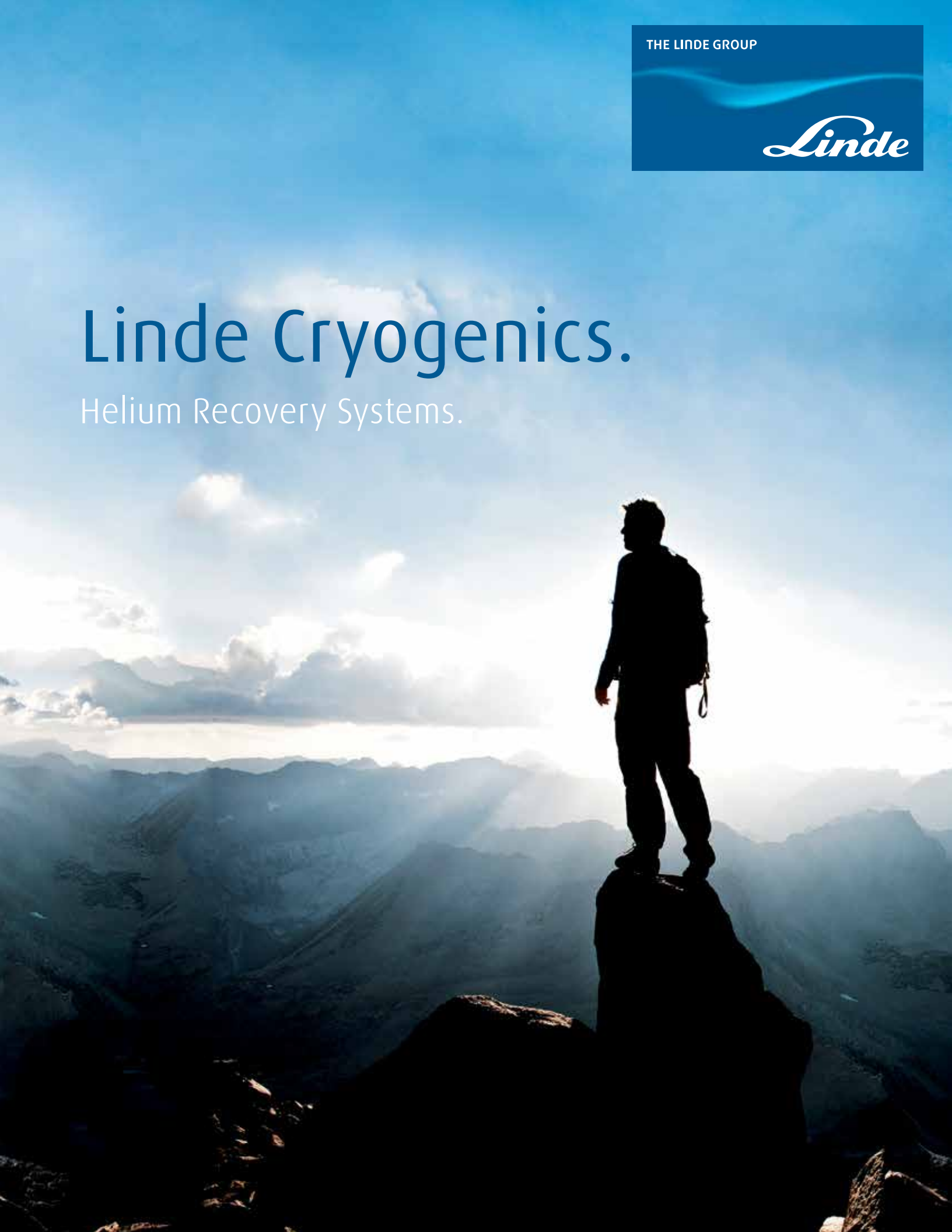


THE LINDE GROUP

*Linde*

# Linde Cryogenics.

Helium Recovery Systems.



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Linde Cryogenics' (LC) Helium Recovery Systems are a reliable means of collecting, compressing, and safely storing helium gas recovered from a laboratory or industrial facility. The components of the system are sized based on the design and operational constraints of the customer.

