hose. The equipment must maintain pressures above 70 psi (4.8 bar) during the transfer. Liquid CO₂ will turn into dry ice at lower pressures.
7. When the scale reads the calculated total filling weight, turn off the liquid valve on the cylinder. Close the vent valve. It is important to maintain pressure above 70 psi (4.8 bar) if filling CO₂ or N₂O. Do not allow the cylinder to vent down after filling.
8. Close the transfer line shut-off valve and relieve the pressure in the transfer line. Remove the transfer line. Remove the cylinder from the scale.

Operating Pressure

The liquid cylinder will automatically maintain a normal operating pressure between the pressure building portion of the regulator (300 psi / 20.7 bar) and the economizer portion of the regulator (325 psi / 22.4 bar). The operating pressure can be set up or down by simply adjusting the regulator while watching the pressure gauge. The adjustment range of the regulator is between 80 and 320 psi (5.5 and 24.1 bar).

The gas delivery pressure should not be confused with the vessel operating pressure. The delivery pressure should be adjusted with a separate regulator that is attached to the gas withdrawal fitting.

Liquid CO₂ Withdrawal

Liquid can be withdrawn from these liquid cylinders in the same manner that was described in the Dura-Cyl® LP Liquid Cylinder section. However, the transfer of liquid CO₂ is slightly different and should follow these steps:

1. Connect the transfer hose to the liquid valve fitting of the high pressure liquid cylinder.
2. Connect the other end of the hose to the receiving equipment.
3. Open the pressure building valve and wait for the pressure gauge to reach the operating pressure (300 psi / 20.7 bar).
4. Refer to the receiving equipment manual for procedures to open the fill valve and vent valve of the receiving equipment.
5. Open the liquid valve on the liquid cylinder. This valve can be adjusted to obtain the proper liquid flow rate and delivery pressures.
6. Adjust the receiving equipment vent valve and the fill valve to maintain pressure in the fill hose. The

equipment and the hose must maintain pressures above 70 psi (4.8 bar) during the transfer. Liquid CO₂ will turn into dry ice at lower pressures.

7. When the transfer is complete, close the receiving equipment's valve. Close the liquid valve on the cylinder and relieve pressure from the hose.
8. Disconnect or remove the hose from the receiving equipment.



Caution! *The liquid and vent valves on liquid cylinders should always be kept closed to protect the inner vessel and plumbing from being contaminated.*

Gas Withdrawal

The high pressure liquid cylinder will deliver gas at various flow rates and temperatures for different applications. The flow rate is controlled by the equipment that is being supplied gas by the liquid cylinder. The continuous flow rate indicates the flow rate that will normally provide gas at a reasonable temperature and should not be exceeded. Higher flow rates may provide very cold gas that could damage the equipment attached to them.

To supply gaseous product follow this step by step procedure:

1. Connect the proper final line regulator to the liquid cylinder's gas use outlet.
2. Connect the proper hose between the liquid cylinder gas use regulator and the receiving equipment.
3. Open the pressure building valve.
4. Allow pressure to build to the operating pressure (300 psi / 20.7 bar).
5. Open the gas use valve.
6. Adjust the gas use regulator for the proper delivery pressure.
7. When the gas delivery is completed, close all liquid cylinder valves.



Caution! *The liquid and vent valves on an empty liquid cylinder should always be kept closed to protect the inner vessel and plumbing from being contaminated.*



Caution! *In the Dura-Cyl HP/Cryo-Cyl HP liquid cylinders the pressure must be kept above 70 psig for CO₂ to prevent solidifying the CO₂.*

Dura-Cyl® HP Liquid Cylinder Filling Weight Table

Relief Valve Setting psig/barg	Argon				Nitrogen				Oxygen				CO ₂				N ₂ O			
	LBS	Kg	SCF	Nm ³	LBS	Kg	SCF	Nm ³	LBS	Kg	SCF	Nm ³	LBS	Kg	SCF	Nm ³	LBS	Kg	SCF	Nm ³
Dura-Cyl 160 HP (350 psig max. RV) (24 barg max. RV) Gross Cap - 176 liters																				
0-45 psig/0-3.1 barg	514	233	4971	130	294	133	4058	106	418	190	5048	133	--	--	--	--	--	--	--	--
46-75 psig/3.2-5.2 barg	503	228	4865	128	286	130	3948	104	406	184	4903	129	--	--	--	--	--	--	--	--
76-105 psig/5.3-7.2 barg	491	222	4748	124	278	126	3837	101	398	180	4770	126	418	190	3654	96	402	182	3502	92
106-170 psig/7.3-11.7 barg	472	214	4565	120	271	123	3741	98	387	176	4673	123	406	184	3549	93	391	177	3406	89
171-230 psig/11.8-15.9 barg	460	209	4448	117	267	121	3685	97	379	172	4577	120	402	182	3514	92	383	174	3336	88
231-295 psig/16.0-20.3 barg	445	202	4304	113	263	119	3630	95	371	168	4480	117	394	179	3444	90	375	170	3267	86
**296-350 psig/20.4-24.8 barg	437	198	4226	111	251	114	3465	91	360	163	4347	114	387	176	3383	89	367	166	3197	84
Dura-Cyl 180 HP (350 psig max. RV) (24 barg max. RV) Gross Cap - 196 liters																				
0-45 psig/0-3.1 barg	573	260	5541	146	327	148	4514	118	465	211	5615	148	--	--	--	--	--	--	--	--
46-75 psig/3.2-5.2 barg	560	254	5416	142	319	145	4403	116	452	205	5458	143	--	--	--	--	--	--	--	--
76-105 psig/5.3-7.2 barg	547	248	5290	139	310	141	4278	113	444	201	5362	141	465	211	4065	107	448	203	3903	102
106-170 psig/7.3-11.7 barg	526	239	5087	134	301	137	4155	109	431	195	5205	136	452	205	3951	104	435	197	3789	99
171-230 psig/11.8-15.9 barg	513	233	4961	130	297	135	4099	108	422	191	5096	134	448	203	3916	103	426	193	3711	97
231-295 psig/16.0-20.3 barg	495	224	4787	125	293	133	4042	106	413	187	4987	131	439	199	3837	101	418	190	3641	96
**296-350 psig/20.4-24.8 barg	487	221	4710	124	280	127	3865	101	401	182	4842	127	431	195	3767	99	409	185	3563	93
Dura-Cyl 200 HP (350 psig max. RV) (24 barg max. RV) Gross Cap - 209 liters																				
0-45 psig/0-3.1 barg	611	277	5909	155	349	158	4817	126	496	225	5990	157	--	--	--	--	--	--	--	--
46-75 psig/3.2-5.2 barg	597	271	5774	152	340	154	4693	123	482	219	5821	153	--	--	--	--	--	--	--	--
76-105 psig/5.3-7.2 barg	583	264	5638	148	331	150	4569	120	473	215	5712	150	496	225	4336	114	478	217	4164	109
106-170 psig/7.3-11.7 barg	560	254	5415	142	321	146	4431	117	459	208	5543	145	482	219	4213	111	464	210	4042	106
171-230 psig/11.8-15.9 barg	547	248	5290	139	317	144	4376	115	450	204	5434	143	478	217	4178	110	455	206	3964	104
231-295 psig/16.0-20.3 barg	528	239	5106	134	312	141	4307	113	441	200	5326	140	468	212	4091	107	446	202	3885	102
**296-350 psig/20.4-24.8 barg	519	235	5019	132	298	135	4072	108	427	194	5156	136	459	208	4012	105	436	198	3798	100
Dura-Cyl 230 HP (350 psig max. RV) (24 barg max. RV) Gross Cap - 240 liters																				
0-45 psig/0-3.1 barg	702	318	6789	178	401	182	5535	145	570	258	6883	180	--	--	--	--	--	--	--	--
46-75 psig/3.2-5.2 barg	686	311	6634	174	390	177	5383	141	554	251	6690	176	--	--	--	--	--	--	--	--
76-105 psig/5.3-7.2 barg	670	304	6480	170	380	172	5245	137	543	246	6557	172	570	258	4982	130	549	249	4782	126
106-170 psig/7.3-11.7 barg	644	292	6228	164	369	167	5093	133	528	239	6376	167	554	251	4843	127	533	242	4643	122
171-230 psig/11.8-15.9 barg	628	285	6073	160	364	165	5024	132	517	234	6243	164	549	249	4799	126	522	237	4547	120
231-295 psig/16.0-20.3 barg	607	275	5870	154	359	163	4955	130	506	229	6110	160	538	244	4703	123	512	232	4460	117
**296-350 psig/20.4-24.8 barg	596	270	5764	151	343	156	4734	125	491	223	5929	156	528	239	4615	121	501	227	4364	115
Dura-Cyl 265 HP (350 psig max. RV) (24 barg max. RV) Gross Cap - 276 liters																				
0-45 psig/0-3.1 barg	807	366	7463	205	461	209	6363	167	655	297	7910	208	--	--	--	--	--	--	--	--
46-75 psig/3.2-5.2 barg	789	358	7630	201	449	204	6198	163	637	289	7692	202	--	--	--	--	--	--	--	--
76-105 psig/5.3-7.2 barg	771	350	7456	196	437	198	6032	158	625	283	7548	198	655	297	5725	150	631	286	5497	144
106-170 psig/7.3-11.7 barg	740	336	7157	188	425	193	5866	154	607	275	7330	192	637	289	5568	146	613	278	5340	140
171-230 psig/11.8-15.9 barg	722	327	6982	183	418	190	5769	152	595	270	7185	189	631	286	5516	145	601	273	5235	138
231-295 psig/16.0-20.3 barg	698	317	6750	178	412	187	5687	149	582	264	7028	185	619	281	5411	142	588	167	5122	135
**296-350 psig/20.4-24.8 barg	686	311	6634	174	394	179	5438	143	564	256	6811	179	607	275	5306	139	576	261	5018	132

** Normal Factory Setting



Note: It is important to fill all liquid cylinders by their published fill weights to comply with the DOT - 4L regulations. There is however, one exception to the filling regulation (CFR49 section 173.320): If you are operating under the 25.3 psig (40 psia) relief valve setting (22 psig is typically used in liquid service), you are not required to fill by weight so the operator can fill the liquid cylinder to "vent full". This is allowed because the liquid will not have a chance to grow as the relief valve is set very low and hence there is minimal risk of liquid dispensing out the safety relief valve.

Cryo-Cyl™ 80 HP Liquid Cylinders

The Cryo-Cyl 80 HP liquid cylinder is designed to transport and store liquid oxygen, nitrogen, argon, carbon dioxide or nitrous oxide and provides it as a gas. It is a smaller version of the liquid cylinder that is designed to supply gas at lower flow rates than the regular liquid cylinders. The Cryo-Cyl liquid cylinder can provide gas at pressure up to 350 psi (24.1 bar). This liquid cylinder will build and maintain an operating pressure at the pressure building regulator setting of 125 psi (8.6 bar).

If the operating pressure exceeds 125 psi (8.6 bar), the pressure will be lowered as the gas is delivered. A separate economizer regulator is not provided on the Cryo-Cyl 80 HP cylinder. A continuous gas flow can be automatically provided from this cylinder.

Liquid can be withdrawn from the liquid cylinder in the same manner that was described in the Dura-Cyl LP Liquid Cylinder section of this manual.

Filling Procedures

The Cryo-Cyl 80 HP liquid cylinder is regulated by the DOT for transporting liquid oxygen, nitrogen, argon, CO₂ or N₂O. The filling of these liquid cylinders must be done by product weight. This will allow enough gas space above the liquid to keep the liquid cylinder from becoming liquid full if its pressure rises to the relief valve setting. The filling weight table indicates the correct product weight for the various relief valve settings. The standard relief valve setting is 350 psi (24.1 bar). The filling procedure will explain the proper way to use the filling weight table.

The liquid cylinders are equipped with liquid and vent valves that are used during the filling procedure. The liquid valve is equipped with a dip tube that extends into the inner vessel of the cylinder and reaches to the bottom. The vent valve has a dip tube attached to it that also extends into the inner vessel near the top of the cylinder.

Filling can be accomplished by pressure transfer. The following procedure should be used:

1. Sample the residual gas that is in the cylinder. Purge the cylinder if necessary to ensure the proper purity.
2. Place the cylinder on the filling scale. Record the weight. Compare this weight to the registered tare weight on the data plate. The difference is the weight of the residual gas.
3. Connect the transfer hose to the fill fitting. Record the new weight. The difference between this weight and the initial weight is the weight of the transfer hose.
4. To determine the total filling weight add the tare weight of the cylinder, the hose weight and the proper filling weight from the table (i.e. oxygen at 350 psi / 24 bar has a product weight of 173 pounds / 78 kg).
5. Open the cylinder's vent and liquid valves. Open the transfer line shut-off valve to begin the flow of product.
6. When the scale reads the calculated total filling weight, turn off the liquid valve on the cylinder. Close the vent valve.
7. Close the transfer line shut-off valve and relieve the pressure in the transfer line. Remove the transfer line. Remove the cylinder from the scale.

Operating Pressure

The Cryo-Cyl 80 HP liquid cylinder will automatically maintain an operating pressure between the pressure building regulator (125 psi / 8.6 bar) and the relief valve setting (350 psi / 24.1 bar). The lower limit of the operating pressure can be set up or down by adjusting the pressure building regulator. The adjustment range of the regulator is between 75 and 175 psi (5.2 and 12.1 bar).

The gas delivery pressure should not be confused with the vessel operating pressure. The delivery pressure should be adjusted with a separate regulator that is attached to the gas withdrawal fitting.

Gas Withdrawal

The Cryo-Cyl 80 HP liquid cylinder will deliver gas at various flow rates and temperatures for different applications. The flow rate is controlled by the equipment that is being supplied gas from the liquid cylinder. The continuous flow rate indicates the flow rate that will normally provide gas at a reasonable temperature and should not be exceeded. Higher flow rates may provide very cold gas that could damage the equipment that they are attached to.

To supply gaseous product follow this step-by-step procedure:

1. Connect the proper regulator to the Cryo-Cyl liquid cylinder gas use outlet.
2. Connect the proper hose between the final line regulator and the receiving equipment.
3. Open the pressure building valve.
4. Allow pressure to build to the operating pressure (125 psi / 8.6 bar).

