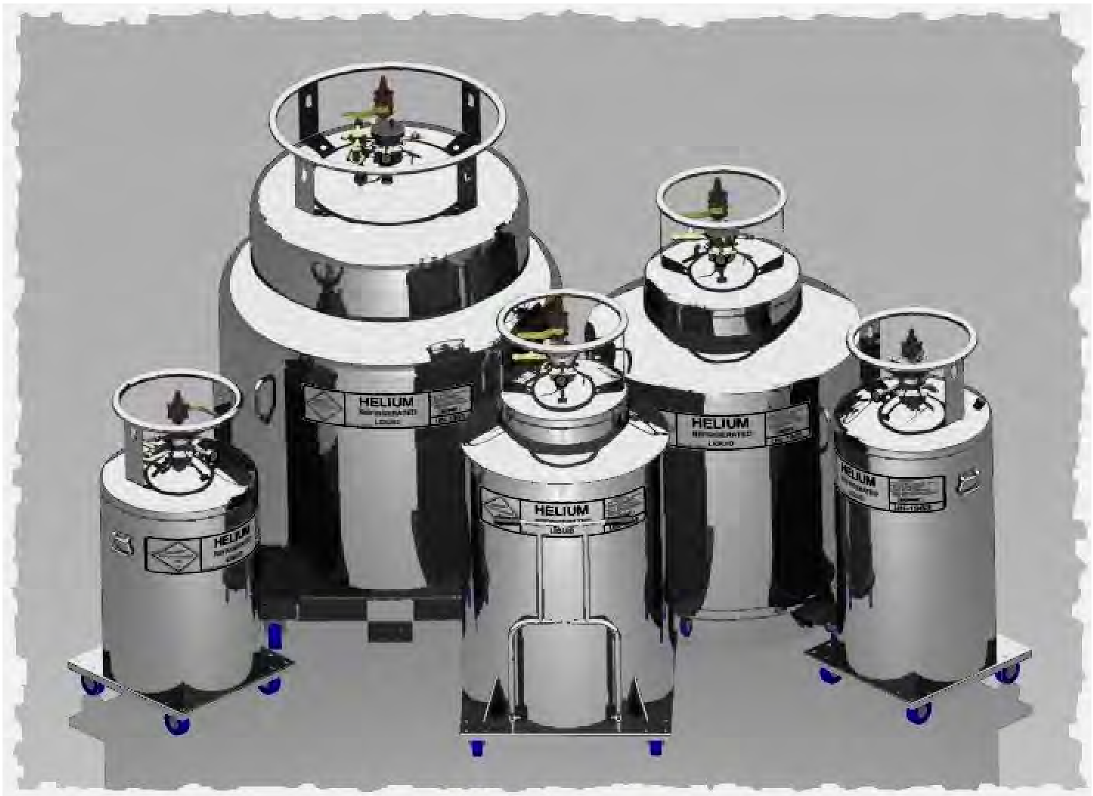
LIQUID HELIUM CONTAINERS



Operating Manual

- Ultra Dewar 60
- Ultra Dewar 100
- Ultra Dewar 250
- Ultra Dewar 350
- Ultra Dewar 500
- Ultra Dewar 1000

- Ultra Dewar 60 TPED
- Ultra Dewar 100 TPED
- Ultra Dewar 250 TPED
- Ultra Dewar 500 TPED
- Ultra Dewar 1000 TPED

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1 PREFACE

The MVE Ultra Dewar Series users manual is designed to be used in conjunction with the Ultra Dewar 60, 100, 250, 350, 500, and 1000 liquid helium vessels. This manual contains information regarding the safe handling of liquid helium with the Ultra Dewar equipment. It should be thoroughly read and understood by anyone that operates the equipment. If there are any questions regarding the operation of the Ultra Dewar equipment, contact Chart Technical Service at 1-800-400-4683.

This manual is intended to provide the user with all the necessary information needed to operate and maintain the Ultra Dewar equipment. The manual discusses the characteristics of liquid helium in section 3.

The safety requirements for handling and transporting liquid helium are shown in sections 4 and 5. Use the safety section as a “Safety Check-List” each time the Ultra Dewar equipment is being used.

Section 6 will familiarize the operator with the working components of the various models in the Ultra Dewar series. The schematic and plumbing illustrations show item numbers for the individual components. The item numbers are sequential and do not repeat for the various models. They will be used throughout this manual to draw specific attention to a component.

The operation of the Ultra Dewar equipment is the same regardless of which model is being used. The variety of models is to offer different capacities to the user. Section 7 discusses the filling, storage, transportation, and withdrawal of liquid helium from the equipment.

Servicing of the Ultra Dewar equipment is discussed in section 8, “Troubleshooting/repair” Helium transfer lines and features are discussed in section 9 – “Optional Equip.”. Re-examine the safety sections (section 4 and 5) before any work is done on the equipment.

The following abbreviations and acronyms are used throughout this manual:

CBM-	Center Back Mount Gauge	**ODT**-	Outside Diameter
CGA-	Compressed Gas Association	**P/N**-	Part Number
DOT-	Department of Transportation	**PPM**-	Parts per Million
FPT-	Female Pipe Thread	**PSI**-	Pounds per Square Inch
MPT-	Male Pipe Thread	**PSIG**-	Pounds per Square Inch (Gauge)
MVE-	Minnesota Valley Engineering	**SCFH**-	Standard Cubic Feet per Hour
NPT-	National Pipe Thread	**SCFM**-	Standard Cubic Feet per Minute
NR-	Not Required	**SS**-	Stainless Steel

3 INTRODUCTION TO HELIUM

GENERAL

Liquid Helium has unique properties that require the specially designed Ultra Dewar cryogenic container. This section of the manual will discuss the properties of helium and how the Ultra Dewar cryogenic equipment is effected by them.

Helium is found in the atmosphere in only small trace amouts (5 ppm) and is not economically obtained by air separation. Helium also exists in larger amounts (2%) in certain types of natural gas wells. The largest concentrations of these wells are in the United States near the Texas, Oklahoma, and Kansas borders.

Helium is chemically inert. It has no color, odor or taste. Helium is non-flammable and only slightly soluble in water. Helium is present in two stable isotopes; Helium 3 (He3) and Helium 4 (He4). He4 is the most common, and makes up over 99% of the helium being used today. This manual will discuss only the properties of He4 and will generically refer to it as helium.

Liquid helium exists at very low temperatures (-453°F, -269°C) at atmospheric pressures, a temperature that is only a few degrees above absolute zero. Helium will not solidify as the temperature approaches absolute zero, therefore making helium an ideal liquid for low temperature physics. The extremely low temperature requires that additional safety precautions be observed while operating the equipment. Liquid helium should not be allowed to come in contact with air. The extreme cold will liquefy the oxygen in the air and cause a safety hazard associated with a high oxygen environment.

Liquid helium has a very low latent heat of vaporization (8.8 BTU/lb, 20.5 kj/kg). This is 1/110 that of water. Liquid helium boils away very easily and requires special equipment and procedures to reduce the heat input that causes evaporation. The Ultra Dewar container takes advantage of helium's high sensible heat (640 BTU/lb, 1,448.6 kj/kg from boiling point to 70°F, 21°C) to offset its low latent heat. The Ultra Dewar's insulation system has radiation shields that intercepts the incoming heat and transfers it into the cold gas that is venting out of the container.

Liquid helium has a very low critical pressure (18 PSIG, 1.2 BAR where it exists as both liquid and gas) and requires very low operating pressures. The container must be a closed system and have a pressure greater than atmospheric. If the containers valves were left open and the atmospheric pressure became greater, air would rush into the vessel and freeze. The frozen water vapor in the air would quickly plug the vessel openings and create a dangerous situation. The Ultra Dewar protects itself with a series of relief valves that are attached to various parts of the plumbing. It is extremely important to make sure all valves are closed and that all relief valves close with a tight seal.

The following table gives some of the properties of liquid helium.

PROPERTIES OF HELIUM		
Boiling Point (B.P.)	-452°F	-269°F
Heat of Vaporization	8.8 BTU/lb	20.5 kj/kg
Critical Pressure	33.2 PSIA	2.26 Bar/Absolute
Critical Temperature	-450°F	-268°F
Triple Point	None	None
Density (liquid)	0.27 lbs/liter	0.12 kg/liter
Density (gas at B.P.)	1.06 lb/ft³	16.98 kg/m³
Density (gas at 70°F)	0.01 lb/ ft³	0.16 kg/m³

GENERAL

This section of the manual deals with the safety precautions that are necessary with cryogenic equipment. The potential hazards in handling liquid helium stems mainly from the physical properties:

- The liquid is extremely cold (helium is the coldest of all cryogenic liquids).
- The ultra-low temperatures of liquid helium will condense and solidify air.
- Very small amounts of liquid helium are converted into large amounts of helium gas.
- Helium gas in non-life supporting.

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.

SAFETY PRECAUTIONS

Prior to using liquid helium, the specific operations should be reviewed with respect to the information that is contained in this section.

WARNING – COVER EYES AND EXPOSED SKIN. Accidental contact of liquid helium or cold issuing gas with the eyes or skin may cause freezing injury similar to a burn. Protect the eyes and cover the skin where possible contact with cold liquids or gas exists.