Helium gas is captured and stored at atmospheric pressure in a helium recovery gas bag. When the gas bag fills, a recovery compressor automatically turns on and compresses the helium into high pressure storage tanks (typically standard gas K cylinders). The K storage cylinders can be installed in a 12-pack cradle assembly or a larger manifold assembly of tanks. The high pressure gas can then be charged to an LC Helium Liquefier System for purification and re-liquefaction. LC's standard installation piping and fitting kits make the installation process easier for our customers. Alternatively, the high pressure gas can be purified separately by an LC Model 500A Automatic Helium Purifier. The helium can then be stored and used as a pure gas or charged to an LC Helium Liquefier System for liquefaction.

# Recovery Compressor Options.

LC Helium Recovery Compressors are self-contained, air-cooled, and oil-lubricated units designed to work at one atmosphere suction pressure and up to 3,000 psig (207 barg) discharge pressure. Flow rates available are 5.9, 11.0, 18.5, 26.4, and 35.0 SCFM. Compressor capacity is corrected for compressibility of helium gas at standard inlet conditions (14.7 psia and 68°F). The compressor motor is belt driven, requires 3 phase, 220-460 VAC, 50 or 60 Hz power, and the starter is built-in. The ambient temperature range is 32° to 105°F.

Impure helium from the gas enters the recovery compressor and is filtered by a dry gas filter. The helium is then compressed through a 4 stage, (5 Stage on 55B), 4 cylinder reciprocating piston compressor. The pressure for each stage as well as the final discharge pressure is displayed on dedicated pressure gauges. Following each compression stage, the helium is cooled in an inter cooler and the final stage is cooled to 18-27°F above ambient temperature in the after cooler.

Consideration must be taken into sizing the recovery system as a whole. The recovery compressor is designed for continuous operation; however, it must not "cycle on" more than four (4) times per hour. Decreasing the size of the compressor will allow longer run times, but the compressor capacity must be greater than the impure helium throughput entering the gas bag. Increasing the gas bag size will also allow longer run times and decrease the number of cycles per hour.

The P2 Purification System uses replaceable filter cartridges to remove both oil and water in the impure helium stream from the gas bag. 99.5% of all oil particles 0.6 microns or larger are removed, while the moisture content is reduced down to 13.6 ppmv. This low moisture content is crucial because the impure helium feed to the internal purifier of the LC liquefier cannot exceed 50 ppmv. LC can provide replacement filter cartridges.

Each compressor is delivered with accessories including:

- Automatic condensate drain (ACD)
- Blow down valves enabling full automatic operation
- Suction filter
- Discharge check valve and isolation valve
- Relief valves at inlet and all stages
- Pressure gauges at all stages and oil and discharge
- Pressure sensors at the inlet and oil and final pressure
- High temperature switch
- The ability to adjust the motor belt tension

The entire unit is delivered on a skid and does not require a special foundation. The LC specification recovery compressor includes an acoustic shell with rubber mounts to significantly reduce noise and vibrations, a necessity for laboratory and academic environments.



Bauer 50B recovery compressor

Maintenance must be performed on all compressors. The maintenance schedule calls for various tasks every 500 hours for the recovery compressors. Decreasing the amount of run time will increase the amount of time between maintenance intervals.

A description of the recovery compressor models are below:

#### Model 40B

The Model 40B Helium Recovery Compressor is a three-stage, three-cylinder unit offering a capacity of 5.9 SCFM (9.3 Nm<sup>3</sup>/hr) capacity. This model is ideally suited for slightly larger laboratories where several helium experiments may be operating at the same time.

#### Model 50B

The Model 50B Helium Recovery Compressor is a four-stage, four-cylinder unit offering a capacity of 11 SCFM (17.4 Nm<sup>3</sup>/hr). This model is ideally suited for typical helium liquefier installation where flash helium from dewar transfers must be recovered, along with the gas from several experiments. It also offers the [same design capacity for the Model 500A Automatic External Helium Purifier](#), which is a liquid nitrogen-cooled stand-alone helium purifier system fabricated and sold separately by LC.

#### Model 55B

The Model 55B Helium Recovery Compressor is a five-stage, four-cylinder unit offering a capacity of 18.5 SCFM (29.2 Nm<sup>3</sup>/hr). This model is ideally suited for operation in a large laboratory or industrial gas distribution facility where significant quantities of helium must be recovered.