5. Open the gas use valve.
6. Adjust the final line regulator for the proper delivery pressure.
7. When the gas delivery is completed, close all liquid cylinder valves.



Caution! The liquid and vent valves on an empty liquid cylinder should always be kept closed to protect the inner vessel and plumbing from being contaminated.

Cryo-Cyl™ HP Liquid Cylinder Filling Weight Table																				
Relief Valve Setting psig/barg	Argon				Nitrogen				Oxygen				CO ₂				N ₂ O			
	LBS	Kg	SCF	Nm³	LBS	Kg	SCF	Nm³	LBS	Kg	SCF	Nm³	LBS	Kg	SCF	Nm³	LBS	Kg	SCF	Nm³
Cryo-Cyl 80 HP (350 psig max. RV) (24 barg max. RV)																				
Gross Cap - 85 liters																				
0-45 psig/0-3.1 barg	248	112	2398	63	142	64	1960	51	201	94	2427	66	--	--	--	--	--	--	--	--
46-75 psig/3.2-5.1 barg	243	110	2350	62	138	63	1904	50	196	89	2367	62	--	--	--	--	--	--	--	--
76-105 psig/5.2-7.2 barg	237	107	2292	60	134	61	1849	49	192	87	2318	61	201	91	1756	46	194	88	1695	44
106-170 psig/7.3-11.7 barg	228	103	2204	58	130	59	1794	47	187	85	2258	59	196	89	1713	45	188	85	1643	43
171-230 psig/11.8-15.9 barg	222	101	2146	57	129	58	1780	46	183	83	2210	58	194	88	1695	44	185	84	1616	42
231-295 psig/16.0-20.3 barg	215	98	2079	55	127	58	1752	46	179	81	2161	57	190	86	1660	43	181	82	1581	41
**296-360 psig/20.4-24.8 barg	211	96	2040	54	121	55	1670	44	173	78	2089	55	187	85	1634	43	177	80	1546	40

** Normal Factory Setting



Note: It is important to fill all liquid cylinders by their published fill weights to comply with the DOT - 4L regulations. There is however, one exception to the filling regulation (CFR49 section 173.320): If you are operating under the 25.3 psig (40 psia) relief valve setting (22 psig is typically used in liquid service), you are not required to fill by weight so the operator can fill the liquid cylinder to "vent full". This is allowed because the liquid will not have a chance to grow as the relief valve is set very low and hence there is minimal risk of liquid dispensing out the safety relief valve.

Maintenance

General

This section contains information regarding the liquid cylinder care and maintenance, troubleshooting and repair. It includes the particular maintenance procedures for changes to the operating pressure, service pressure and liquid service changes. When performing a procedure that is described in this section, refer to the Specifications section for component item numbers and locations.

O₂ Cleaning

Always keep cylinders clean and free from grease and oil. This applies not only to containers used in oxygen service, but also to those used in nitrogen and argon service.

When repairing containers, use only parts which are considered compatible with liquid oxygen and which have been properly cleaned for oxygen service (refer to CGA Pamphlet G.4.1 "Equipment Cleaned for Oxygen Service"). Do not use regulators, fittings, or hoses which were previously used in a compressed air service. Use only oxygen compatible sealants or Teflon tape on the threaded fittings. All new joints should be leak tested with an oxygen compatible leak test solution.



Caution! Before conducting maintenance or replacing parts on a cylinder, release container pressure in a safe manner. Replacement of certain parts may also require that the tank contents be completely emptied.

Changing Service

The Dura-Cyl® and Cryo-Cyl™ Liquid Cylinders are designed to hold any of the gas products specified in the Operations section of this manual. They can easily be modified to work as well with nitrogen as oxygen. The fittings and decals need to be changed and the inner vessel needs to be purged.

If a cylinder is changed from inert (argon or nitrogen) to CO₂ service, the relief valve must be changed to a CO₂ relief valve.



Warning! Cylinders used in oxygen service must not be changed to CO₂ service.



Warning! Once a cylinder is used in CO₂ service, it cannot be used for other gas products, especially oxygen or nitrous oxide.



Warning! Whenever converting a nitrogen or argon cylinder to oxygen use, inspect the cylinder to assure cleanliness.

Recommended Inner Vessel Purging (with a vacuum pump)

Before any operation that involves pressure or handling of a cryogenic fluid, make sure that all safety precautions are taken.

1. Open the vent to remove any pressure that has built in the inner vessel.
2. Open the pressure building valve to boil away any cryogenic liquid that remains in the vessel.
3. Warm the inner vessel with warm nitrogen gas through the liquid valve. Check the gas temperature as it escapes through the open vent valve. Continue until it is warm.
4. Close the liquid valve, gas use and pressure building valves.
5. Attach a vacuum pump to the vent valve and evacuate the inner vessel to 26 inches of mercury.
6. Break the vacuum to 5 psig (0.3 barg) with high purity gas as required by the service of the container.
7. Repeat steps 5 and 6 twice.
8. Close all valves and remove the vacuum and gas purge lines. The container is now ready for filling.

Fittings and Decals

It is very important that the proper fittings for the specific gas product being transported are installed on the liquid cylinder. The Compressed Gas Association regulates the fitting design so that equipment compatibility is based on gas product. This keeps from having a nitrogen tank being attached to a hospital's oxygen supply. DO NOT use fitting adapters.

The decals should be placed on the tank as shown in Figure 17. The decal's part numbers are shown in the table. The sight gauge decal for the Dura-Cyl® LP Liquid Cylinders should be located so that the bottom of the decal lines up with the ridge on the sight gauge tube. The Dura-Cyl MP/HP and Cryo-Cyl™ 80 HP Liquid Cylinders have a unique plastic level gauge that can be snapped off the tank and replaced for each gas product. Pull the plastic level gauge straight to the side to remove it. The new level gauge should be snapped on securely.

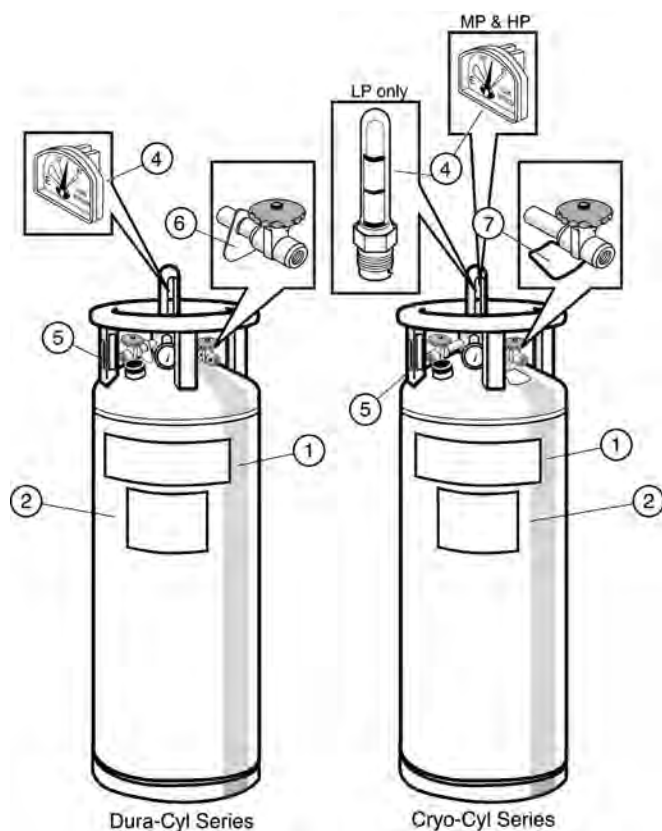


Figure 17

Item	PN	Description
1	14381385	Dura-Cyl 120 LP
1	14324831	Dura-Cyl 180 LP
1	13283046	Dura-Cyl 200 LP
1	14324840	Dura-Cyl 230 LP
1	10537961	Dura-Cyl 160 MP
1	10537987	Dura-Cyl 180 MP
1	10538007	Dura-Cyl 200 MP
1	10538023	Dura-Cyl 230 MP
1	10538040	Dura-Cyl 265 MP
1	10537979	Dura-Cyl 160 HP
1	10537995	Dura-Cyl 180 HP
1	10538015	Dura-Cyl 200 HP
1	10538031	Dura-Cyl 230 HP
1	10538058	Dura-Cyl 265 HP
1	10662770	Cryo-Cyl 80 HP
2	10580264	Argon
2	10580272	Oxygen
2	10580281	Nitrogen
2	10591140	Carbon Dioxide
2	10591131	Nitrous Oxide
4	N/R	(see liquid level gauge decals/heads)
5	N/R	(see DOT/TC data plate)
6	3811599	Valve Tag - Gas Use
6	3811589	Valve Tag - Liquid
6	3811609	Valve Tag - Vent
6	3815029	Valve Tag - Vent/Gas Use

Troubleshooting

This troubleshooting section contains information on the normal operating conditions and the problems that may occur with the Dura-Cyl/Cryo-Cyl liquid cylinders. The troubleshooting guide assumes that the tank is in its normal operating environment having a cooled down inner vessel and a reasonable vacuum. Before troubleshooting an operational problem, the liquid cylinder should be examined for vacuum.

Loss of Vacuum

The loss of vacuum on a liquid cylinder is usually associated with excessive cylinder frosting or rapid pressure rise. Excessive pressure rise, however, can be normal. A new liquid cylinder or one that has not been used recently is considered to have a warm inner vessel. Warm cylinders will build pressure fast after filling and vent off the excess. A liquid cylinder that has been filled and not used will build pressure and vent the excess off. The higher the pressure was in the storage tank at the time of filling, the faster the liquid cylinder will vent off.

Excessive pressure rise can also be an indication of vacuum loss. The Dura-Cyl®/Cryo-Cyl™ Liquid Cylinders are equipped with a pump-out plug that is expelled from the pump-out body if there is a loss of vacuum. This indicates an inner vessel leak. The pump-out body and plug are covered by a black plastic cap to protect them from the environment and tampering. If it is determined that the pump-out plug is properly seated in the pump-out body, but a loss of vacuum is still suspected, an evaporative loss rate test should be performed.

Vented Evaporation Loss Test

The vented evaporation loss test should be used on liquid cylinders that are in nitrogen, oxygen or argon service. It should be done over a period of three to four days.

1. Fill the container to the half full mark using the same product the container previously contained.
2. Verify that the pressure building, gas use, and liquid withdrawal valves are all closed.
3. Allow container to vent for approximately 24 hours.
4. Weigh the container as accurately as possible.
5. Allow the container to continue venting for an additional 48 hours.
6. Weigh the container as accurately as possible.
7. Calculate the difference between the two weights obtained in steps 4 and 6. A weight loss of more than 16 pounds (7.3 kg) in 48 hours is considered excessive; contact your local Chart distributor or the factory for appropriate disposition.
8. If the weight loss is not excessive, proceed with pressurized evaporation loss test.

Pressurized Evaporation Loss Test

The pressurized evaporation loss test should be used on liquid cylinders that passed the vented loss test or are in CO₂ or N₂O service. It will take longer than a vented test since pressure must rise by evaporation only.

1. Pressurize the unit to 50 psig (3.4 barg) and check for any plumbing leaks.
2. Vent and then fill the unit with its designated service product. Maintain pressure in the liquid cylinder while filling. Do not vent after filling.
3. Verify that all valves are tightly closed.
4. Observe pressure rise to relief valve setting (this could take up to six days for a typical cylinder).
5. Once the unit is at relief valve pressure, weigh it as accurately as possible.
6. Check weight a second time after 24 hours.
7. Calculate the difference between the two weights obtained in steps 5 and 6. A weight loss of more than 10 pounds (4.5 kg) in 24 hours is considered excessive; contact your local Chart distributor or the factory for appropriate disposition.
8. If the weight loss is not excessive, the liquid cylinder is considered to have the proper vacuum level.

Follow the troubleshooting guide on the next page and the repair procedures found later in this section. If there are any other questions, contact Chart's Technical Service Department at: 1-800-400-4683.

The following table is arranged in a Trouble/Probable Cause/Remedy format. The probable causes for specific problems are listed in descending order of significance. That is, check out the first cause listed before proceeding to the next. Repair procedures required, as listed in the remedy column, may be found in the Repair portion of this section. Perform all procedures in the order listed and exactly as stated (Refer to drawings as required to locate system components identified in the troubleshooting guide.)

Trouble	Possible Cause	Remedy
Liquid cylinder builds excessive pressure or builds pressure too fast.	Low usage	If daily gas usage is under 100 SCF (2.8 Nm ³), the cylinder will build pressure. In liquid service the cylinder should be equipped with low pressure relief valve and regulator. Normal pressure rise should not be more than 50 psi (3.4 bar) per day.
	Cylinder is over filled	If the cylinder is filled past the vent trycock or past the DOT specified fill weight, the pressure may rise rapidly after a fill.
	Pressure building regulator is set improperly or leaks	If the pressure builds and stays at a pressure higher than desired, adjust the pressure building regulator to a new setting.
		If the pressure builds to the relief valve setting and the PB coil near the bottom of the tank is cold or frosted, replace the regulator.
	Vacuum is deteriorating	This can be accompanied by cold or frost occurring evenly over the cylinder surface. Refer to the Troubleshooting section on frost.
Liquid cylinder pressure is too low	Pressure builder valve is closed	Open valve
	Pressure building regulator is set too low	Adjust the regulator as described in the Repairs section titled 'Changing Operating Pressure'.
	Pressure building regulator is not opening properly	Bench test the regulator for full flow at the set pressure as described in the Repairs section titled 'Bench Setting a Pressure Control Regulator'.
	Usage is too high	Refer to the Specifications section of this manual for maximum recommended delivery rates or to the Introduction section for pressure building capacities.
	Cylinder is leaking	Check for frost on lines or on top of head. Listen for hissing, soap test joints for leaks. Isolate leak and call Chart for repair details.
Frost occurs around the circumference of the shell 4" to 8" (10.2 to 20.4 cm) from the floor	Cylinder is building pressure with the pressure building circuit	This is normal if the cylinder pressure is lower than the pressure building regulator setting.
	Frost is residual from last fill or earlier use.	This is normal. A ring of ice or an oval shaped ice ball often remains on the cylinder for days after the last use or fill.
Frost occurs around the circumference of the shell 10" (25.4 cm) from the floor and up. Frost spot spirals up the shell	Cylinder is vaporizing liquid into gas.	This is normal. The frost should melt within two hours after the gas use stops.
Frost occurs on head or knuckle.	Residual frost remains from last fill or recent product use	This is normal. Ice may remain for days after a fill or heavy use.
	Sight gauge is leaking	Check for gas escaping from under sight gauge. Refer to the Repairs section titled 'Level Gauge' for assistance.
Frost occurs evenly over the cylinder surface	The gas withdrawal rate is high. Both the PB and gas use vaporizers are frosted.	This is normal.
	Cylinder has lost vacuum.	This is accompanied by high rate of pressure rise or high loss rate. Call Chart for return instructions.