WARNING – KEEP AIR AND OTHER GASES AWAY FROM LIQUID HELIUM. The low temperatures of liquid helium or cold gaseous helium can solidify any other gas. Solidified gases or liquid that is allowed to form on the plumbing can plug pressure relief passages and relief valves. Plugged passages are hazardous because of the continual need to relieve excess pressure. Always store and handle liquid helium under positive pressure. Use liquid helium in a closed system to prevent the infiltration of air or other gases.

WARNING – KEEP EXTERIOR SURFACES CLEAN TO PREVENT COMBUSTION. Atmospheric air will condense on exposed helium piping. The nitrogen, having a lower boiling point than the oxygen, will evaporate first from the condensed air leaving an oxygen enriched liquid. This liquid may drip or flow to nearby surfaces. These surfaces must be clean to "oxygen clean" standards to prevent a possible combustion.

WARNING – KEEP THE EQUIPMENT AREA WELL VENTILATED. Although helium is non-toxic it can cause asphyxiation in a confined area without ventilation. Any atmosphere that does not contain enough oxygen for breathing can cause dizziness, unconsciousness, or even death. Helium, being colorless, odorless, and tasteless, cannot be detected by human senses. Without adequate ventilation, helium will displace the air and give no warning that a non-life supporting atmosphere is present. Store liquid helium in a well ventilated area.

HANDLING

The Ultra Dewar Series cryogenic containers are designed to be portable and are equipped with square roller bases, and handles. The various models have three different styles of portable handling systems.

WARNING – DO NOT handle these containers in any other fashion that what is described in this manual. DO NOT transport or store the containers on there side. DO NOT attempt to lift the container by any other means that described in this manual. Failure to observe proper handling procedures could cause the container to tip over causing possible injury.

CAUTION – The Ultra Dewar containers are designed to be moved over clean, flat, hard surfaces only. DO NOT attempt to roll the container over aberrations in the floors surface that could lock a wheel and tip the container.

The Ultra Dewar 60 and 100 have a square base with two fixed, and two swivel casters. These models have a handle mounted on each side of the outer container. Figure 1 illustrates the handles, base, and casters for the Ultra Dewar 60 and 100.

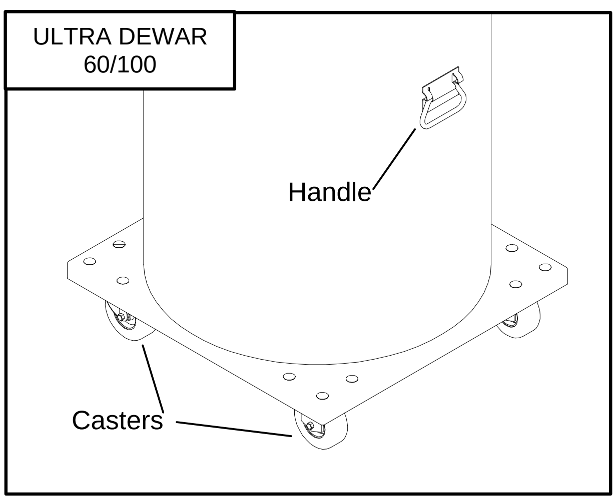


Figure 1

The Ultra Dewar 250 and 350 also have a square base with two fixed, and two swivel casters. These models are equipped with a pull handle assembly. (See Figure 2)

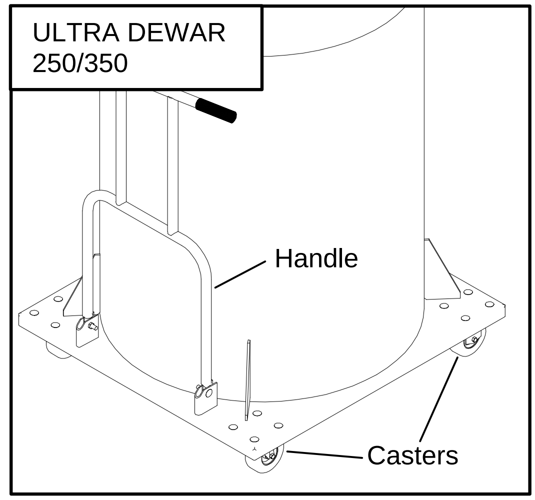


Figure 2

The Ultra Dewar 500 has four bracket-mounted casters equally spaced about the circumference of the vessel. It also has two fixed, and two swivel casters. The Ultra Dewar 500 and 1000 have four side mounted grab handles. (See Figure 3)

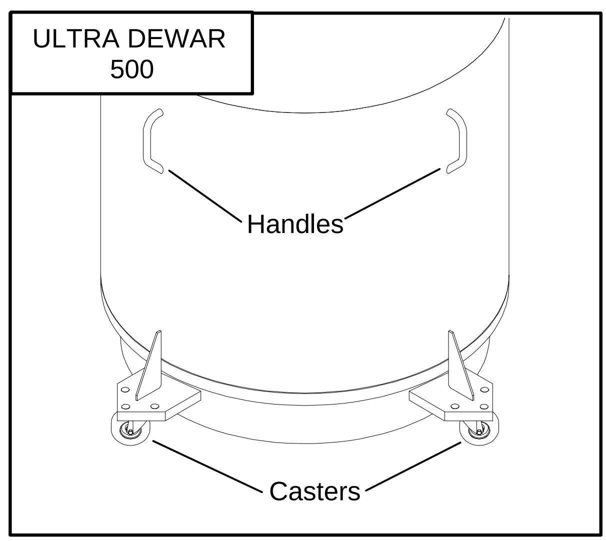


Figure 3

TRANSPORTATION BY TRUCK

The Ultra Dewar cryogenic containers are low pressure (below 25 psi) portable containers that are not required to meet DOT requirements for the transport of liquid helium. The container does require the proper labeling for low temperature liquid helium and should be handled carefully and with the respect due any cryogenic container. When transporting by truck:

- Use a lift gate to load and unload the container from the truck.
- Stand next to the container and steady it while it is on the lift gate.
- Use nylon straps to secure the container in the truck.

CAUTION – DO NOT use chains to secure the containers. The chain will damage the outer vacuum jacket.

TRANSPORTING BY AIR CARGO

The Ultra Dewar cryogenic containers are designed to be transported by air cargo and meet the requirements of International Air Transport Association (IATA). When an air shipment is required the shipper should make advanced arrangements with the cargo manager. This should avoid any questions or unnecessary delays when the container is presented for shipment.

The Ultra Dewar container must be secured, or packed in a proper shipping crate or frame, to prevent it from tipping or moving during transport. The container should have the following shipping notices on it, at 120° intervals, in clear view of the handlers;

DO NOT DROP

THIS SIDE UP (with arrows)

CARGO AIRCRAFT ONLY

HELIUM, LIQUID, LOW PRESSURE (and the proper DOT product labeling)

The change of atmospheric pressure, even in a pressurized compartment, can cause a problem with the relief valves. Ordinary relief valves can freeze and plug up following rapid ejection of cold gas following altitude changes. An absolute pressure relief valve should be used for all air transportation of liquid helium. The relief valves should be examined upon arrival for normal operation to assure that ice plugs have no occurred.

6 EQUIPMENT DESCRIPTION

GENERAL

The Ultra Dewar series cryogenic containers are designed for the specific application of transporting and storage of liquid helium. These containers should not be used for other cryogenic liquids. They do not require liquid nitrogen shielding to achieve good thermal performance. They are constructed with a stainless steel inner and outer vessel. The containers are attached to roller bases that make them easily transported. Refer to the components illustration (Figure 4) for the nomenclature of the Ultra Dewar parts.

ULTRA DEWAR NOMENCLATURE

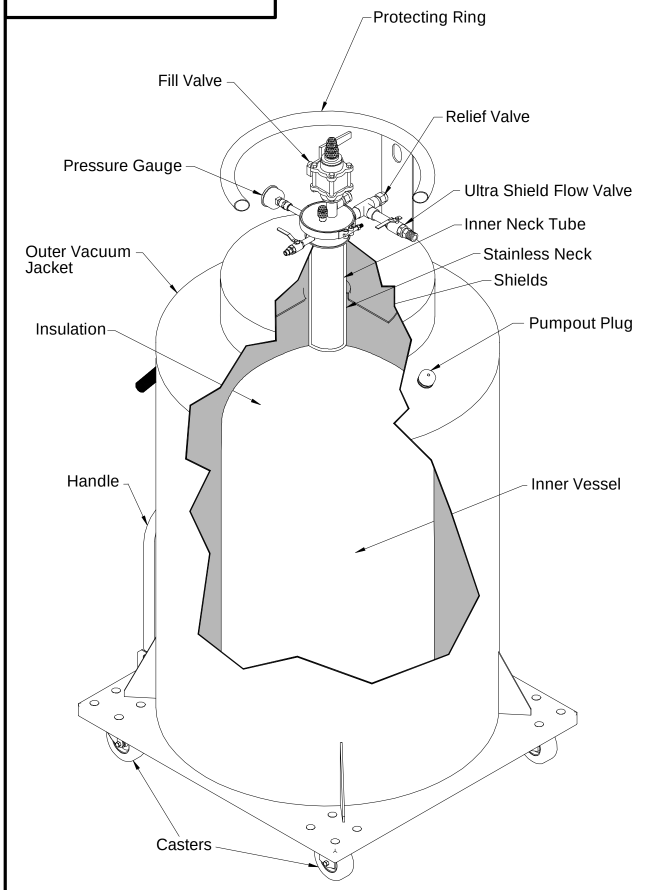


Figure 4

THERMAL INSULATION

The specially designed insulation system is composed of multiple layers of paper and foil that use a low vacuum to provide an extremely low heat leak between the inner and outer vessel. The system also employs radiation shields that take advantage of the sensible heat of the boiling liquid helium to reduce the normal boil-off of the product. As the helium boils it forces gas up the passage between the stainless steel neck tube to vent at the shield flow valve. The cold helium gas is raised in temperature by absorbing heat from the radiation shields as it travels up the neck tubes.