#### Model 60B

The Model 60B Helium Recovery Compressor is a four-stage, four-cylinder unit offering a capacity of 26.4 SCFM (41.6 Nm<sup>3</sup>/hr). This model is ideally suited for operation in large laboratory or industrial gas distribution facility where large quantities of helium must be recovered.

#### Model 70B

The Model 70B helium Recovery Compressor is a four-stage, four-cylinder unit offering a capacity of 35.0 SCFM (41.6 Nm<sup>3</sup>/hr). This model is also ideally suited for operation in a large laboratory or industrial gas distribution facility where large quantities of helium must be recovered.

### Linde Cryogenics Recovery Compressors

LC Model No.	Bauer Model No.	Weight		Compressor Pump						3 Phase Motor			
				Flow	Capacity	Oil	Capacity	HP	kW	Speed	Heat Reject,		
		lbs	Kg	Hz.	Stages	Speed RPM	SCFM	Nm <sup>3</sup> /hr	(L)		kW	RPM	BTU/min
40B	G120-7.5	350	159	60 50	3	1300	5.9	9.3	2.9	8	6.0	3600	318
50B	G150-15	500	227	60 50	4	1100	11.0	17.4	4.0	15	11.2	3600	636
55B	G180-20	750	340	60 50	5	1300	18.5	29.2	4.0	20	14.9	3600	848
60B	G220-30	1600	726	60 50	4	1400	26.4	41.6	8.0	30	22.3	3600	1272
70B	G21-40	2000	907	60 50	4	1250	35.0	55.1	11.0	40	29.9	3600	1696

# Installation Recovery Piping and Fitting Kits.

LC's installation recovery piping and fittings kits provide the recommended low pressure tubes and fittings to connect between the gas bag and the suction side of the recovery compressor.

They also contain the required stainless steel high pressure tubes and fittings to connect between the recovery compressor discharge, both pure and impure helium high pressure storage, and an LC Model 500A Automatic Helium Purifier. This standardized kit simplifies your procurement process as you customize the piping runs to fit your unique facility operations.

## Model 500A Automatic External Helium Purifier.

The Model 500A Automatic External Helium Purifier is designed for purification of impure high pressure helium gas mixed with air contaminants and moisture. A fully-automatic batch operation enables the purification of helium contaminated with up to 40% air impurities before regeneration is required. This automatic operation eliminates the need of operator attention during all modes of operation including:

- Cool down
- Purification
- Regeneration
- Shutdown via automatic blow down of the liquid air phase separator vessel

When the user is ready to purify impure helium either directly from the recovery compressor or impure helium already in high pressure storage, the push of a button starts filling the Model 500A with liquid nitrogen. A built-in level controller automatically keeps the liquid nitrogen reservoir full. The impure helium gas is then continuously fed by the high pressure storage and passes through a phase separator where water is removed. Impure helium then enters a counter flow heat exchanger sized to freeze out moisture at 100% saturation where it is cooled by the return flow, followed by a liquid-nitrogen-cooled condenser where most of the air is liquefied. A phase separator subsequently removes the liquid air.

The helium gas mix at this point contains approximately 1.8% impurities. The mix is then charged through a series of four (4) liquid-nitrogen-cooled activated charcoal adsorption beds where it is returned to 99.995% purity (Grade 4.5). A purity monitor checks the helium as it discharges from the Model 500A and initiates the regeneration cycle when the purity level delivery drops below 99.995%. The adsorbers are regenerated by warming them up to 80°C and purging with pure helium (approximately a 3-4 hour process).

A Model 500A Automatic Purifier can also be connected to the recovery compressor's discharge to purify up to 40% impure helium gas. If a Model 500A Automatic Purifier is incorporated in the system, a 50B recovery compressor is recommended because its capacity of 11 SCFM matches the flow rate of the Model 500A Automatic Purifier.



Model 500A Automatic External Helium Purifier

# Purity Monitor Options.

Helium Purity Monitors are available at various sensitivity levels for monitoring contaminants in either the recovered impure helium gas, or pure helium gas.