Trouble	Possible Cause	Remedy
Miscellaneous frost spots on cylinders.	Cylinder may have internal damage.	Call Chart for evaluation or repair/return information.
Delivery gas is too cold.	Delivery rate exceeds recommended delivery.	Refer to the Introduction section for recommended maximum delivery rates.
In liquid delivery liquid is mixed with high amount of gas.	Cylinder pressure is higher than optimum for liquid withdrawal.	Refer to the Repairs section titled 'Changing Operating Pressure' for instruction on resetting the cylinder pressure for liquid use. Also, use a phase separator on the end of the transfer hose.
In CO ₂ service, cylinder does not deliver product properly.	Possible dry ice blocks have formed in the system.	Refer to the Repairs section titled 'Reliquefying Solid CO ₂ ' for instructions.

Repairs

Reliquefying Solid CO₂

In the event the Dura-Cyl® HP/Cryo-Cyl™ HP Liquid Cylinder loses pressure and the contents become solidified, the following procedure should be used:

1. Locate and correct the reason for the pressure loss; refer to the Troubleshooting table in this section.
2. Connect the proper gas source to the vent valve on the frozen Dura-Cyl HP/Cryo-Cyl HP.
3. Open the vent and gas source valve on the frozen liquid cylinder and monitor its pressure.
4. Pressure in a frozen Dura-Cyl HP/Cryo-Cyl HP should rise to 60 psig (4.1 barg) and remain there. When the pressure starts to rise above 60 psig, it is an indication that the solid has relquefied. Continue to raise the pressure to 200-300 psig (13.8-20.7 barg).



Note: Depending on length of time contents have been frozen, the time to relquefy could last from six minutes to two weeks. This should be done as soon as possible. It could take up to two full liquid cylinders to relquefy a fully solidified tank.

Changing the Service Pressure

The inner pressure vessel used in the Dura-Cyl/Cryo-Cyl liquid cylinders is designed and rated to a maximum operating pressure by the DOT. All of the vessels have been proof tested for that rating. The maximum pressure rating is shown in the Specification section of this manual and on the individual liquid cylinder's data plate. DO NOT install a relief valve with a higher pressure than specified. Lower pressures are commonly used for limiting the maximum pressure of the liquid.

The relief valve can be changed in the following manner:

1. Open the vent valve and release all pressure from the vessel. If the liquid cylinder is in CO₂ service the vessel must be emptied of product.
2. Remove the relief valve. DO NOT attempt to repair or reset the relief valve.
3. Remove the metal identification tag.
4. Install the new identification tag and relief valve; use oxygen compatible thread sealant or Teflon tape.
5. Pressurize the container and leak test with oxygen compatible snoop solution.

The following relief valve parts list shows the various pressure settings that are offered. The relief valves that are marked for CO₂ and N₂O are specially designed for those gas products.

Relief Valves		
Rego PN	Generant PN	Pressure Setting (PSIG)
1810012	11884770	22
1810022	13382941	35
1810032	11531510	50
1810042	11868374	100
1810652	11868374	125
1811412	11884796	230
1810462	11884788	350

*Standard relief valves currently supplied are Generant. The above Rego valves are also supplied upon request.

Changing Operating Pressure

The Dura-Cyl®/Cryo-Cyl™ Liquid Cylinders have preset operating pressure and preset pressure building and economizer regulators. These settings can be changed using the procedures that follow.

Dura-Cyl® MCR Liquid Cylinder with Combo Regulator in Gas Service

When a container is dedicated to a gas withdrawal service, change of operation pressure requires adjustment as follows:

1. Release pressure in the container by opening the vent valve.
2. If the desired pressure setting is not within the regulator's range the regulator will have to be replaced as shown in Figure 20.
3. With liquid in the container, open the pressure building valve and observe the pressure gauge until it stops rising. The gauge will then indicate the pressure control regulator setting.
4. Turn the pressure control regulator screw clockwise to increase the pressure. Use the calibrated scale to approximate the desired setting. The pressure gauge will stop rising at the new regulator setting.
5. Continue adjusting the regulator until the desired pressure has been reached.
6. Vent the tank pressure and allow it to build up to confirm the pressure setting.

Dura-Cyl® Liquid Cylinder with LCCM Pressure Control Manifold in Gas Service (refer to Figure 18)

1. Close all four manual valves on the Dura-Cyl cylinder.
2. Back out adjusting knob (Item A) on the pressure control manifold.
3. Release pressure in the container by opening the vent valve (the container must be at least 1/2 full).
4. Close vent valve and turn the adjusting knob (Item A) until the knob registers a desired pressure setting.
5. With liquid in the container, open the pressure building valve (Item B) and observe the pressure gauge until it stops rising. The gauge will then indicate the pressure control manifold setting.
6. Turn the pressure control manifold knob (Item A) clockwise to increase the pressure. The pressure gauge will stop rising at the new regulator setting.
7. Continue adjusting the regulator until the desired pressure has been reached.

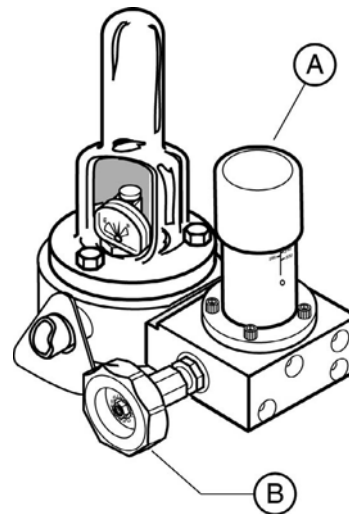


Figure 18

Dura-Cyl®/Cryo-Cyl™ Liquid Cylinder in Liquid Service

When a cylinder is dedicated to a liquid dispensing service, change the operating pressure as follows:

1. Release pressure in the container by opening the vent valve.
2. Isolate the pressure control regulator by turning off the pressure builder valve. The heat leak of the liquid cylinder will be enough to maintain the pressure at 22 psig (1.5 barg).
3. Replace standard pressure relief valve with one to maintain the desired operation pressure (22 psig is normal). Use an oxygen compatible liquid thread sealant (or Teflon tape) to prevent leaking.
4. Pressure test all new joints using an oxygen compatible leak test solution.

Installing the LCCM (Dura-Cyl® Liquid Cylinder Only)

1. Install the four screws and washers into the manifold (Figure 19).
2. Apply a thin layer of Halocarbon® grease to each side of each ferrule, and to the threaded end of the four screws.
3. Install the gasket on the end of the manifold.
4. Place the manifold on the knuckle of the liquid cylinder with the screws lined up with the tapped holes. Use your fingers on a 5/32" hex key to start the four screws.
5. Tighten all screws "finger tight".

- Referring to Figure 19 for the proper torque sequence, torque each screw to 50 in/lbs.
- Using the same sequence, torque each screw to 70 in/lbs.

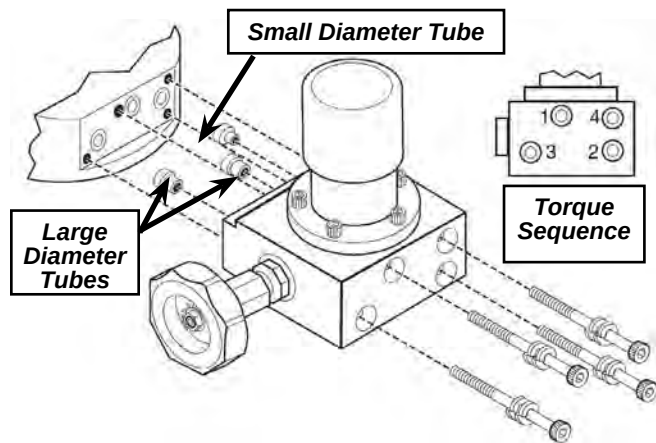


Figure 19

Portable Regulator Bench Setting

Use the following procedure to change the pressure range for either the pressure building or economizer regulator.

- Remove the liquid product from the liquid cylinder. Vent the liquid cylinder of all pressure.
- Remove the regulator from the liquid cylinder.
- Place the regulator body in a vise with the bonnet and adjusting screw pointed up.
- Back out the adjusting screw until there is no spring pressure on it.
- Remove the regulator dome from the body.
- Carefully remove only the spring.
- Replace the spring and reassemble.
- See table below for appropriate springs.

Alternate Regulator Springs			
Pressure Builder		Economizer	
Pressure (PSI)	Part No.	Pressure (PSI)	Part No.
2 - 25	5710031	0 - 3-	5710241
15 - 65	5710191	30 - 50	5710211
40 - 100	5710111	51 - 80	5710151
100 - 250	5710201	81 - 150	5710161
		151 - 250	5710341
		200 - 400	5710301

Bench Setting an MCR Regulator

- Connect the pressure control regulator to a nitrogen pressure source as shown in Figure 20.
- Connect "EC OUT" (economizer out) port to tee on "PB OUT" of regulator with a piece of tubing.
- Close valve "B". Open valve "D".
- Open the pressure source valve (follow appropriate safety rules).
- Open valve "C" slowly.
- Pressure gauge "A" will indicate the pressure to which the regulator has been set. The pressure can be increased by turning the adjusting screw in. The pressure may be decreased by turning the screw out; however, after each adjustment outward it will be necessary to open and then close valve "B" to relieve excess pressure.
- This setting should match the calibrated scale. If it does not, go to step 8.
- Loosen lock nut "E" and adjust screw "F" until calibrated scale matches set pressure. When completed, tighten lock nut "E". "E" and "F" are only to be loosened or adjusted during bench setting procedure.

Factory Settings:

MP 125 psig
HP 300 psig

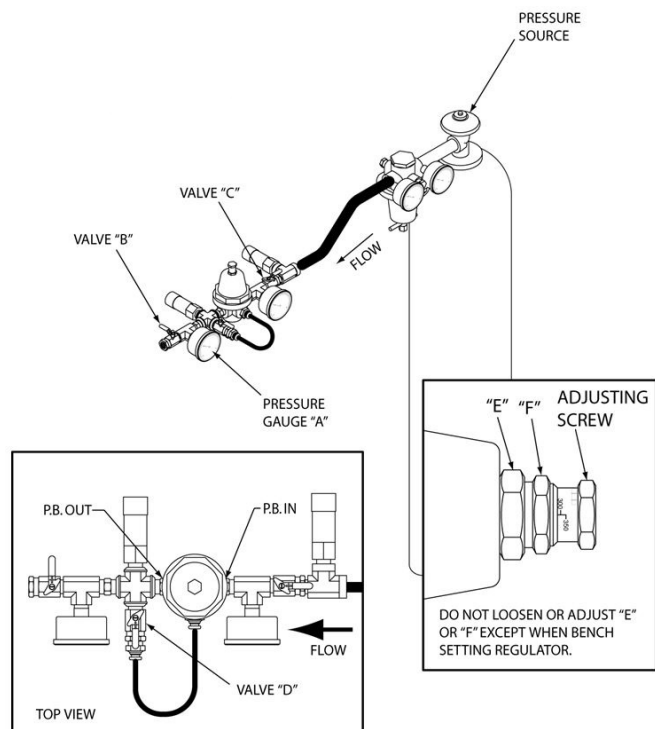


Figure 20

Bench Setting a PB Regulator

1. Connect the pressure building regulator to a nitrogen pressure source as shown in Figure 21.
2. Close valve "B" and "D".
3. Open the pressure source valve (follow the appropriate safety rules).
4. Open valve "C" slowly.
5. Pressure gauge "A" will indicate the pressure to which the regulator has been set. The pressure can be increased by turning the adjusting screw in. The pressure may be decreased by turning the screw out; however, after each adjustment outward it will be necessary to open and then close valve "B" to relieve excess pressure.

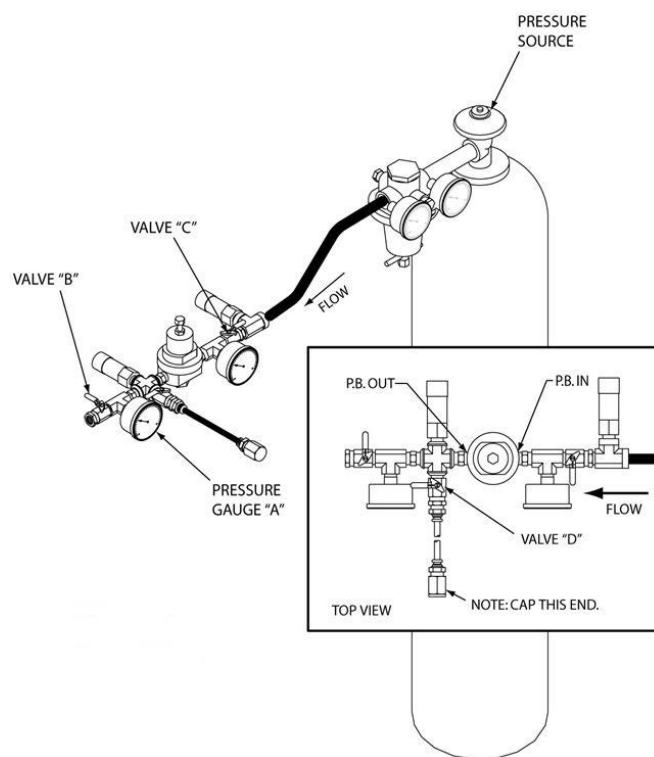


Figure 21

Bench Setting an Economizer Regulator

1. Connect the inlet of the economizer regulator to a pressure source as shown in Figure 22.
2. Open the valve at the pressure source (follow appropriate safety rules).
3. Slowly open valve "B".
4. Pressure gauge "A" will indicate the setting to which the economizer regulator is set. This setting may be increased by turning the adjusting screw in, or lowered by turning the adjust screw out.
5. Gas will flow through the economizer regulator when the pressure of the gas reaches the preset setting.