The insulation and vacuum systems are designed to be self-maintaining for years. The vacuum is sealed with an o-ring sealed plug that also acts as a relief device in case there is an inner vessel leak.

CAUTION – DO NOT tamper with the vacuum pump-out plug. The rapid loss of container vacuum can cause damage to the insulation system.

PLUMBING COMPONENTS

The operational controls on the Ultra Dewar container are very simple. They are located on the top of the container and protected by the containers protection ring. The controls operate all of the functions of the Ultra Dewars' operations. Refer to the Ultra Dewar schematic (figure 5) for the plumbing component locations.

The fill and withdrawal ball valve is located on the top of the tank in the vertical position with quick couplings attached to it. A transfer line can be passed through the coupling and ball valve and into the inner vessel of the container. The transfer line is then sealed in place with the quick coupling. Each container has a variety of quick couplings to allow for different sizes of transfer lines.

The vent valve is located so that it can be used to depressurize the tank during filling or pressurize the tank from another source for liquid transfer.

CAUTION – DO NOT leave the vent valve open after filling or transfer operation.

The relief valves are located so that if one stops operating from an ice plug the other will function properly. The primary relief valve is set at 10 psi. The alternative relief valve is set at 12 psi. Each one protects the inner pressure vessel, but from different paths.

SCHEMATIC

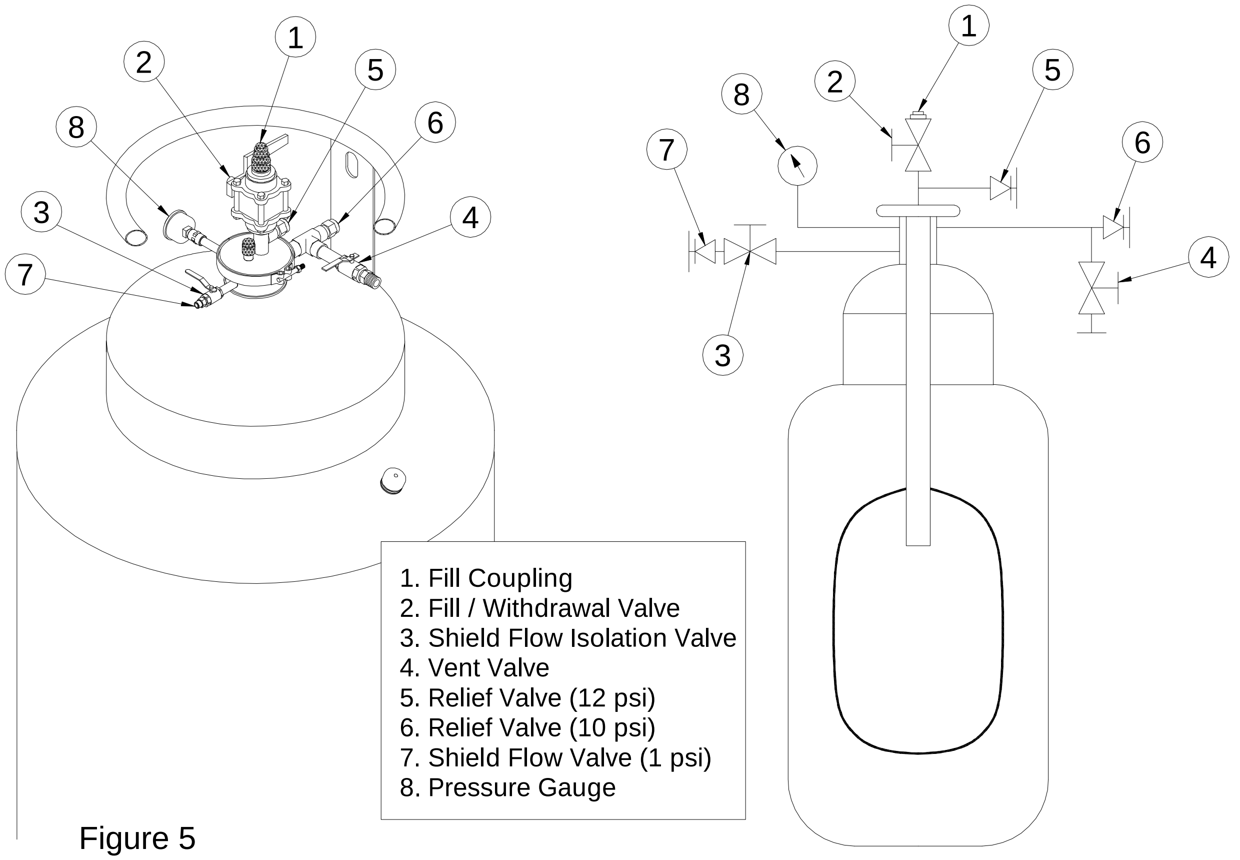


Figure 5

WARNING – DO NOT use relief valves that are set at higher pressures than allowed by the Ultra Dewar equipment. Refer to the specifications (Page 11) for the maximum allowable pressure setting.

The shield flow valve is set at 1 psi. It is located behind an isolation valve that allows it to be turned off while the container is being filled or pressurized for liquid transfer. This valve must be open for the insulation shields to be active.

NOTE – The thermal performance of the Ultra Dewar will be reduced if the shield flow valve is closed or malfunctioning.

The container's pressure gauge is designed so that it will show vacuum as well as pressure. There are times when changes in the outside atmospheric pressure can cause the inner vessel to have a lower pressure that the atmosphere pressure.

WARNING – DO NOT open any valves if the tank pressure reads below 0 on the pressure gauge. This would allow air to rush into the vessel and form an ice plug.

SPECIFICATIONS

	Ultra Dewar 60	Ultra Dewar 100	Ultra Dewar 250	Ultra Dewar 350	Ultra Dewar 500	Ultra Dewar 1000
Dimensions: inches (cm)						
Outside Diameter	24 (61.0)	24 (61.0)	32 (81.3)	32 (81.3)	42 (106.7)	52 (132.1)
Overall Height	50.1 (127.3)	59.0 (147.9)	67.4 (171.1)	72.5 (184.2)	70.6 (179.3)	77.4 (196.6)
Number of Casters	4	4	4	4	4	4
Caster Size	4 (10.1)	4 (10.1)	5 (12.7)	5 (12.7)	5 (12.7)	5 (12.7)
Neck Inside Diameter	1.45 (3.7)	1.45 (3.7)	2.40 (6.1)	2.40 (6.1)	2.90 (7.4)	2.90 (7.4)
Dip Tube Length*	35.0 (88.9)	43.8 (111.1)	54.4 (138.2)	55.5 (141.0)	56.4 (143.1)	67.5 (170.9)
Capacity: (liters)						
Liquid (Gross)	66	110	275	368	550	1050
Liquid (Net)	60	100	250	350	500	1000
Weight: lbs (kg)						
Empty	184 (83)	212 (96)	348 (158)	380 (172)	480 (218)	1050 (476)
Full	201 (91)	240 (109)	417 (189)	449 (204)	618 (280)	1326 (601)
Maximum Working Pressure: PSI (BAR)	12 (.83)	12 (.83)	12 (.83)	12 (.83)	12 (.83)	12 (.83)
NER** (% per day)	1.75	1.25	1.0	1.0	1.0	1.0

* The dip tube length is measured from the tank flange to the bottom of the inner vessel.
** Based on gross capacity.