MCD model



MCD Model



# High Pressure Cylinder Storage Options.

The recovery compressor discharges the recovered helium gas (up to 3,000 psig) into the impure helium storage cylinders. The recommended internal pressure range for storing in “K” size bottles can range between 450 to 2,460 psig and can be supplied by LC or your helium gas and liquid supplier.

Downstream from the impure K cylinders, the helium is regulated at 500 psig by a pressure regulator that feeds a model L1410/L1610 helium liquefier. This connection supplies the impure helium into the internal purifier of the liquefier to be purified to 99.995% purity (Grade 4.5) to provide the “make-up” gas that replaces the helium mass removed as liquid. This automatic process enables the continuous recycling of helium in the liquefaction system.

LC has two options for combining 12 cylinders together for impure and pure helium gas service.

## 1. 12-Pack Cradle (with or without wheels)

A 12-Pack of K cylinders and cradle has twelve (12) 2,400 psig service pressure cylinders (2,460 psig max) with 300 SCF capacity, DOT 3AA2400 specification, size 9.25-in OD, 55-in height and 139 lbs each. Each has Cavagna CGA 580 inert valves with 4,000 psig pressure relief. The 12-pack manifold includes 3,000 psig-rated ETFE pigtailed with stainless steel exterior braid and special TSCZEL internal lining compatible for helium service. The frame is blasted and galvanized, size 75-in x 39-in x 29-in, total weight 2,100 lbs (953 kgs) including cylinders.

## 2. Linear 6 or 12 K Cylinder Manifolds

LC Helium K Cylinder Manifolds consist of two six-station manifolds with cylinder adapters at each station and relief valve. The impure gas manifolds contain tees for each station plus a single isolation valve. The pure gas manifolds typically require periodically removing of individual cylinders from the manifold. They are provided with a pigtail connection, manual isolation valve at each station, and the total assembly is mounted on a floor stand.





Storage tank



# Gas Bag Options.

LC Helium Recovery Gas Bags are made from a modified vinyl-based polymer sheet stock (J-22) which is 0.050" thick and is non-backed. Each bag is supplied complete with appropriate recovery compressor controls (e.g. optical switch), relief valve and check valve. Sizes available include 100, 200, 300, 400, 500, and 1,000 cubic feet (CF). These gas bags are suitable for both indoor and outdoor installations at temperatures between -10° and 100°F (-23°C and 38°C).

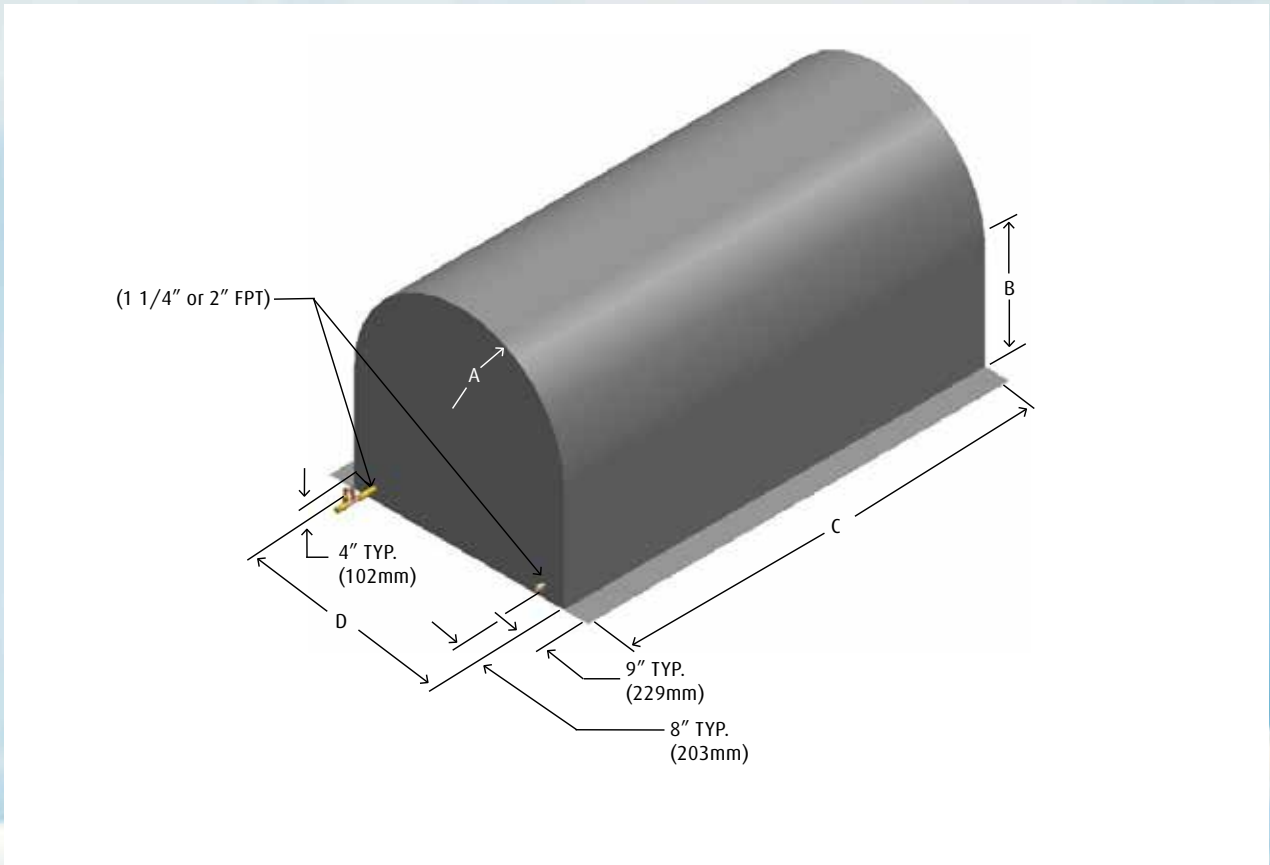
The gas bag is not intended for use as a pressure vessel, as it can only hold up to a maximum of 0.15 psig (7.75 mm Hg). The internal pressure of the gas bag is regulated by a check valve that will relieve to atmosphere at 0.15 psig and 40 SCFM. If greater incoming flow rates are anticipated, the check valve can be replaced with one having a higher flow capacity (SCFM).