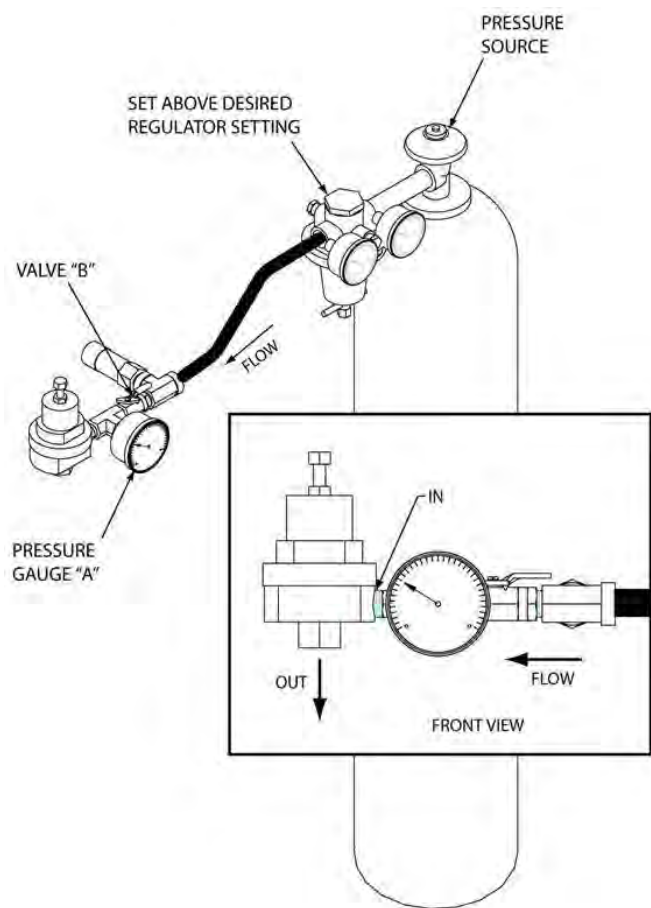


Figure 22

Level Gauge

The liquid level gauge is a float and spring that approximates the amount of product in the container. The design of this gauge makes it possible to use the same float and spring for nitrogen, oxygen and argon. However, the liquid level decal must be changed for each product. The decals are marked N for nitrogen, O for oxygen and A for argon. If the gauge is malfunctioning it should be removed from the container and repaired. The following procedure should be followed (see Figure 23).

1. Open the vent valve and release any pressure that is in the container.
2. Remove the nylon sight gauge protector (Item 3).
3. Unscrew and remove the sight gauge (Item 5).
4. Replace any damaged parts, stretched springs or bent floats.
5. Adjust the sight gauge assembly as follows:
 - a. Hold the sight gauge assembly allowing the float to hang freely.
 - b. The top of the indicator's white tip should be in the empty zone.

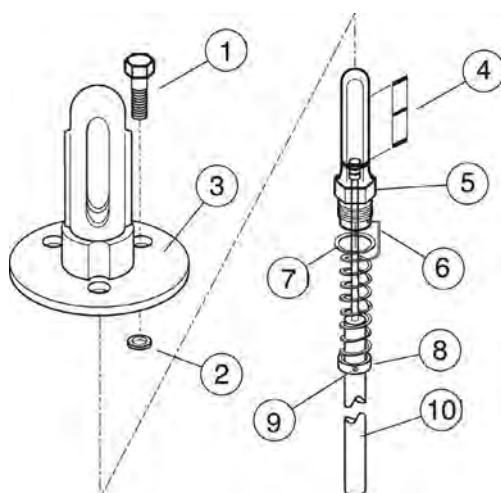


Figure 23

- c. Loosen the spring retainer (Item 8) and adjust the spring up and down the float rod until the indicator hangs freely in the right location. Tighten the spring retainer.
- d. Replace the o-ring/gasket (Item 7).
- e. Insert the float and sight gauge assembly into the container. Make sure that it engages in the float guide located approximately 21 inches into the container.
- f. Tighten the sight gauge to 1/4 turn past hand tight (150 in/lbs) and replace the protector.



Warning! Remove all pressure from the cylinder before repairing the liquid level gauge. Gloves should be worn when handling the float rod to prevent burns.



Warning! DO NOT clean the plastic sight gauge with solvent cleaners.

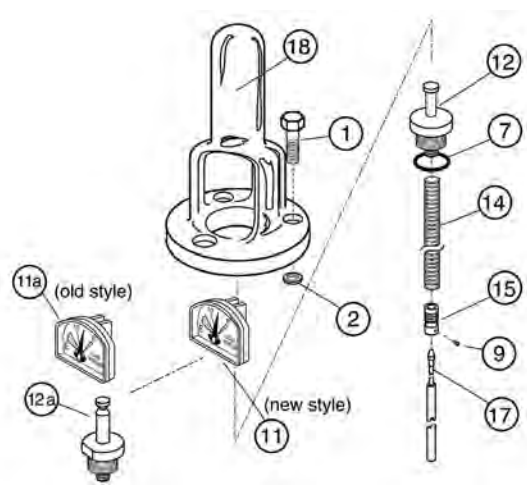


Figure 24

Level Gauge Parts				
Item	Part No.	Qty	Spares*	Description
1	2910501	3		Stainless Steel Screw - 1/4"-20NC x 5/8"
2	2910601	3		Lock washer - 1/4" Split Type SS
3	5410446	1	1	Sight Gauge Protector - Sight Glass (Blue) (MP)
3	5410486	1	1	Sight Gauge Protector - Sight Glass (Yellow) (LP)
3	5410476	1	1	Sight Gauge Protector - Sight Glass (Orange) (HP)
4	3830659	1	1	Sight Gauge Decal (Nitrogen)

Level Gauge Parts (continued)				
Item	Part No.	Qty	Spares*	Description
4	3830569	1	1	Sight Gauge Decal (Oxygen)
4	3830579	1	1	Sight Gauge Decal (Argon)
4	3830799	1	1	Sight Gauge Decal (Carbon Dioxide)
4	3831069	1	1	Sight Gauge Decal (Nitrous Oxide)
5	5411086	1	1	Liquid Level Sight Gauge
6	5410591	1		Extension Spring
7	2300094	1	1	O-Ring (Silicone)
8	5410582	1		Spring Retainer - 120, 160, 230 and 265 w/Sight Glass
8	10561266	1		Spring Retainer - 180 and 200 w/Sight Glass
9	2952321	1		Set Screw
10	10659280	1		Float Rod Assy - Cryo-Cyl 120LP w/Sight Glass
10	9091609	1		Float Rod Assy - 160 w/Sight Glass
10	5411369	1		Float Rod Assy - Cryo-Cyl 180LP w/Sight Glass
10	5410769	1		Float Rod Assy - 200 w/Sight Glass
10	9092339	1		Float Rod Assy - Cryo-Cyl 230 LP w/Sight Glass
10	10616095	1		Float Rod Assy - 265 w/Sight Glass
11	10591342	1	1	Liquid Level Indicator (Nitrogen) (for tanks built after 1/1/95)
11	10591385	1	1	Liquid Level Indicator (Oxygen) (for tanks built after 1/1/95)
11	10591377	1	1	Liquid Level Indicator (Argon) (for tanks built after 1/1/95)
11	10591369	1	1	Liquid Level Indicator (Carbon Dioxide) (for tanks built after 1/1/95)
11	10591351	1	1	Liquid Level Indicator (Nitrous Oxide) (for tanks built after 1/1/95)
11a	10591406	1		Liquid Level Indicator (Nitrogen) (for tanks built before 1/1/95)
11a	10591431	1		Liquid Level Indicator (Oxygen) (for tanks built before 1/1/95)
11a	10591393	1		Liquid Level Indicator (Argon) (for tanks built before 1/1/95)
11a	10591422	1		Liquid Level Indicator (Carbon Dioxide) (for tanks built before 1/1/95)
11a	10591414	1		Liquid Level Indicator (Nitrous Oxide) (for tanks built before 1/1/95)
12	10591511	1		Level Gauge Plug
12a	5410992	1		Level Gauge Plug (Pre-1995 Cylinders only - Use with 11a)
14	5411029	1		Extension Spring
15	5411012	1		Spring Retainer 160, 180
15	5411622	1		Spring Retainer 230, 265
17	9094119	1		Float Rod Assy (Magnetic) 160
17	5411779	1		Float Rod Assy (Magnetic) 180/200
17	5411729	1		Float Rod Assy (Magnetic) 230/265
17	10602291	1		Float Rod Assy (Magnetic) Cryo-Cyl 80HP
18	10534583	1	1	Sight Gauge Protector - (Blue) MP
18	10534567	1	1	Sight Gauge Protector - (Orange) HP

*Recommended Spare Parts

Rebuilding the Operational Valves

The valves that are used on the Dura-Cyl®/Cryo-Cyl™ Liquid Cylinder models have a spring loaded rotary stem. This automatically compensates for thermal shrinkage and wear.

When a defective valve is suspected, follow this procedure to repair it:



Caution! To avoid binding due to freezing at cryogenic temperatures, entry of moisture into the upper valve stem area must be prevented. Seals, gaskets and washers must be in good condition and installed carefully and properly. Torque recommendations must be strictly followed.

Disassembly

1. Open valve by turning hand wheel counter-clockwise as far as it will go to release any trapped gas in the system.



Caution! Do not apply force after valve is fully open.

2. Using a screwdriver, remove hand wheel screw and washer (Items 3 & 14) by turning counter-clockwise to allow removal of spring retainer, washer, spring, seal washer, seal, hand wheel, and bonnet washers (Items 2, 8, 4, 13, 10, 1 and 7). Discard these parts.
3. Using a large adjustable wrench to hold valve body, remove and discard bonnet (Item 5) by turning counter-clockwise with a 15/16" socket wrench that is capable of developing at least 1000 in/lbs torque.
4. Remove these parts from the valve body and discard: stem, stem gasket, seat disc and nipple assembly, and bushing.
5. Inspect body and clean if necessary, be sure interior and seal areas are free of dirt, residue, and foreign particles.



Caution! Do not scratch or mar internal surfaces of valve.

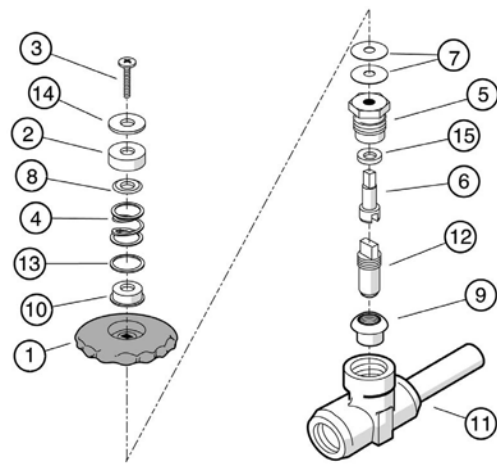


Figure 25

Item	Description	Qty	PN
1	Handwheel	1	Included in Valve Repair Kit PN 9715759 (Except Item 11 which is not available as a repair part)
2	Spring Retainer	1	
3	Screw	1	
4	Spring	1	
5	Bonnet	1	
6	Stem	1	
7	Bonnet Washer	2	
8	Washer	1	
9	Bushing	1	
10	Seal	1	
11	Body and Tube	1	
12	Seat Disc & Nipple Assembly	1	
13	Seal Washer	1	
14	Washer	1	
15	Gasket	1	

Reassembly

1. Partially thread seat disc and nipple assembly (Item 12) (seat disc first), into large end of bushing (Item 9), leaving tang of nipple assembly exposed about 1/3" beyond top of bushing (nipple must rotate freely in bushing).
2. Insert seat disc and nipple assembly (Item 12) (seat disc first), with attached bushing, into valve body until properly seated.
3. Place stem gasket (Item 15) carefully over stem (Item 6) convex side facing downward.
4. Insert slotted end of stem into valve body, making sure that slot fully engages tank of seat disc and nipple assembly.

5. Place bonnet (Item 5) over stem and, while holding square end of stem to keep it from turning, thread bonnet into valve body. Hold body with one wrench and, using another wrench (15/16 socket), tighten bonnet to 1000 in/lbs torque.



Caution! *Hex section of bonnet (Item 5) must be free of burrs or raised edges and top of bonnet must be absolutely flat to provide an effective seal with bonnet gasket washer (Item 7).*

6. Install bonnet washer (Item 7) over stem (Item 6) on bonnet.
7. Place hand wheel (Item 1) over stem and on bonnet.
8. Install seal (Item 10) over stem into recess of hand wheel.
9. Install seal washer (Item 13) over seal at the bottom of hand wheel recess as shown.
10. With the flat side facing downward, place retainer washer (Item 8) on top of seal.
11. Align the holes of these parts and place spring (Item 4) over seal.
12. Place spring retainer over assembly as shown, keeping center hole aligned with parts installed in steps 6-11.
13. Install washer and screw (Items 3 & 14) over retainer. Tighten firmly with a screwdriver, turning clockwise.
14. Turn hand wheel (Item 1) fully clockwise to close valve.
15. Pressurize system, check valve for proper operation and check all seal points for leaks by inspecting thoroughly.