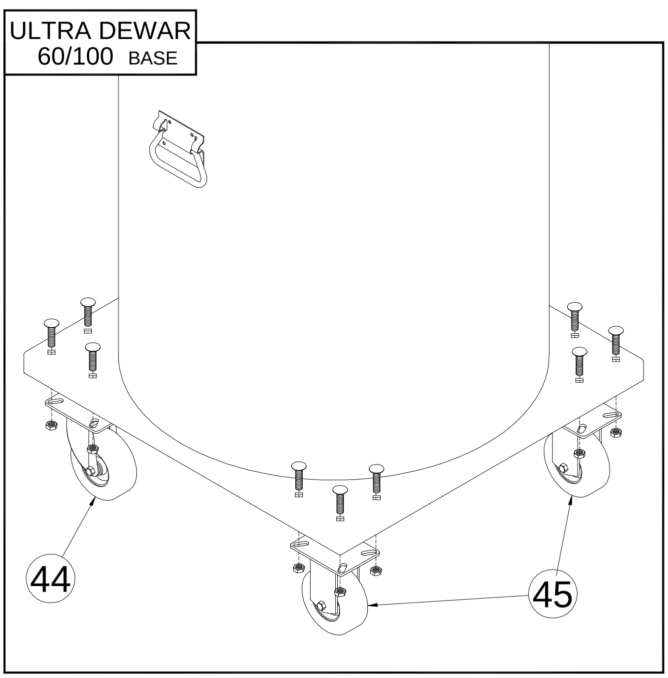
SPECIFICATIONS

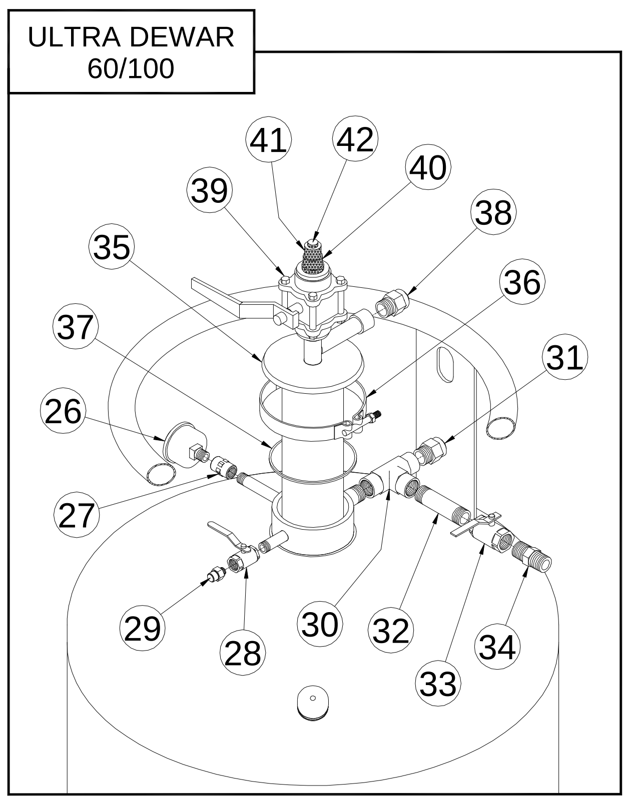
	Ultra Dewar 60 TPED	Ultra Dewar 100 TPED	Ultra Dewar 250 TPED	Ultra Dewar 500 TPED	Ultra Dewar 1000 TPED
Dimensions: inches (cm)					
Outside Diameter	24 (61.0)	24 (61.0)	32 (81.3)	42 (106.7)	52 (132.1)
Overall Height	50.1 (127.3)	59.0 (147.9)	67.4 (171.1)	78.75 (200)	78.75 (200)
Number of Casters	4	4	4	4	4
Caster Size	4 (10.1)	4 (10.1)	5 (12.7)	5 (12.7)	5 (12.7)
Neck Inside Diameter	1.45 (3.7)	1.45 (3.7)	2.40 (6.1)	2.90 (7.4)	2.90 (7.4)
Dip Tube Length*	35.0 (88.9)	43.8 (111.1)	54.4 (138.2)	56.4 (143.1)	61.4 (155.9)
Capacity: (liters)					
Liquid (Gross)	66	110	275	550	995
Liquid (Net)	60	100	250	500	1000
Weight: lbs (kg)					
Empty	184 (83)	212 (96)	348 (158)	827 (375)	1375 (625)
Full	201 (91)	240 (109)	417 (189)	913 (414)	1531 (696)
Maximum Working Pressure: PSI (BAR)	10 (.7)	10 (.7)	10 (.7)	10 (.7)	10 (.7)
NER** (% per day)	1.75	1.25	1.0	1.0	1.0

* The dip tube length is measured from the tank flange to the bottom of the inner vessel.
** Based on gross capacity.

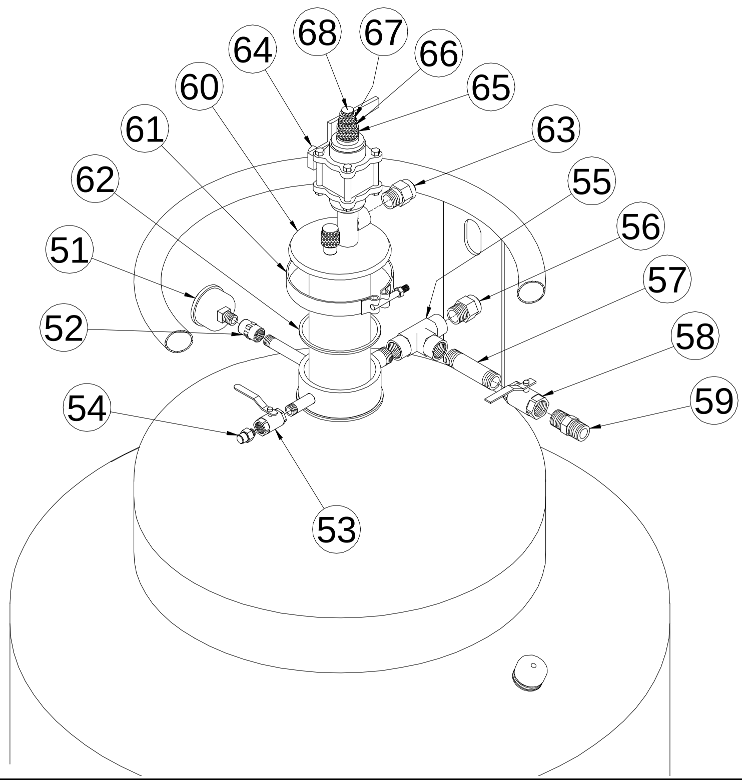
PARTS LIST **60/100, STANDARD AND TPED**				
ITEM	**PART NUMBER**	**QTY**	**SPARES***	**DESCRIPTION**
26	2013869	1	1	Pressure Gauge – (30” Hg / 0-15 PSI)
27	1210212	1		Coupling – 1/4” FPT
28	1717702	1		Ball Valve – 1/4” FPT
29	11366278	1	1	Relief Valve – 1/4” MPT (1 PSI) (CE if applicable)
30	11044869	1		Brass Tee – 1/2” FPT
31	11366251	1	1	Relief Valve – 1/2” MPT (10 PSI) (CE if applicable)
32	1312502	1		Brass Nipple – 1/2” x 3”
33	1717692	1		Ball Valve – 1/2” FPT
34	1310102	1		Brass Nipple – 1/2” x 1 1/2”
35	8505601	1		Top Flange Assembly
36	3411601	1		Vee Band Clamp
37	2300159	1		O-ring (Square Cut)
38	11491811	1	1	Relief Valve – 1/2” MPT (12 PSI)
39	10586201	1		Ball Vavle 1/2” MPT (Fill) (PI if applicable)
40	2210372	1	1	Fill Coupling Tube – 1/2”
41	2210072	1	1	Fill Coupling Tube – 3/8”
42	2210212	1	1	Fill Coupling Plug – 3/8”
43	11484282	2		Caster – 4” Dia. (Fixed)
44	11484303	2		Caster – 4” Dia. (Swivel)

*Recommended spare parts.