When the gas bag is filled with impure helium gas to the operator's desired set point level (e.g. 85–90%), the recovery compressor automatically turns on to empty the gas bag and store the helium in high pressure impure storage, such as K cylinders. Once the gas bag reaches the low level set point (e.g. 10–15%), the compressor will shut off and allow the gas bag to be filled. The gas bag level is monitored by an optical sensor.

## Linde Cryogenics: Helium Gas Bags

Gas Bag Capacity		Dimensions, in (mm)			
(CF)	(m3)	A	B	C	D
100	2.8	36 (914 mm)	N/A	84 (2134 mm)	72 (1829 mm)
200	5.6	36 (914 mm)	24 (610 mm)	96 (2438 mm)	72 (1829 mm)
300	8.5	36 (914 mm)	36 (914 mm)	114 (2896 mm)	72 (1829 mm)
400	11.3	72.2 (945 mm)	37.2 (945 mm)	146.4 (3718 mm)	74.4 (1890 mm)
500	14.2	39.6 (1006 mm)	39.6 (1006 mm)	158.4 (4023 mm)	79.2 (2012 mm)
1,000	28.3	50.4 (1280 mm)	50.4 (1280 mm)	201.6 (5120 mm)	100.8 (2560 mm)





Gas bag diagram



# Engineering excellence – every step of the way.

Linde Kryotechnik AG and Linde Cryogenics are the world's Leading cryogenic technology and engineering companies, bundling low temperature know-how and cutting-edge technologies with value-add services for scientific research and industrial organizations around the globe. Highly skilled Linde teams partner with customers to develop and deliver innovative cryogenic solutions for liquefaction and refrigeration systems at temperatures below 80 K (-193°C).

Linde Engineering is a leading player in the international plant engineering business, covering every step in the design, project management and construction of turnkey industrial plants. Drawing on its extensive, proven process know-how, this division sets the standards for innovation, flexibility and reliability with ground-breaking concepts and a dedication to engineering excellence.

## Core competencies of Linde Kryotechnik AG and Linde Cryogenics:

- Helium liquefiers
- Helium refrigerators
- Helium recovery systems
- Hydrogen liquefiers
- Storage and distribution systems
- After sales parts and services
- Special cryogenic plant engineering services

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