Specifications

Dura-Cyl Footring Specifications									
Model		160 L	160 L	180 L	180 L	180 L	200 L	200 L	200 L
	Pressure	MP	HP	LP	MP	HP	LP	MP	HP
LCCM	Part Number	10508748	10508756	--	10508764	10496433	--	10508772	10496417
MCR	Part Number	10783424	10783467	--	10783491	10782539	--	10783598	10783619
None ⁽¹⁾	Part Number	--	--	10648450	--	--	13277869	--	--
Capacity⁽²⁾⁽³⁾									
Liquid (Gross)	liters	176	176	196	196	196	209	209	209
Liquid (Net)	liters	165	165	185	185	185	196	196	196
Gas (N ₂)	ft ³ / Nm ³	3,685 / 97	3,464 / 91	--	4,099 / 108	3,864 / 102	--	4,375 / 115	4,072 / 108
Gas (O ₂)	ft ³ / Nm ³	4,577 / 120	4,348 / 114	--	5,096 / 134	4,843 / 127	--	5,435 / 143	5,048 / 133
Gas (Ar)	ft ³ / Nm ³	4,448 / 117	4,226 / 111	--	4,961 / 130	4,709 / 124	--	5,290 / 139	4,932 / 130
Gas (CO ₂)	ft ³ / Nm ³	--	3,382 / 89	--	--	3,766 / 99	--	--	4,011 / 105
Gas (N ₂ O)	ft ³ / Nm ³	--	3,207 / 84	--	--	3,574 / 94	--	--	3,810 / 100
Performance									
NER (N ₂)	% per day	2.0	2.0	1.5	1.9	1.9	1.85	1.85	1.85
NER (O ₂ - Ar)	% per day	1.4	1.4	1.0	1.3	1.3	1.2	1.2	1.2
NER (CO ₂ - N ₂ O)	% per day	--	0.5	--	--	0.5	--	--	0.5
Gas Flow (N ₂ , O ₂ , Ar)	SCFH/Nm ³ /hr	350 / 9.2	350 / 9.2	--	350 / 9.2	350 / 9.2	--	400 / 10.5	400 / 10.5
Gas Flow (CO ₂ , N ₂ O)	SCFH/Nm ³ /hr	--	110 / 2.9	--	--	110 / 2.9	--	--	110 / 2.9
Dimensions & Pressure Ratings									
Relief Valve Setting	psig / barg	230 / 16	350 / 24	22 / 1.5	230 / 16	350 / 24	22 / 1.5	230 / 16	350 / 24
DOT/TC Rating		4L200	4L292	4L100	4L200	4L292	4L100	4L200	4L292
Diameter	in / cm	20 / 50.8	20 / 50.8	20 / 50.8	20 / 50.8	20 / 50.8	20 / 50.8	20 / 50.8	20 / 50.8
Height ⁽⁴⁾	in / cm	59.8 / 151.9	59.8 / 151.9	64.3 / 163.3	64.3 / 163.3	64.3 / 163.3	66.6 / 169.2	66.6 / 169.2	66.6 / 169.2
Tare Weight	lb / kg	250 / 113.4	280 / 126.9	210 / 95.2	260 / 117.9	300 / 136.1	210 / 95.2	280 / 126.9	320 / 145.1
Full Weight (N ₂)	lb / kg	517 / 234	531 / 241	540 / 245	557 / 253	580 / 263	559 / 253.5	597 / 271	618 / 280
Full Weight (O ₂)	lb / kg	629 / 285	640 / 290	676 / 307	682 / 309	701 / 318	706 / 320.2	730 / 331	747 / 339
Full Weight (Ar)	lb / kg	710 / 322	717 / 325	778 / 354	773 / 351	787 / 357	821 / 372.4	827 / 375	839 / 380
Full Weight (CO ₂)	lb / kg	--	667 / 303	--	--	731 / 331	--	--	779 / 353

(1) Pressure building regulator optional on LP models.

(2) Gas capacities at DOT4L limits.

(3) Most of the Dura-Cyl models are available with permanently installed CGA fittings for medical applications. Contact Customer Service (1-800-400-4683) for details.

(4) Dimensions are measured from the floor to the top of the sight gauge protector.

Dura-Cyl Caster Base Specifications (round base)							
Model		120 L RB	230 L RB	230 L RB	230 L RB	265 L RB	265 L RB
	Pressure	LP	LP	MP	HP	MP	HP
LCCM	Part Number	--	--	--	10616546	--	--
MCR	Part Number	--	--	10783635	10783651	10783678	10783694
None ⁽¹⁾	Part Number	10648396	10648599	--	--	--	--
Capacity⁽²⁾⁽³⁾							
Liquid (Gross)	liters	120	240	240	240	276	276
Liquid (Net)	liters	110	230	230	230	265	265
Gas (N ₂)	ft ³ / Nm ³	--	--	5,024 / 132	4,734 / 124	5,769 / 152	5,438 / 143
Gas (O ₂)	ft ³ / Nm ³	--	--	6,244 / 164	5,930 / 156	7,186 / 189	6,811 / 179
Gas (Ar)	ft ³ / Nm ³	--	--	6,073 / 160	5,763 / 151	6,982 / 183	6,634 / 174
Gas (CO ₂)	ft ³ / Nm ³	--	--	--	4,614 / 121	--	5,305 / 139
Gas (N ₂ O)	ft ³ / Nm ³	--	--	--	4,378 / 115	--	5,034 / 132
Performance							
NER (N ₂)	% per day	2.0	1.5	1.8	1.8	2	2
NER (O ₂ - Ar)	% per day	1.4	1.0	1.2	1.2	1.4	1.4
NER (CO ₂ - N ₂ O)	% per day	--	--	--	0.5	--	0.5
Gas Flow (N ₂ , O ₂ , Ar)	SCFH/Nm ³ /hr	--	--	400 / 10.5	400 / 10.5	400 / 10.5	400 / 10.5
Gas Flow (CO ₂ , N ₂ O)	SCFH/Nm ³ /hr	--	--	--	110 / 2.9	--	110 / 2.9
Dimensions & Pressure Ratings							
Relief Valve Setting	psig / barg	22 / 1.5	22 / 1.5	230 / 16	350 / 24	230 / 16	350 / 24
DOT/TC Rating		4L100 ⁽⁴⁾	4L100	4L200	4L292	4L200	4L292
Diameter	in / cm	20 / 50.8	26 / 66.0	26 / 66.0	26 / 66.0	26 / 66.0	26 / 66.0
Height ⁽⁵⁾	in / cm	51 / 129.5	57.2 / 145.3	57.2 / 145.3	57.2 / 145.3	59.9 / 152.2	59.9 / 152.2
Tare Weight	lb / kg	177 / 80.3	296 / 134.3	311 / 141.1	367 / 166.5	330 / 149.7	390 / 176.9
Full Weight (N ₂)	lb / kg	377 / 171	697 / 316.2	675 / 306.1	710 / 322	748 / 339.2	784 / 355.6
Full Weight (O ₂)	lb / kg	462 / 209.5	866 / 392.8	828 / 375.5	858 / 389.1	925 / 419.5	954 / 432.7
Full Weight (Ar)	lb / kg	528 / 239.5	998 / 452.7	939 / 425.9	963 / 436.8	1052 / 477.1	1076 / 488
Full Weight (CO ₂)	lb / kg	--	--	--	895 / 405.9	--	997 / 452.2

(1) Pressure building regulator optional on LP models.

(2) Gas capacities at DOT 4L limits.

(3) Most of the Dura-Cyl models are available with permanently installed CGA fittings for medical applications. Contact Customer Service (1-800-400-4683) for details.

(4) Dura-Cyl 120LP is not TC approved.

(5) Dimensions are measured from the floor to the top of the sight gauge protector.



Note: All caster base models are available with stainless steel casters.

Dura-Cyl Caster Base Specifications (square base)						
Model		230 L SB	230 L SB	230 L SB	265 L SB	265 L SB
	Pressure	LP	MP	HP	MP	MP
LCCM	Part Number	--	10496468	10496492	10510039	10512561
MCR	Part Number	--	10810779	10794027	--	--
None ⁽¹⁾	Part Number	10648556	--	--	--	--
Capacity⁽²⁾⁽³⁾						
Liquid (Gross)	liters	240	240	240	276	276
Liquid (Net)	liters	230	230	230	265	265
Gas (N ₂)	ft ³ / Nm ³	--	5,024 / 132	4,734 / 124	5,769 / 152	5,438 / 143
Gas (O ₂)	ft ³ / Nm ³	--	6,244 / 164	5,930 / 156	7,186 / 189	6,811 / 179
Gas (Ar)	ft ³ / Nm ³	--	6,073 / 160	5,763 / 151	6,982 / 183	6,634 / 174
Gas (CO ₂)	ft ³ / Nm ³	--	--	4,614 / 121	--	5,305 / 139
Gas (N ₂ O)	ft ³ / Nm ³	--	--	4,378 / 115	--	5,034 / 132
Performance						
NER (N ₂)	% per day	1.5	1.8	1.8	2	2
NER (O ₂ - Ar)	% per day	1.0	1.2	1.2	1.4	1.4
NER (CO ₂ - N ₂ O)	% per day	--	--	0.5	--	0.5
Gas Flow (N ₂ , O ₂ , Ar)	SCFH/Nm ³ /hr	--	400 / 10.5	400 / 10.5	400 / 10.5	400 / 10.5
Gas Flow (CO ₂ , N ₂ O)	SCFH/Nm ³ /hr	--	--	110 / 2.9	--	110 / 2.9
Dimensions & Pressure Ratings						
Relief Valve Setting	psig / barg	22 / 1.5	230 / 16	350 / 24	230 / 16	350 / 24
DOT/TC Rating		4L100	4L200	4L292	4L200	4L292
Diameter ⁽⁴⁾	in / cm	26 / 66.0	26 / 66.0	26 / 66.0	26 / 66.0	26 / 66.0
Height ⁽⁵⁾	in / cm	56.8 / 144.3	56.8 / 144.3	56.8 / 144.3	59.5 / 151.1	59.5 / 151.1
Tare Weight	lb / kg	325 / 147.4	340 / 154.2	395 / 179.2	360 / 163.3	418 / 189.6
Full Weight (N ₂)	lb / kg	726 / 329.3	704 / 319.3	738 / 334.7	778 / 352.8	812 / 368.3
Full Weight (O ₂)	lb / kg	895 / 406	857 / 388.7	886 / 401.8	955 / 433.1	982 / 445.4
Full Weight (Ar)	lb / kg	1027 / 465.8	968 / 439	991 / 449.5	1082 / 490.7	1104 / 500.7
Full Weight (CO ₂)	lb / kg	--	--	923 / 418.6	--	1025 / 464.9

(1) Pressure building regulator optional on LP models.

(2) Gas capacities at DOT 4L limits.

(3) Most of the Dura-Cyl models are available with permanently installed CGA fittings for medical applications. Contact Customer Service (1-800-400-4683) for details.

(4) Dimension of square caster bases: 27-3/4"W x 28-3/4"D.

(5) Dimensions are measured from the floor to the top of the sight gauge protector.



Note: All caster base models are available with stainless steel casters.

Cryo-Cyl Specifications		
Model		80 L
	Pressure	HP
	Part Number	10648610
Capacity⁽¹⁾⁽²⁾		
Liquid (Gross)	liters	85
Liquid (Net)	liters	80
Gas (N ₂)	ft ³ / Nm ³	1,680 / 44
Gas (O ₂)	ft ³ / Nm ³	2,108 / 55
Gas (Ar)	ft ³ / Nm ³	2,049 / 54
Gas (CO ₂)	ft ³ / Nm ³	1,640 / 43
Gas (N ₂ O)	ft ³ / Nm ³	1,555 / 41
Performance		
NER (N ₂)	% per day	3.0
NER (O ₂ - Ar)	% per day	2.0
NER (CO ₂ - N ₂ O)	% per day	0.8
Gas Flow (N ₂ , O ₂ , Ar) ⁽³⁾	SCFH/Nm ³ /hr	100 / 2.6
Gas Flow (CO ₂ , N ₂ O)	SCFH/Nm ³ /hr	35 / 0.9
Dimensions & Pressure Ratings		
Relief Valve Setting	psig / barg	350 / 24
Operating Pressure ⁽⁴⁾	psig / barg	125 / 8.6
DOT/TC Rating		4L292
Diameter	in / cm	20 / 50.8
Height ⁽⁵⁾	in / cm	39.5 / 100.3
Tare Weight	lb / kg	165 / 74.8
Full Weight (N ₂)	lb / kg	287 / 130
Full Weight (O ₂)	lb / kg	340 / 155
Full Weight (Ar)	lb / kg	377 / 171
Full Weight (CO ₂)	lb / kg	353 / 161

(1) Net gas capacities at DOT 4L limits.

(2) The Cryo-Cyl model is available with permanently installed CGA fittings for medical applications. Contact Customer Service (1-800-400-4683) for details.

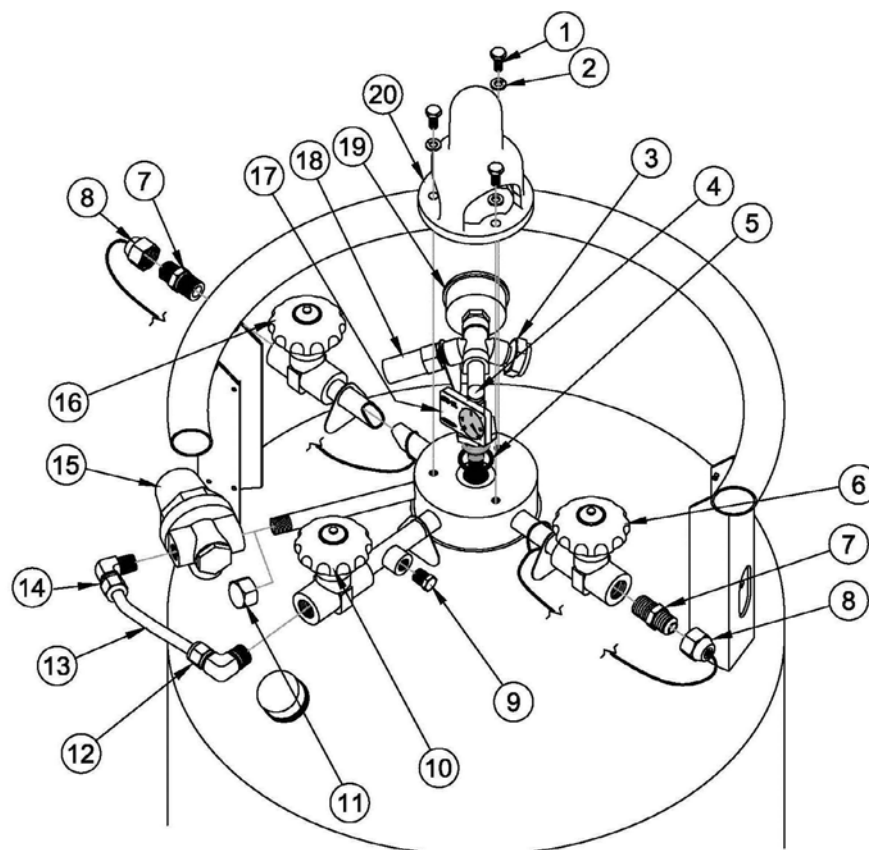
(3) Gas flows of twice the continuous flow rate can be achieved for one hour over an eight hour period.