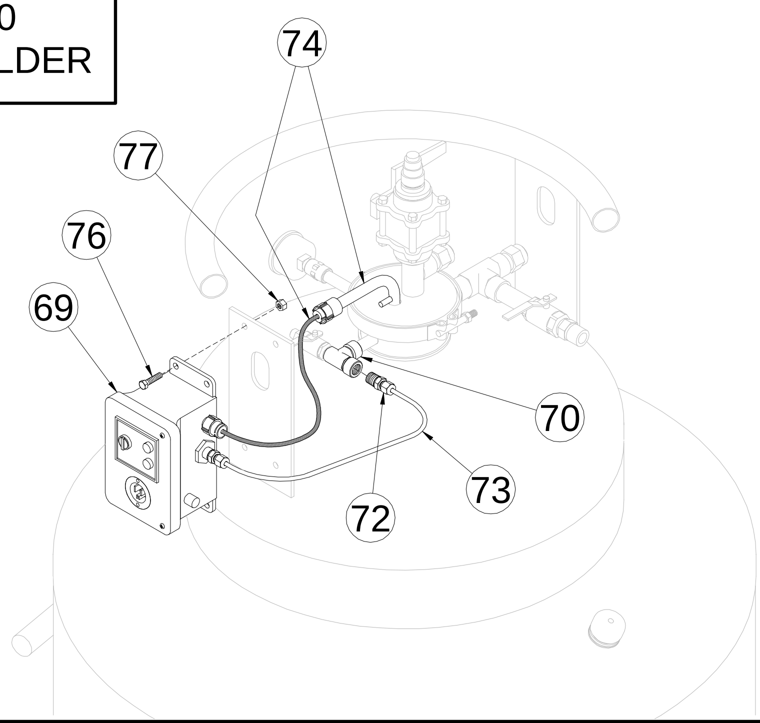




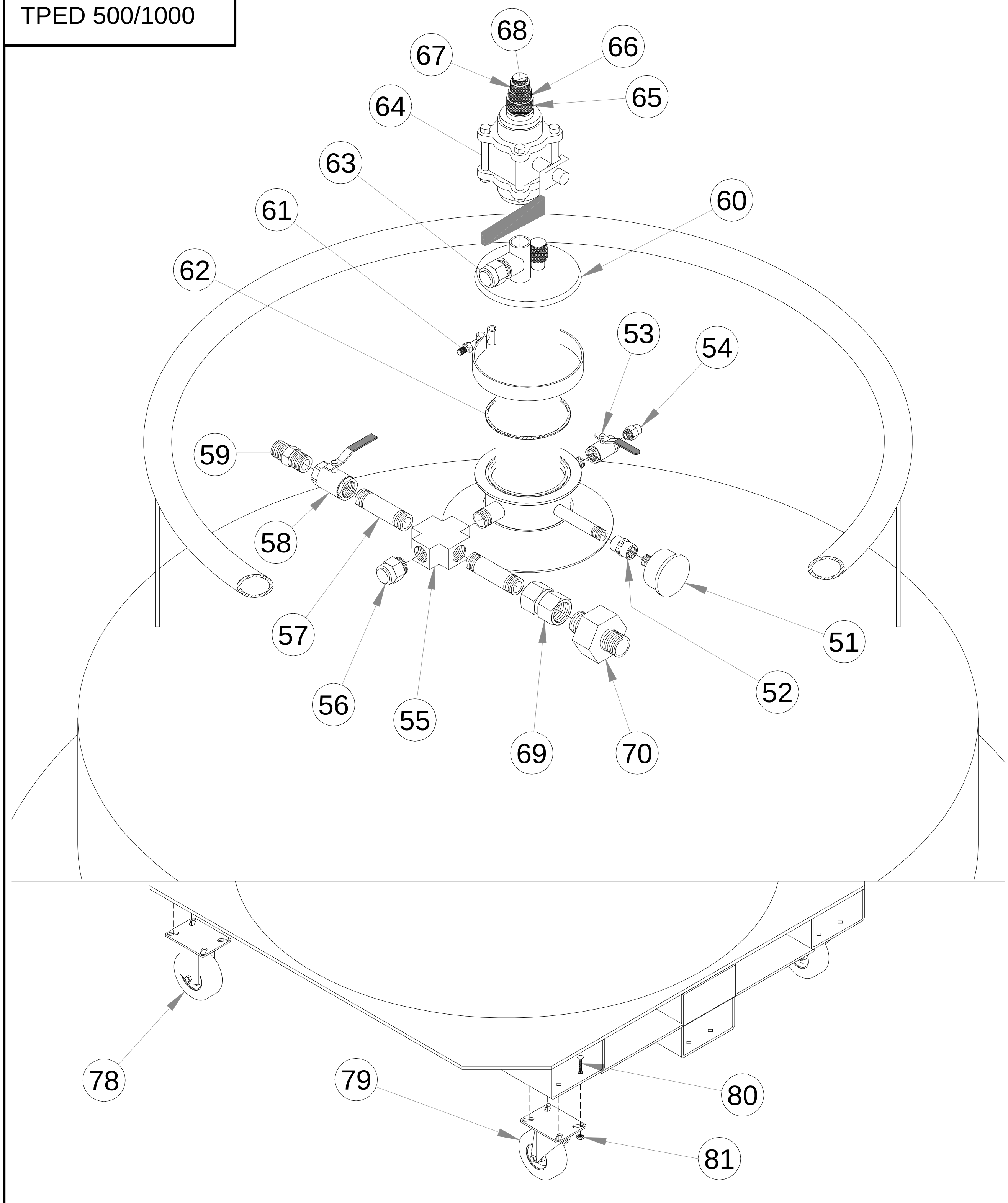
ULTRA DEWAR
250/350/500/100



ULTRA DEWAR
250/350/500/1000
PRESSURE BUILDER



ULTRA DEWAR
TPED 500/1000

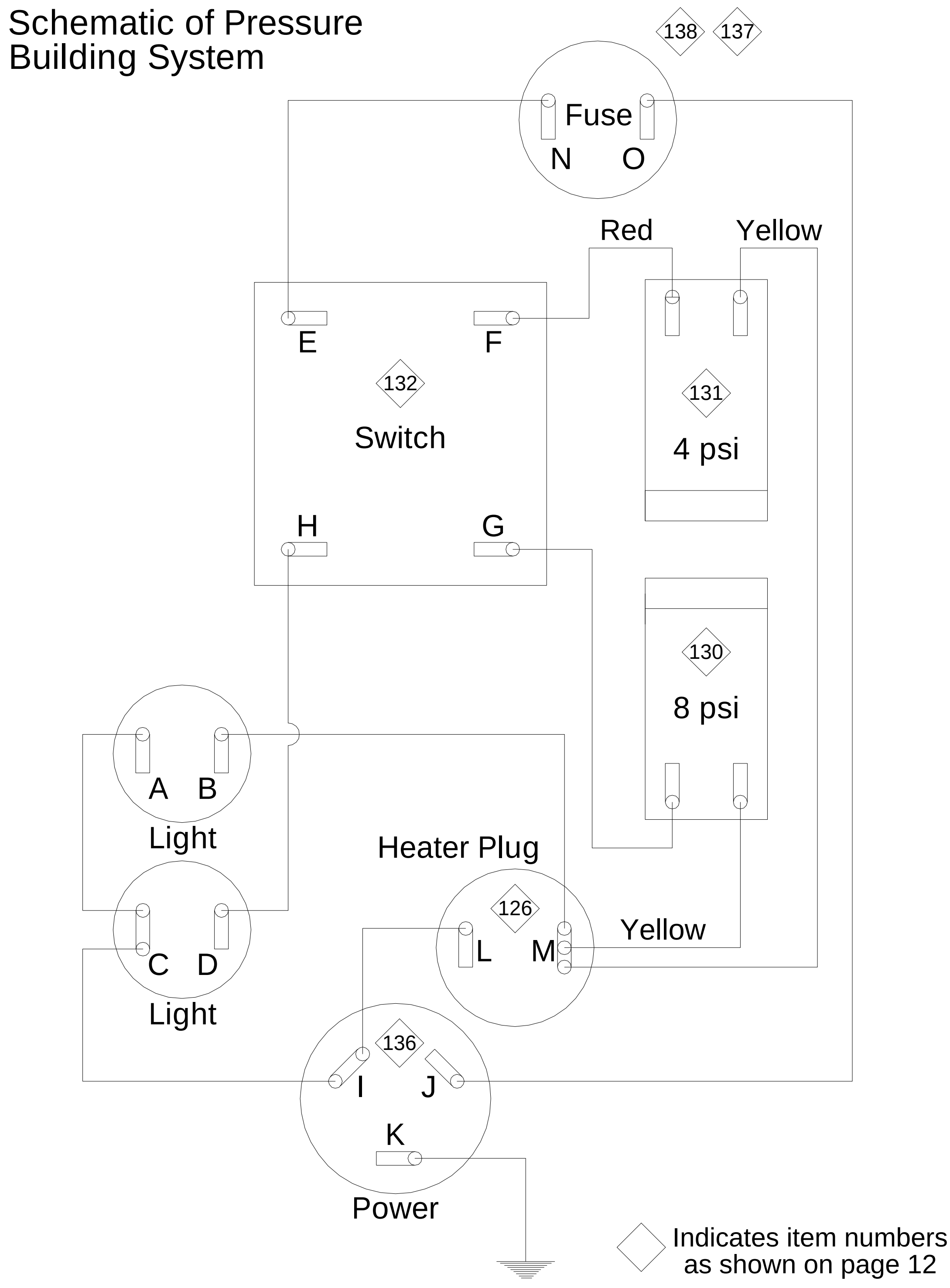


PARTS LIST **250/350/500/1000 STANDARD, 250 TPED**				
ITEM	**PART NUMBER**	**QTY**	**SPARES***	**DESCRIPTION**
51	2013869	1	1	Pressure Gauge – (30” Hg / 0-15 PSI)
52	1210212	1		Coupling – 1/4” FPT
53	1717702	1		Ball Valve – 1/4” FPT
54	11366278	1	1	Shield Flow Valve – 1/4” MPT (1 PSI)
55	11044869	1		Brass Tee – 1/2” FPT
56	11366251	1		Relief Valve – 1/2” MPT (10 PSI) (CE if applicable)
57	1312502	1		Brass Nipple – 1/2” x 3”
58	1717692	1		Ball Valve – 1/2” FPT
59	1310102	1		Brass Nipple – 1/2” x 1 1/2”
60	11634252	1		Top Flange Assembly (250/350) 5” O.D.
60	11528960	1		Top Flange Assembly (500) 5” O.D.
61	3411601	1		Vee Band Clamp
62	2300159	1		O-ring (Square Cut)
63	11491811	1	1	Relief Valve – 1/2” MPT (12 PSI) (CE if applicable)
64	1717682	1		Ball Vavle 3/4” Solder End (PI if applicable)
65	2210382	1	1	Fill Coupling - 3/4”
66	2210392	1	1	Fill Coupling Tube – 5/8”
67	2210372	1	1	Fill Coupling Plug – 1/2”
68	1213302	2	1	Fill Plug – 1/2”
69	9722169	2		P.B. Control Box
70	11213072	1		Street Tee – 1/4” MPT
71	1717819	1		Ball Valve – 1/4” MPT x 1/4” FPT (P.B.)
72	1013532	1		Connector – 3/16” Tube x1/4” MPT
73	6910823	2 ft.		Tube – 3/16” O.D.
74	9722009	1		P.B. Probe/Sub Assembly
75	2210372	1		P.B. Coupling 1/2”
76	2914361	4		Bolt – 1/4-20 x 1”
77	2914071	4		Locknut 1/4-20

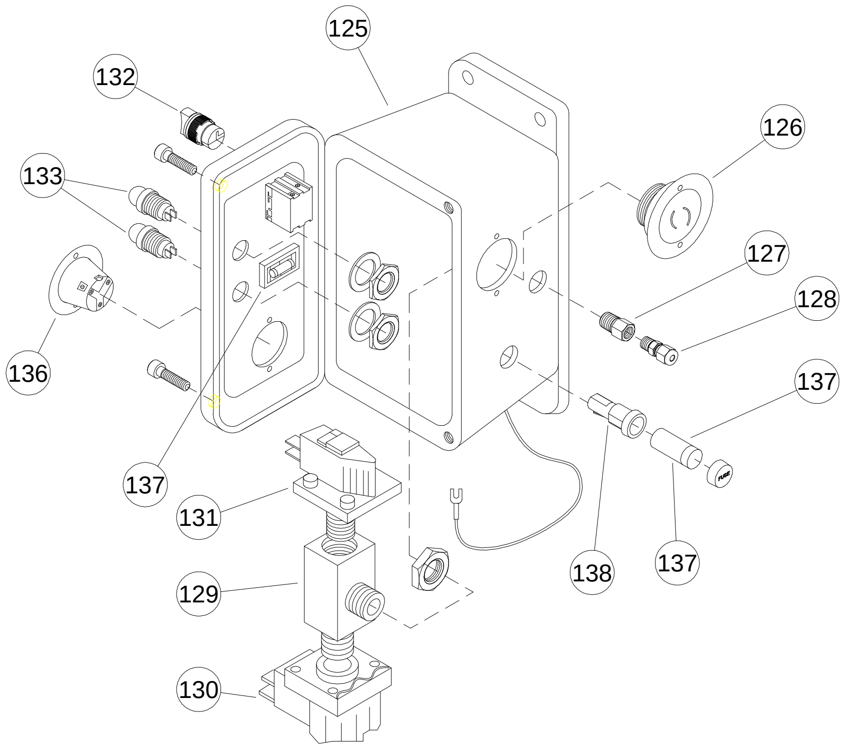
PARTS LIST **500/1000 TPED** (Reference above list for non-listed parts)				
ITEM	**PART NUMBER**	**QTY**	**SPARES***	**DESCRIPTION**
53	11891291	1		Ball Valve – 1/4” FPT
54	11891304	1	1	Relief Valve –1/4” MPT (1 PSI) CE marked
55	1213372	1		Brass Cross – 1/2“ FPT
57[1]	1312502	2		Brass Nipple Tube - 1/2“ x 3”
58	11891427	1		Ball Valve - 1/2“ FPT
60	11891321	1		Top Flange Assembly TPED
64	11891283	1		Ball Valve - 3/4“ PI marked
64	11907476	1		Ball Valve- 1” PI marked
69[2]	11920689	1		Adapter Reducing Coupling – 3/4“ x 1/2“
70[2]	11919813	1		Rupture Disc – 3/4" MPT (25 PSI) CE marked
70[3]	11919821	1		Rupture Disc –1/2” MPT (25 PSI) CE marked
78	3110501	2		Caster – 5” Dia. (Fixed)
79	3110481	2		Caster – 5” Dia. (Swivel)
80	2913721	16		Carriage Bolt – 3/8-16 x 1 1/2” LG

* Recommended spare parts.
[1] Qty. of (1) on 500
[2] Only used on 1000
[3] Only used on 500

WIRING DIAGRAM:
Schematic of Pressure
Building System



PRESSURE BUILDER



ITEM	PART NUMBER	QTY	SPARES*	DESCRIPTION
125	8503639	1		Control Box
126	4314989	1		PB Probe Plug (Female)
127	2914202	1		Connector – 1/8” MPT
128	1013372	1		Tube Connector – 1/8” MPT x 3/16” OD
129	1213082	1		Branch Tee – 1/8” NPT
130	10490728	1	1	Pressure Switch – 1/8” NPT (8 PSI)
131	10490710	1	1	Pressure Switch – 1/8” NPT (4 PSI)
132	4614429	1		Switch – 3 position
133	11683919	2		Indicator – Neon Green 115V
136	4614329	1		Female Socket – 3 Wire
137	4615069	2		Fuse- 1/4” x 1 1/4” (5 AMP)
138	4614359	1		Fuse Socket – 1 1/4” x 1 1/4”

*Recommended spare parts.

GENERAL

The Ultra Dewar cryogenic containers should be operated and handled as a piece of specialized equipment. The operational personnel should be thoroughly trained in the vessels operation and the nature of liquid helium. Rough, careless handling must be avoided. Review the section on safety before each operation to reinforce the proper cautions and warnings.

WARNING – Liquid helium containers and lines must be cleaned and purged before use.

It is necessary to purge the inner vessel and its related plumbing of the nitrogen gas that is normally in a new tank. The transfer line must also be purged. Liquid helium would solidify any air in it and cause an ice plug.

The inner vessel must also be cooled down to near liquid helium temperatures before it will accept liquid helium. Filling with liquid helium will cool the vessel and it's insulation so that it will accept liquid helium. The vent gas can be recovered for re-liquefaction during this process. Cooling the vessel with liquid helium without vent gas recovery can be very costly.

Liquid nitrogen can be used in conjunction with the purging operation to cool the vessel to -320°F (-140°C) before liquid helium is introduced into the vessel. New dewars are at ambient temperature and should be pre-cooled to prevent large filling losses. Use the following procedure to purge and cool with liquid nitrogen.

LIQUID NITROGEN PRE-COOL and HELIUM PURGE (Refer to Figure 6.)

1. Insert a nitrogen fill stinger into the inner vessel until it reaches the bottom. The fill stinger should pass through the proper size quick coupling and the open fill valve (Item B).
2. Open the vent valve (Item A).
3. Close the shield flow isolation valve (Item C).
4. Fill the vessel to 10-20% of its full capacity by weight with liquid nitrogen. NOTE – vigorous venting will occur since the vessel is at ambient temperature.
5. Allow the liquid nitrogen to completely cool the inner vessel for at least 24 hours.
6. Attach a gaseous nitrogen pressure line to the vent valve (Item A) and pressurize the vessel to 5 PSI (0.34 BAR).
7. Remove the liquid nitrogen through the fill stinger.
8. Examine the container for vacuum integrity. Check that the pump-out plug is in place to confirm vacuum.

CAUTION- Evacuation of the inner vessel of a container that has lost it's vacuum insulation will cause the inner vessel to collapse and require a major repair.

9. Attach a vacuum pump to the vent valve (Item A).
10. Open the vent valve and close all other valves.
11. Evacuate the container and close the vent valve. Remove the pump.
12. Connect a dry helium gas source to the vent valve and break the vacuum back with helium gas.
13. Slowly raise the pressure to 1 PSI (0.069 BAR) to purge shield flow valve. Close shield flow isolation valve. Pressurize to 12 PSI (0.82 BAR) to purge the relief valves and vent system.
14. The vessel is now ready for filling with liquid helium.

INITIAL LIQUID HELIUM FILLING

The initial filling of the Ultra Dewar container is done in the same manner as described in the next paragraph on Liquid Helium Filling. It is very important to observe the following for the initial fill:

1. Make sure that the vessel was properly purged of air.
2. Make sure there is no residual liquid nitrogen if that was used for cool down.
3. Examine the vessel after filling.

LIQUID HELIUM FILLING

It is important that the contents of the Ultra Dewar be measured as the filling operation is taking place. Liquid helium's heat of evaporation is so low that it is possible to go through the filling operation without collecting any liquid helium into the vessel. The heat input of any of the filling components or vessel could be high enough to vaporize the liquid before it reaches the vessel. The filling must be done through vacuum jacketed piping, valves, and a vacuum jacketed transfer tube. The best way to confirm the filling operation is to fill the Ultra Dewar on a scale. The weight will start to increase as the vessel begins to accept liquid.

The filling should be done at low pressure. The optimum filling pressure varies with the configuration of each filling system. A balance between filling speeds and product loss will have to be maintained. The higher the pressure the faster the fill, but the more helium will be vaporized as the liquid helium depressurizes (see figure 8 and 9). The average system filling pressure is between 2 and 8 PSI (0.136 BAR and 0.54 BAR).