(4) Pressure building regulator range (50-175 psig)

(5) Dimensions are measured from the floor to the top of the sight gauge protector.

Plumbing Configurations and Parts Lists

LP Plumbing Configuration



LP Parts List

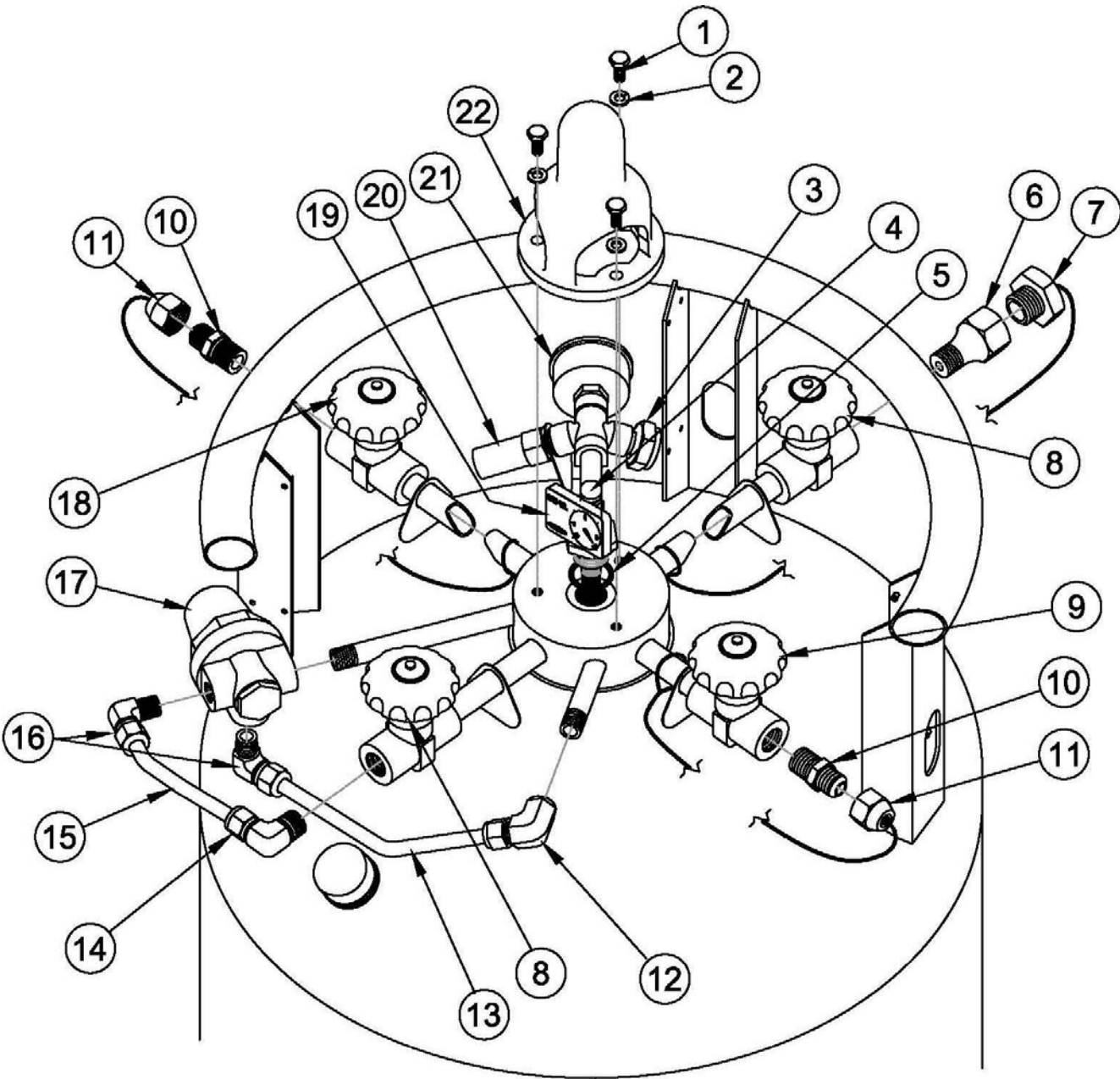
Item	Part No.	Qty	Description
1	2910501	3	HHMS SS 1/4-20x5/8" LG
2	2910601	3	WASHER SPLIT SS 1/4 18-8 B18
3	1911622	1	RPD ASSY 1/4MPT 200PSI BRS YEL
4	20696077	1	FLOAT ROD ASSY R-TEL SPV 120
4	20551882	1	FLOAT ROD ASSY R-TEL SPV 180
4	20551883	1	FLOAT ROD ASSY R-TEL SPV 200
4	20551884	1	FLOAT ROD ASSY R-TEL SPV 230
5	2300094	1	O-RING .924IDx1.130OD
6	13801405	1	LIQUID VALVE STEM ASSY (BLUE)
7	4010022	1	CGA FITTING AR/N2 (INERT) GAS USE CGA-580
7	4010012	1	CGA FITTING O2 GAS USE CGA-540
8	4010629	1	DUST CAP BRS AR/N2 (INERT) GAS USE FOR CGA-580
8	4010512	1	DUST CAP BRS O2 GAS USE FOR CGA-540
9	1212962	1	PLUG BRS HEX HD .125NPT 218P-2

Item	Part No.	Qty	Description
10	13744463	1	PB/GU VALVE STEM ASSY (GREEN)
11	1210752	1	CAP BRS 1/4"NPTF
12	1213152	1	ELBOW BRS 90D 3/8ODTx1/4FPT
13	8512163	1	TUBE CU .375"OD .032W 5.000
14	1011432	2	ELBOW BRS 90D 3/8ODTx1/4MPT
15	10582809	1	REGULATOR LP 18PSI A-32
16	9715759	1	VENT VALVE STEM ASSY (SILVER)
17	20546190	1	ROTO-TEL GAUGE ARGON
17	20546188	1	ROTO-TEL GAUGE NITROGEN
17	20546189	1	ROTO-TEL GAUGE OXYGEN
18	11884770	1	RV BRS 1/4MPT 22 PSI
19	14932554	1	PG 2"DIAL 0/100PSI/BAR/KPA
20	10534575	1	SIGHT GAUGE PROTECTOR YELLOW

Note: Sequence number 12, 13, 14 and 15 make up the optional PB Regulator Kit PN 10658826.

Note: Roto-Tel Assembly kits that include sequence numbers 4, 5 and 17 for each model and gas service are available on www.chartparts.com.

MCR Plumbing Configuration



MP MCR Parts List

Item	Part No.	Qty	Description
1	2910501	3	HHMS SS 1/4-20x5/8" LG
2	2910601	3	WASHER SPLIT SS 1/4 18-8 B18
3	1910882	1	RPD ASSY 1/4MPT 400PSI BRS BLU
4	20551881	1	FLOAT ROD ASSY R-TEL SPV 160
4	20551882	1	FLOAT ROD ASSY R-TEL SPV 180
4	20551883	1	FLOAT ROD ASSY R-TEL SPV 200
4	20551884	1	FLOAT ROD ASSY R-TEL SPV 230
4	20551887	1	FLOAT ROD ASSY R-TEL SPV 265
5	2300094	1	O-RING .924IDx1.130OD
6	4010022	1	CGA FITTING AR/N2 (INERT) GAS USE CGA-580
6	4010012	1	CGA FITTING O2 GAS USE CGA-540
7	4010629	1	DUST CAP BRS AR/N2 (INERT) GAS USE FOR CGA-580
7	4010512	1	DUST CAP BRS O2 GAS USE FOR CGA-540
8	13744463	2	PB/GU VALVE STEM ASSY (GREEN)
9	13715355	1	LIQUID VALVE STEM ASSY (BLUE)
10	1110072	2	CGA FITTING AR/N2 (INERT) VENT/ LIQUID CGA-295
10	1110112	2	CGA FITTING O2 VENT/LIQUID CGA-440
11	4016639	2	DUST CAP BRS INERT VENT/LIQUID FOR CGA-295
11	4016649	2	DUST CAP BRS O2 VENT/LIQUID FOR CGA-440
12	1213152	1	ELBOW BRS 90D 3/8ODTx1/4FPT
13	10590999	1	TUBE CU .375"ODx.032Wx7"LG
14	1011442	1	ELBOW BRS 90D 3/8ODTx3/8MPT
15	8512163	1	TUBE CU .375"OD .032W 5.000
16	1011432	2	ELBOW BRS 90D 3/8ODTx1/4MPT
17	11081336	1	REGULATOR MCR-MP 125PSI PBE-3A
18	9715759	1	VENT VALVE STEM ASSEMBLY (SILVER)
19	20546190	1	ROTO-TEL GAUGE ARGON
19	20546188	1	ROTO-TEL GAUGE NITROGEN
19	20546189	1	ROTO-TEL GAUGE OXYGEN
20	11884796	1	RV BRS 1/4MPT 230PSI
21	14932538	1	PG 2"DIAL 0/400PSI/BAR/KPA
22	10534583	1	SIGHT GAUGE PROTECTOR BLUE

Note: Roto-Tel Assembly kits that include sequence numbers 4, 5 and 19 for each model and gas service are available on www.chartparts.com.