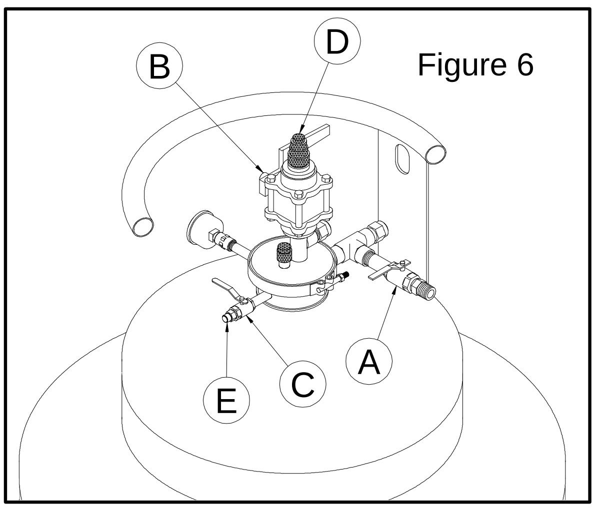


Figure 6

The following filling operation is done on a filling scale that is accurate to .1 pounds (45.4g) over the weight range of 100 to 1,000 pounds (45.4 kg to 453.5 kg). This accuracy is necessary to indicate liquid helium, which weighs 0.28 lbs/liter (.12 kg/liter). The operation is as follows (Refer to figure 6):

1. Purge and pre-cool the Ultra Dewar as previously described.
2. Place the container on the filling scale. Record the empty weight.
3. Compare the empty weight with the tare weight that is stamped on the data plate. The difference could be cold helium gas. (Cold helium gas at 0 PIS equals 0.004 lbs/liter or 0.17 kg/liter). If the difference is too large there could be residual helium in the vessel. If the vessel was just purged with liquid nitrogen there could be residual nitrogen in the vessel. Re-purge the vessel if that is the case.
4. Purge the fill transfer tube with gaseous helium.
5. Open the fill valve (Item B). Insert the filling transfer tube through the appropriate quick connect (Item D). The filling tube should be pushed to the bottom of the inner vessel and tightened with the quick connect. Record the new weight. Subtract the vessel empty weight from the weight with the transfer hose. This will be the weight of the transfer hose. Add the transfer hose weight to the vessel tare weight and the desired amount of helium. This will be the target full weight.
6. Connect the vapor recovery system to the vent valve (Item A). If a vapor recovery system is not being used, the vent valve will be used to relieve helium-filling pressure. Venting will take place during the fill.
7. Open the vent valve (Item A) and the liquid helium transfer valve on the liquid source.
8. Watch the weight on the filling scale. Terminate the fill when the scale reads the target fill weight.
9. Close the transfer line valve. Allow the tank to vent down. Remove the filling tube and close the filling valve (Item B). Replace the plug in the quick connect that was used for filling. Close the vent valve (Item A).
10. Open the shield flow isolation valve (Item C). Make sure that all other valves are closed and that the tank is venting from the shield flow valve (Item A).

LIQUID WITHDRAWAL

Liquid helium can be withdrawn from the Ultra Dewar containers through the fill/withdrawal ball valve located on the top flange of the tank. The entire transfer must be made through vacuum insulated lines and into a cold vacuum insulated container. The most common procedure is to use a vacuum jacketed transfer line that can be provided from Chart (refer to back of manual for toll-free phone number). Use the following procedure to transfer liquid helium from one tank to another without external pressurization: (Refer to figure 6 and 7).

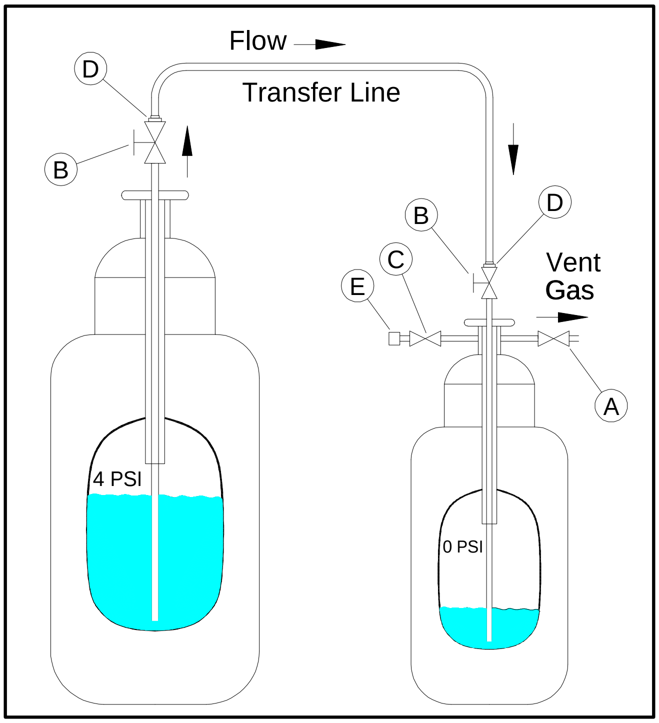


Figure 7

1. Close all valves on both the delivery and receiving tank.
2. Remove the quick coupling plugs on both tanks. Make sure that the proper size quick coupling (Item D) is being used for the transfer line.
3. Place the ends of the transfer line into the quick coupling on both tanks and insert them until they tough the fill/withdrawal ball valve (Item B). Tighten the quick couplings.

   NOTE: The boil-off, caused by the warm transfer line being inserted into the helium tank will cause immediate pressure rise and transfer of liquid helium. The transfer line should have a flow valve in it or be installed simultaneously into both tanks.

4. Open the ball valves (Item B) on both tanks and insert the transfer line into the tanks. Tighten the quick couplings (Item D).
5. Open the vent valve (Item A) on the receiving tank. Liquid transfer will take place as helium gas is vented from the receiving tank.
6. The liquid transfer can be measured by using a scale as described on page 17, “Filling” – steps 2 thru 8.

   When the transfer is complete:

7. Remove the transfer line until it just clears the fill/withdrawal valve. Close the fill/withdrawal valve (Item B) and remove the line completely.
8. Close the receiving tanks vent valve. Open the shield flow valve (Item C) and let the tank vent to 1 PSI (0.07 BAR).
9. Install the quick coupling plugs and make sure that all valves except the shield flow valve are closed.

EXTERNAL PRESSURIZATION

Liquid transfer rate is a function of pressure. The higher the pressure the faster the transfer will occur. However, liquid helium gives off large quantities of gas as it is depressurized. The higher the transfer pressure the more liquid will be lost as gas. A balance is needed between transfer speed and product loss.

Pressure can be raised on the Ultra Dewar containers by connecting a high-pressure helium gas bottle with regulator to the Ultra Dewar's vent connection. The pressure should be adjusted between 4 and 8 PSI (0.27 BAR and 0.54 BAR). The tank's pressure gauge and vent valve should be used to control the pressure. Pressures that exceed 10 PSI will activate the tanks relief valves and cause large product losses.

An electronic pressure building (PB) system is available for some models of Ultra Dewar containers. The electric PB is designed to raise and maintain the pressure in the container to either 4 or 8 PSI (0.27 BAR or 0.54 BAR). It indicates when the power and the pressure-building heater are on. The pressure builder should not be turned on until the transfer line is completely installed in both tanks (Step 4, page 16, in the withdrawal procedure).

Caution: The pressure builder must be turned off when the transfer is complete. The heater can be burned out if it is left on after the transfer.

PRODUCT LOSS FROM LIQUID TRANSFER

The Ultra Dewar is a specially insulated tank that is designed to have very low product loss due to the normal heat leak into the vessel. There are other product loss factors that must be considered when making a liquid transfer. The introduction of the warm transfer line into the cold liquid helium will vaporize a certain amount of product. The cool down of the transfer line and receiving tank will use a certain amount of product. The addition of pressure to the tank from an outside source or the pressure builder will cause a certain amount of liquid to boil and increase the saturation pressure of the remaining liquid.

Flash loss due to pressure drop through the transfer line may be estimated by use of Figure 8 "Helium Flash Rate". Depressurization loss of liquid in the container may be estimated by use of Figure 9 "Helium Depressurization Losses".