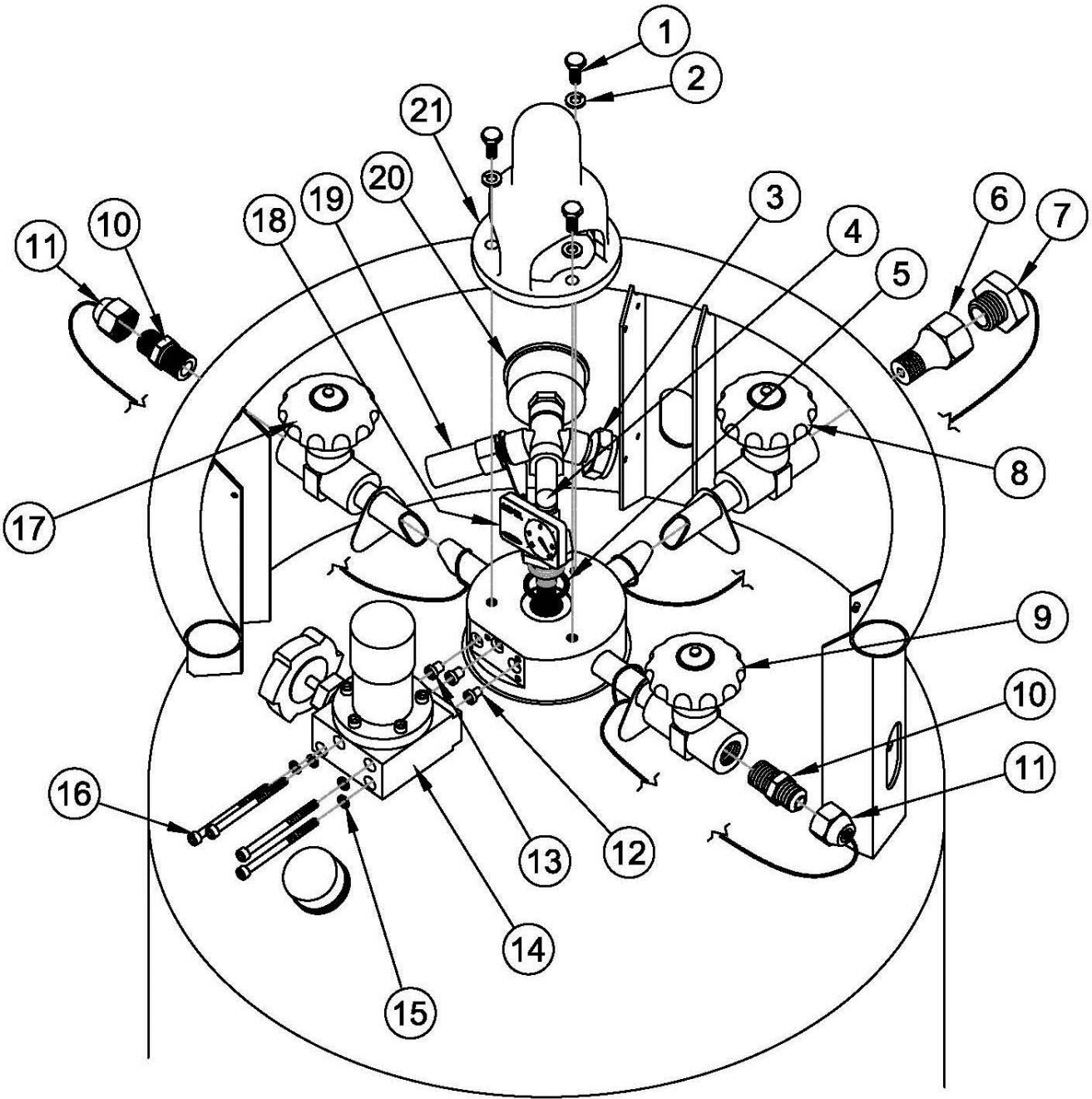
HP MCR Parts List

Item	Part No.	Qty	Description
1	2910501	3	HHMS SS 1/4-20x5/8" LG
2	2910601	3	WASHER SPLIT SS 1/4 18-8 B18
3	1911632	1	RPD ASSY 1/4MPT 584PSI BRS ORG
4	20551881	1	FLOAT ROD ASSY R-TEL SPV 160
4	20551882	1	FLOAT ROD ASSY R-TEL SPV 180
4	20551883	1	FLOAT ROD ASSY R-TEL SPV 200
4	20551884	1	FLOAT ROD ASSY R-TEL SPV 230
4	20551887	1	FLOAT ROD ASSY R-TEL SPV 265
5	2300094	1	O-RING .924IDx1.130OD
6	4010022	1	CGA FITTING AR/N2 (INERT) GAS USE CGA-580
6	4010012	1	CGA FITTING O2 GAS USE CGA-540
6	4010562	1	CGA FITTING CO2 GAS USE CGA-320
6	11764031	1	GENERANT SDC DEVICE N2O GAS USE CGA-326
7	4010629	1	DUST CAP BRS AR/N2 (INERT) GAS USE FOR CGA-580
7	4010512	1	DUST CAP BRS O2 GAS USE CGA-540
7	4016669	1	DUST CAP BRS CO2 GAS USE CGA-320
7	10785948	1	DUST CAP BRS N2O GAS USE CGA-326
8	13744463	2	PB/GU VALVE STEM ASSY (GREEN)
9	13715355	1	LIQUID VALVE STEM ASSY (BLUE)
10	1110072	2	CGA FITTING AR/N2 (INERT) VENT/LIQUID CGA-295
10	1110112	2	CGA FITTING O2 VENT/LIQUID CGA-440
10	13222817	2	CGA FITTING CO2 VENT/LIQUID CGA-622
10	13202120	2	GENERANT SDC DEVICE N2O VENT/ LIQUID CGA-624
11	4016639	2	DUST CAP BRS INERT VENT/LIQUID FOR CGA-295
11	4016649	2	DUST CAP BRS O2 VENT/LIQUID FOR CGA-440
11	13348727	2	DUST CAP BRS CO2/N2O VENT/LIQUID FOR CGA-622 & 624
12	1213152	1	ELBOW BRS 90D 3/8ODTx1/4FPT
13	10590999	1	TUBE CU .375"OD x .032W x 7" LG
14	1011442	1	ELBOW BRS 90D 3/8ODTx3/8MPT
15	8512163	1	TUBE CU .375"OD .032W 5.000
16	1011432	2	ELBOW BRS 90D 3/8ODTx1/4MPT
17	11080138	1	REGULATOR MCR-HP 300 PSI PBE-3A
18	9715759	1	VENT VALVE STEM ASSY (SILVER)
19	20546190	1	ROTO-TEL GAUGE ARGON
19	20546188	1	ROTO-TEL GAUGE NITROGEN
19	20546189	1	ROTO-TEL GAUGE OXYGEN
19	14049702	1	ROTO-TEL GAUGE CO2
19	14455997	1	ROTO-TEL GAUGE N2O
20	11894788	1	RV BRS 1/4MPT 350 PSI
21	14932546	1	PG 2"DIAL D/600PSI/BAR/KPA
22	10534567	1	SIGHT GAUGE PROTECTOR ORANGE

Note: Roto-Tel Assembly kits that include sequence numbers 4, 5 and 19 for each model and gas service are available on www.chartparts.com.

Note: Only Generant SDC devices are available for N₂O service (sequence #10).

LCCM Plumbing Configuration



MP LCCM Parts List

Item	Part No.	Qty	Description
1	2910501	3	HHMS SS 1/4-20x5/8" LG
2	2910601	3	WASHER SPLIT SS 1/4 18-8 B18
3	1910882	1	RPD ASSY 1/4MPT 400PSI BRS BLU
4	20551881	1	FLOAT ROD ASSY R-TEL SPV 160
4	20551882	1	FLOAT ROD ASSY R-TEL SPV 180
4	20551883	1	FLOAT ROD ASSY R-TEL SPV 200
4	20551884	1	FLOAT ROD ASSY R-TEL SPV 230
4	20551887	1	FLOAT ROD ASSY R-TEL SPV 265
5	2300094	1	O-RING .924IDx1.130OD
6	4010022	1	CGA FITTING AR/N2 (INERT) GAS USE CGA-580
6	4010012	1	CGA FITTING O2 GAS USE CGA-540
7	4010629	1	DUST CAP BRS AR/N2 (INERT) GAS USE FOR CGA-580
7	4010512	1	DUST CAP BRS O2 GAS USE FOR CGA-540
8	13744463	1	PB/GU VALVE STEM ASSY (GREEN)
9	13715355	1	LIQUID VALVE STEM ASSY (BLUE)
10	1110072	2	CGA FITTING AR/N2 (INERT) VENT/ LIQUID CGA-295
10	1110112	2	CGA FITTING O2 VENT/LIQUID CGA-440
11	4016639	2	DUST CAP BRS INERT VENT/LIQUID FOR CGA-295
11	4016649	2	DUST CAP BRS O2 VENT/LIQUID FOR CGA-440
12	11526163	1	FERRULES SS/CU LCCM SMALL
13	11526180	2	FERRULES SS/CU LCCM LARGE
14	11077134	1	REGULATOR LCCMA-MP 125 PSI
15	2911071	1	WASHER SPLIT SS #10 18-8 b18
16	11534542	4	SHCS SS #10-32 x 2.500 LG 18-8
17	9715759	1	VENT VALVE STEM ASSY (SILVER)
18	20546190	1	ROTO-TEL GAUGE ARGON
18	20546188	1	ROTO-TEL GAUGE NITROGEN
18	20546189	1	ROTO-TEL GAUGE OXYGEN
19	11884796	1	RV BRS 1/4MPT 230PSI
20	14932538	1	PG 2"DIAL 0/400PSI/BAR/KPA
21	10534583	1	SIGHT GAUGE PROTECTOR BLUE

Note: Roto-Tel Assembly kits that include sequence numbers 4, 5 and 18 for each model and gas service are available on www.chartparts.com.

HP LCCM Parts List

Item	Part No.	Qty	Description
1	2910501	3	HHMS SS 1/4-20x5/8" LG
2	2910601	3	WASHER SPLIT SS 1/4 18-8 B18
3	1911632	1	RPD ASSY 1/4MPT 584PSI BRS ORG
4	20551881	1	FLOAT ROD ASSY R-TEL SPV 160
4	20551882	1	FLOAT ROD ASSY R-TEL SPV 180
4	20551883	1	FLOAT ROD ASSY R-TEL SPV 200
4	20551884	1	FLOAT ROD ASSY R-TEL SPV 230
4	20551887	1	FLOAT ROD ASSY R-TEL SPV 265
5	2300094	1	O-RING .924IDx1.130OD
6	4010022	1	CGA FITTING AR/N2 (INERT) GAS USE CGA-580
6	4010012	1	CGA FITTING O2 GAS USE CGA-540
6	4010562	1	CGA FITTING CO2 GAS USE CGA-320
6	11764031	1	GENERANT SDC DEVICE N2O GAS USE CGA-326
7	4010629	1	DUST CAP BRS AR/N2 (INERT) GAS USE FOR CGA-580
7	4010512	1	DUST CAP BRS O2 GAS USE CGA-540
7	4016669	1	DUST CAP BRS CO2 GAS USE CGA-320
7	10785948	1	DUST CAP BRS N2O GAS USE CGA-326
8	13744463	1	PB/GU VALVE STEM ASSY (GREEN)
9	13715355	1	LIQUID VALVE STEM ASSY (BLUE)
10	1110072	2	CGA FITTING AR/N2 (INERT) VENT/ LIQUID CGA-295
10	1110112	2	CGA FITTING O2 VENT/LIQUID CGA-440
10	13222817	2	CGA FITTING CO2 VENT/LIQUID CGA-622
10	13202120	2	GENERANT SDC DEVICE N2O VENT/ LIQUID CGA-624
11	4016639	2	DUST CAP BRS INERT VENT/LIQUID CGA-295
11	4016649	2	DUST CAP BRS O2 VENT/LIQUID CGA-440
11	13348727	2	DUST CAP BRS CO2/N2O VENT/LIQUID FOR CGA-622 & 624
12	11526163	1	FERRULES SS/CU LCCM SMALL
13	11526180	2	FERRULES SS/CU LCCM LARGE
14	11077142	1	REGULATOR LCCMA-HP 300 PSI
15	2911071	1	WASHER SPLIT SS #10 18-8 b18
16	11534542	4	SHCH SS #10-32 x 2.500 LG 18-8
17	9715759	1	VENT VALVE STEM ASSY (SILVER)
18	20546190	1	ROTO-TEL GAUGE ARGON
18	20546188	1	ROTO-TEL GAUGE NITROGEN
18	20546189	1	ROTO-TEL GAUGE OXYGEN
19	11884788	1	RV BRS 1/4MPT 350 PSI
20	14932546	1	PG 2"DIAL /600PSI/BAR/KPA
21	10564567	1	SIGHT GAUGE PROTECTOR ORANGE

Note: Roto-Tel Assembly kits that include sequence numbers 4, 5 and 18 for each model and gas service are available on www.chartparts.com.

Note: Only Generant SDC devices are available for N₂O service (sequence #10).



Warranty

Chart Packaged Gas Products Warranty Policy

Warranty only applies to original purchaser of Chart equipment and does not transfer to any other party.

Materials, components and workmanship are warranted to be free of defects for 90 days from date of invoice.

Vacuum integrity as measured by conformance to Chart NER (Normal Evaporation Rate) specifications is warranted as follows:

- Dura-Cyl® and Cryo-Cyl™ liquid cylinders - 7 years from date of invoice (as of 1/1/2016).
- All Chart repaired liquid cylinders - 2 years from date of invoice.

Damage or abuse caused by purchaser voids Chart warranty obligations.

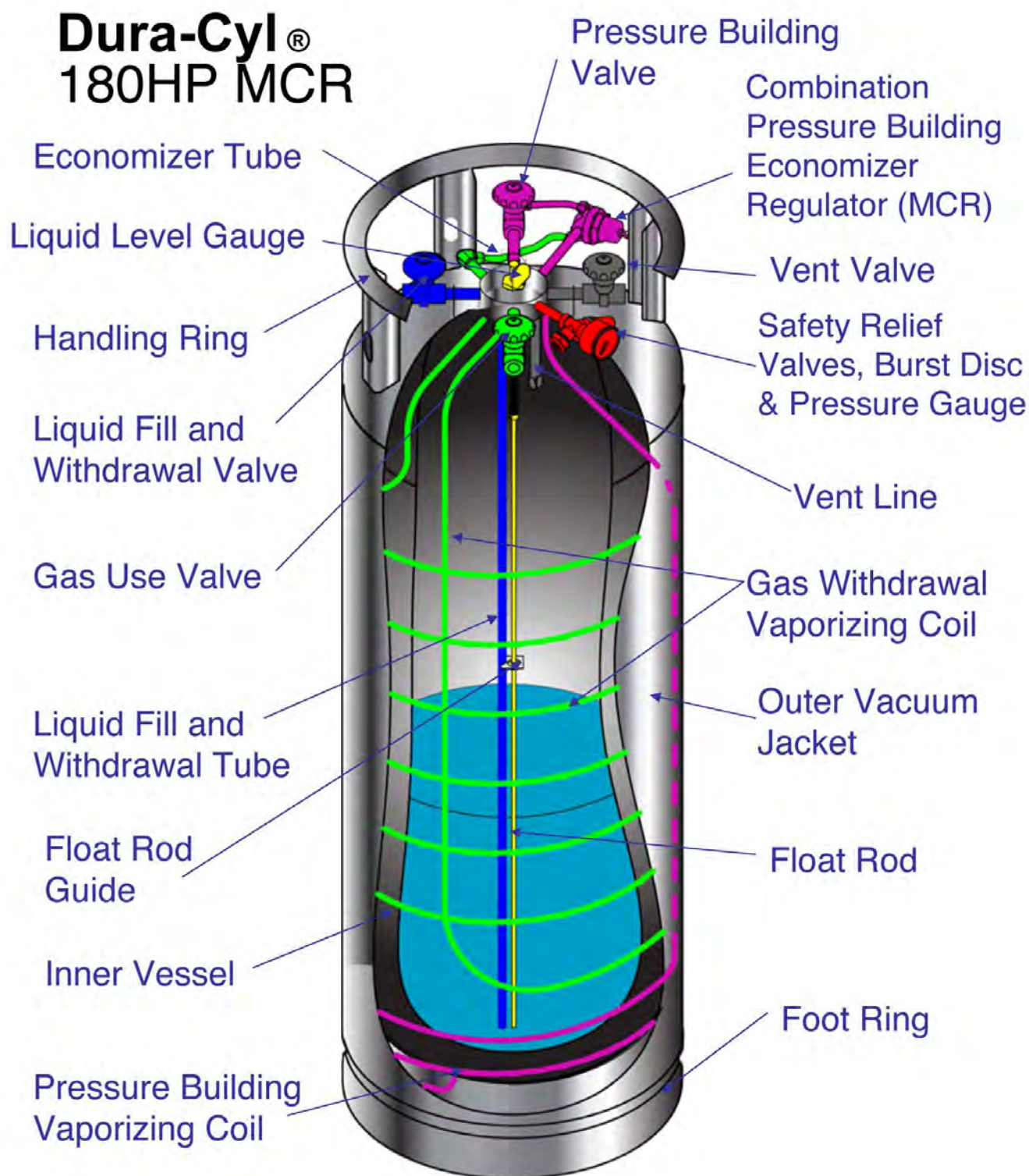
Freight damage incurred during shipment from Chart to purchaser must be reported immediately to Chart, and before placing equipment into service.

In the event of a valid warranty claim, Chart reserves the right to repair, replace or refund the value of the equipment at its discretion. The warranty applies only to the purchased Chart equipment and in no case is Chart obligated to reimburse the purchaser for consequential damages resulting from the operation of Chart equipment.

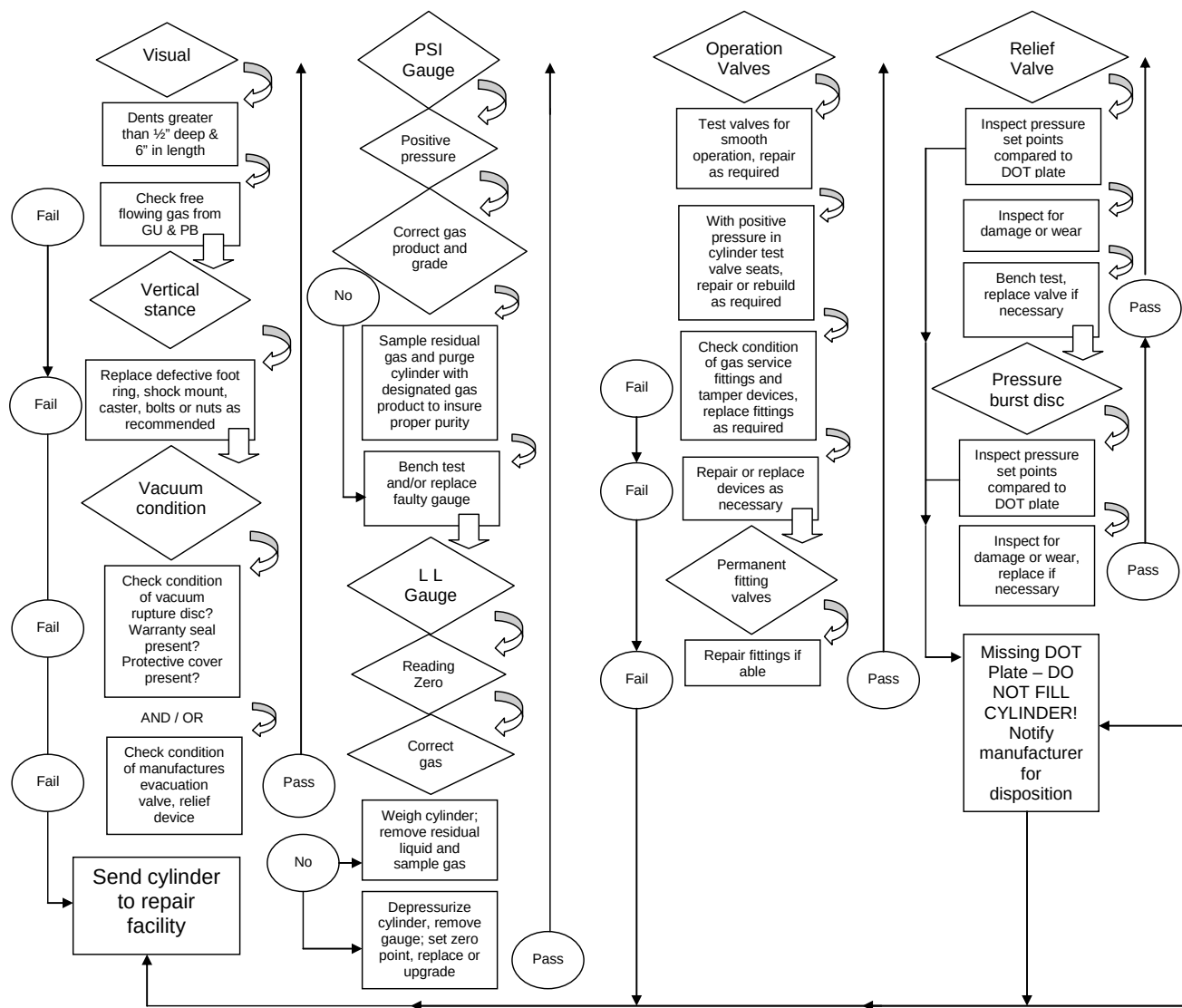


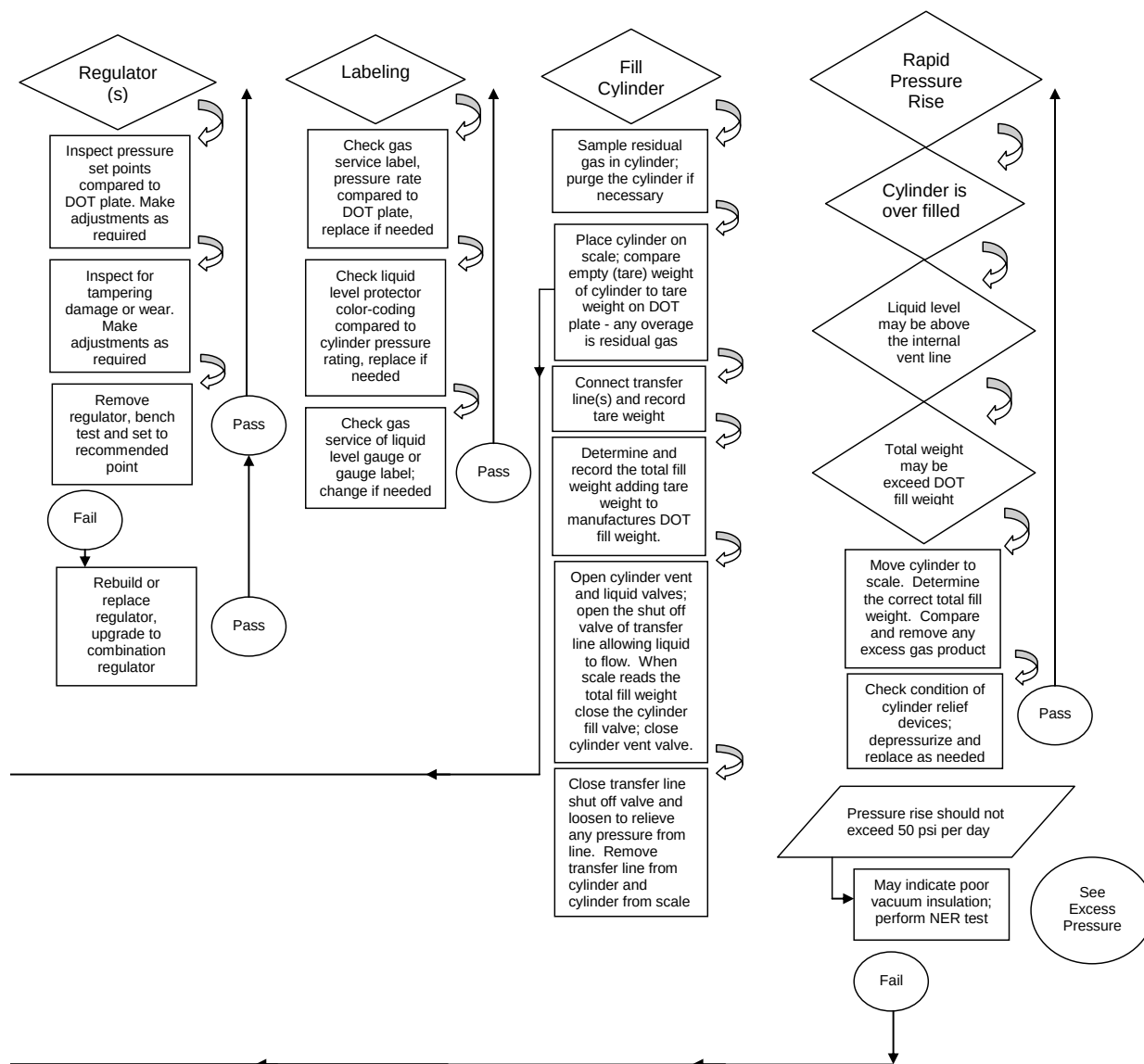
Appendix 1 - Troubleshooting Guides

Cutaway Explanation

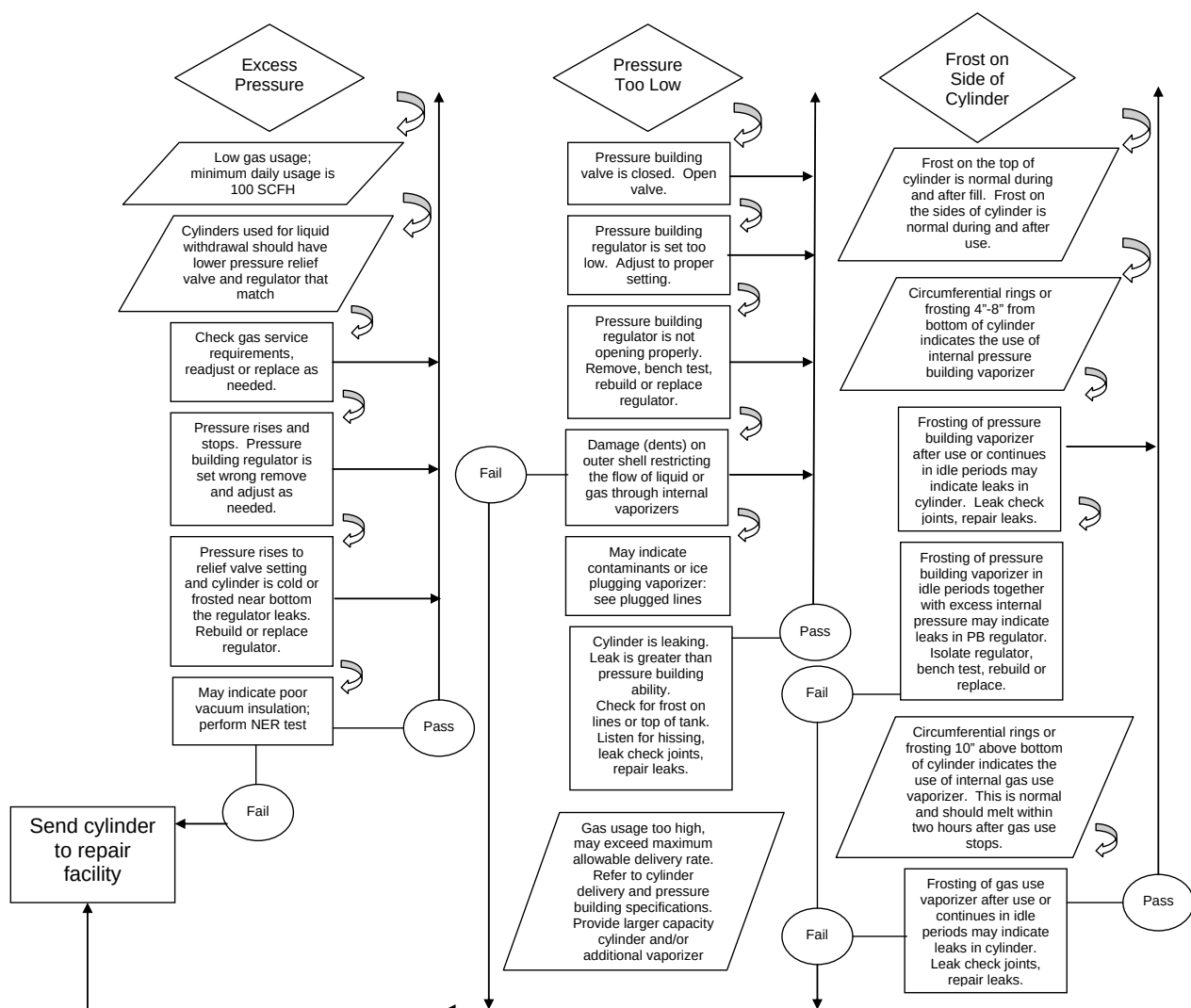


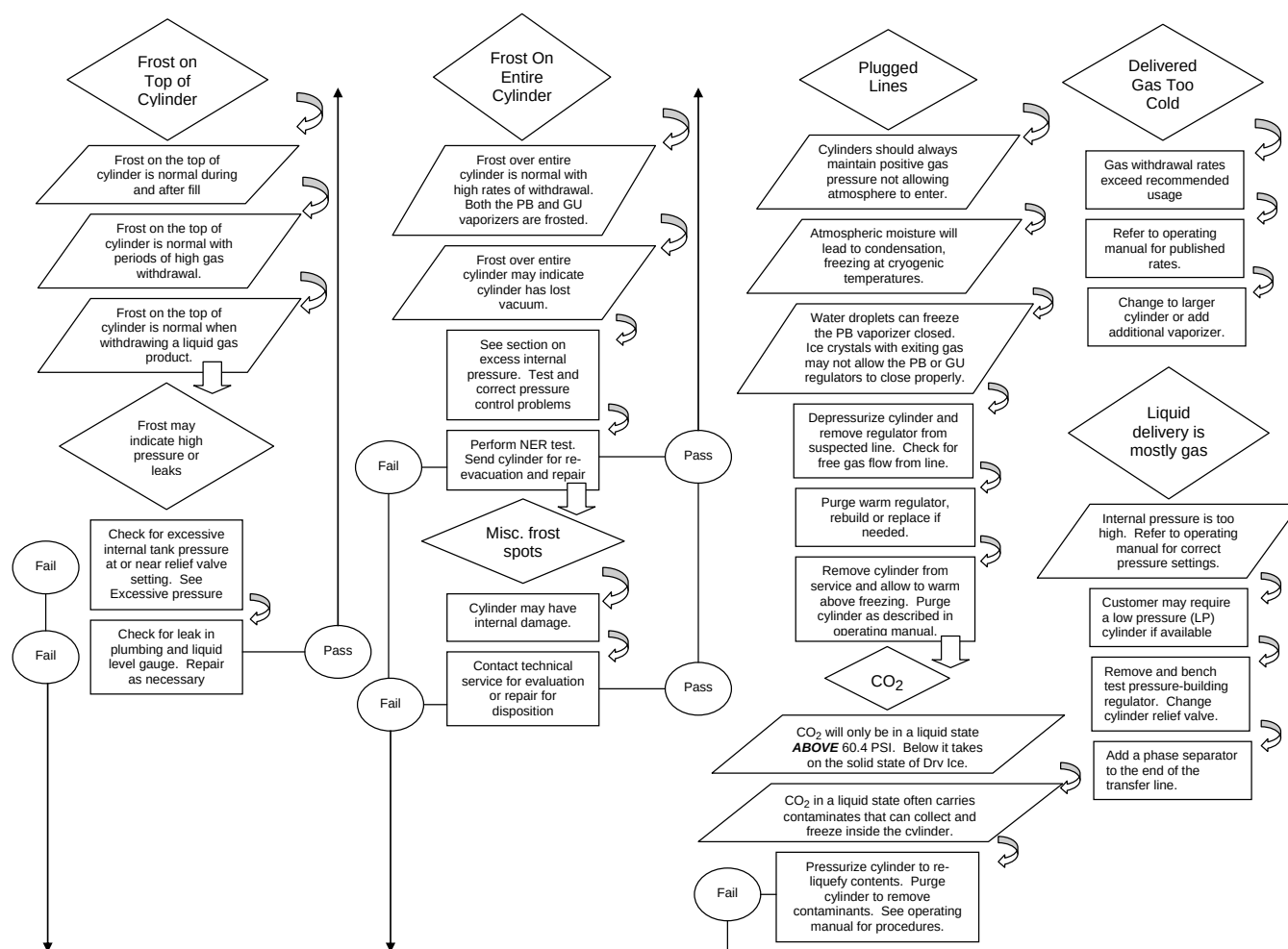
Troubleshooting Flow Chart #1





Troubleshooting Flow Chart #2





Troubleshooting Flow Chart #3