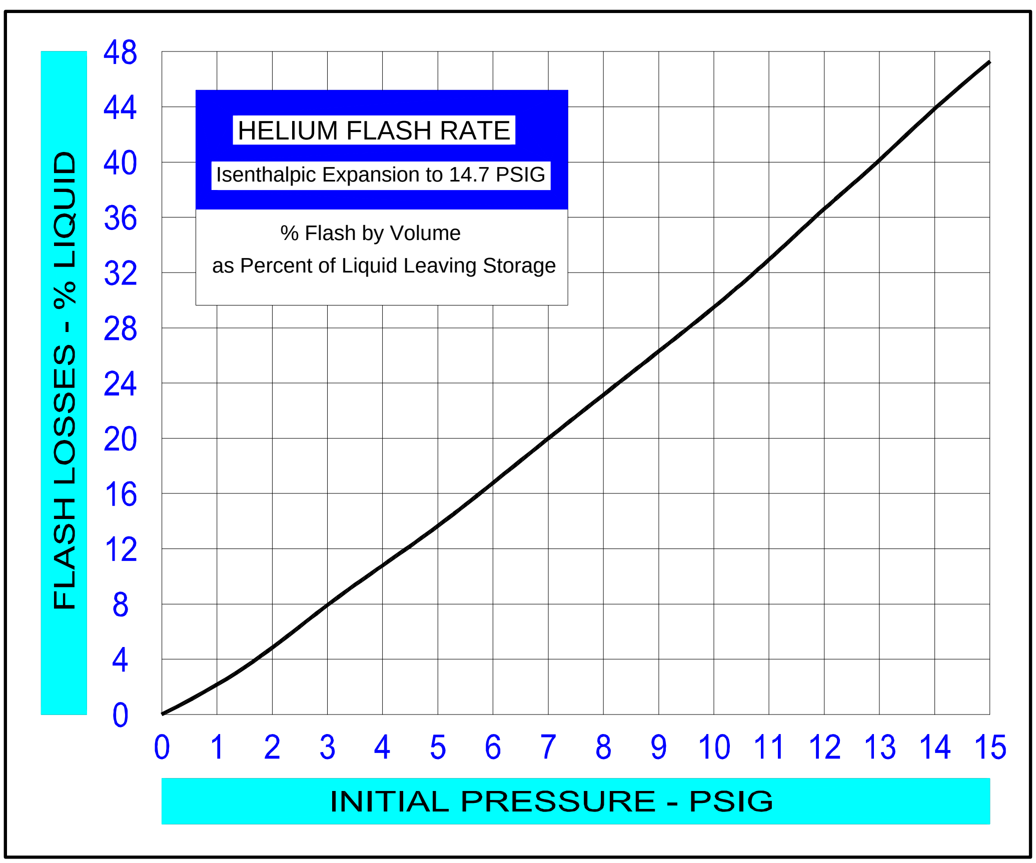


Figure 8

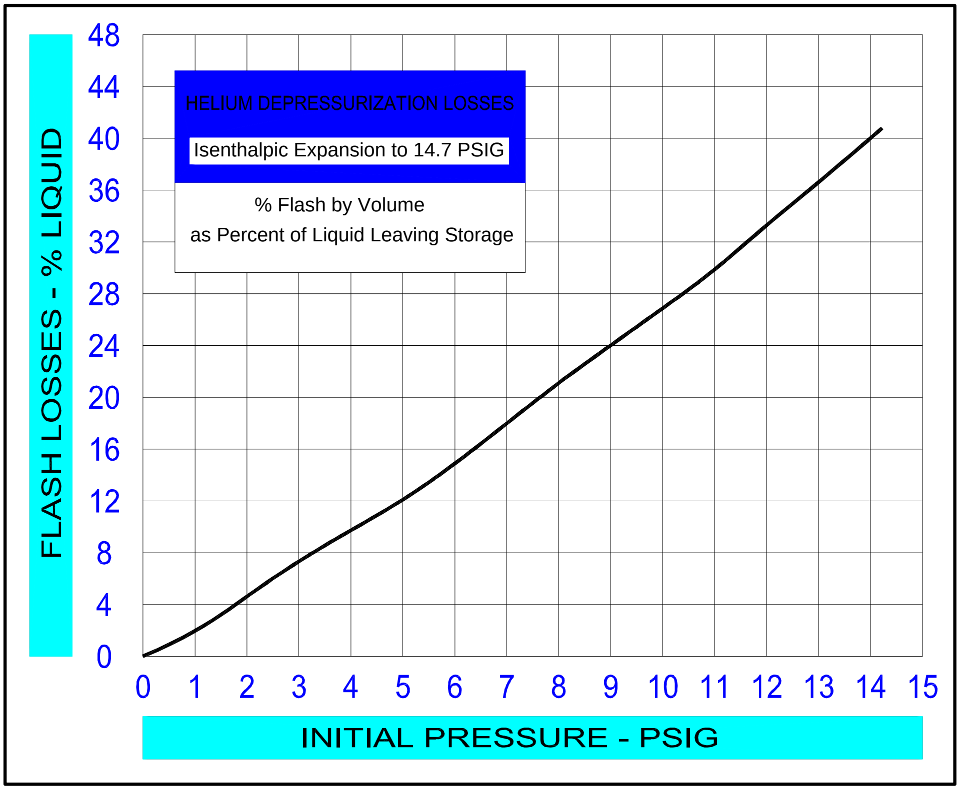


Figure 9

For example: Assume a helium container is discharging at a constant pressure of 5 PSIG (0.34 BAR). From Figure 8 the flash loss is approximately 13.8% of the liquid entering the transfer tube. From Figure 9 the loss from depressurizing the container is approximately 12.5% of the liquid remaining in the container.

For best transfer efficiency, the withdrawal should be started and maintained with as low a pressure as practical. Too low a pressure will require a longer time to make a transfer and thus permit heat leak in the transfer system to become excessive. A balance between effects of heat leak and depressurization may generally be attained by operating in a pressure range of 2 to 8 (0.13 BAR to 0.54 BAR) PSIG.

STORAGE

Maximum storage efficiency is obtained when the liquid helium is maintained near atmospheric pressure. If liquid helium is stored in a closed vessel, the normal heat leak will cause a pressure rise, which ultimately must be relieved with accompanying blow down losses. (Fig. 8)

This container is designed so that the refrigeration available in the boil-off gas from the liquid helium is used to cool multiple heat sink temperature barriers, which intercept the heat in-leak toward the helium reservoir. For operation, keep the 1 PSI relief valve open and close all other vent valves. This forces the boil-off gas to circulate through the space between the necks. The relief valve is set to prevent air and/or moisture from entering the vessel while permitting the boil-off gas to escape.

LIQUID LEVEL READING

The most accurate means of determining the amount of helium in the Ultra Dewar is to weigh the container. The difference between the recorded weight and the tare weight is the amount of helium. The level of helium in the container can also be measured with a dipstick that is inserted through the fill ball valve to the surface of the liquid. The difference between the measured dipstick and the total length of the vessel can be compared to the Contents Chart for the associated volume of helium.

CALIBRATION CHART						
Inches from Bottom	Ultra Dewar 60 (liters)	Ultra Dewar 100 (liters)	Ultra Dewar 250 (liters)	Ultra Dewar 350 (liters)	Ultra Dewar 500 (liters)	Ultra Dewar 1000 (liters)
0	0	0	0	0	0	0
1	1	1	2	2	2	3
2	4	4	7	7	7	10
3	9	9	15	15	15	23
4	14	14	24	24	26	34
5	19	19	34	34	39	51
6	24	24	44	44	54	72
7	29	29	55	55	70	93
8	34	35	66	66	87	121
9	39	40	76	76	104	150
10	44	45	87	87	122	179
11	50	50	98	98	140	208
12	55	55	109	109	157	237
13	60	60	119	119	175	266
14	65	65	130	130	192	295
15	68	71	141	141	210	324
16	69	76	152	152	228	353
17		81	162	162	245	382
18		86	173	173	263	411
19		91	184	184	280	440
20		96	195	195	298	469
21		101	205	205	316	498
22		106	216	216	333	527
23		109	227	227	351	556
24		110	242	242	369	585
25			248	248	386	614
26			258	259	404	643
27			266	270	421	672
28			272	281	439	701
29			275	292	457	730
30				303	474	759
31				314	490	788
32				325	506	817
33				336	519	846
34				346	531	872
35				355	541	898
36				363	547	921
37				368	550	942
38						960
39						972
40						985
41						992
42						995

8 TROUBLESHOOTING

Ultra Dewar will not fill with liquid.	Vent valve is closed.	Open vent valve.
	Ultra Dewar has not completely cooled down.	Continue to fill.
	Transfer line has lost vacuum (heavy frost on line).	Replace transfer line.
	Transfer line is blocked.	Purge the transfer line with helium gas.
	Ultra Dewar has lost vacuum (heavy Frost on the outside of the tank).	Return for repairs.
	Residual LN^2 is freezing solid (heavy tare weight noticed).	Warm container and purge with helium gas.
Ultra Dewar pressure is high and it will not vent.	Vent valve is closed.	Open the valve.
	Relief valve has malfunctioned.	Bench test the relief valve and replace if necessary.
	Ice block has formed between the neck tubes.	Remove the helium and warm up the tank.
Ultra Dewar has high NER.	Shield flow valve is not working.	Open the isolation valve.
		Remove and test the relief valve. Replace if necessary.
	Ultra Dewar has been overfilled.	Fill by weight to the prescribed volume.
	Thermal-acoustical oscillation is occurring.	Make sure that no optional equipment has been attached to the plumbing.
	Ultra Dewar has marginal vacuum.	Call customer technical support.

HELIUM TRANSFER LINE

When using cryogenic fluids with a low heat of vaporization such as helium and hydrogen, it is necessary to have an efficient transfer apparatus. To meet these operating requirements, transfer tubes are carefully assembled using all welded stainless steel construction, and are super-insulated to provide the optimum in thermal performance.

All Chart transfer tubes are custom built to meet the customer's specific requirements for configuration, diameter, and length. Special features may be added as necessary, and fast delivery is available from our complete stock of components.

STANDARD FEATURES

The inner configuration of all assemblies, whether they are rigid or flexible, is stainless steel of minimum wall thickness to reduce cool down losses and heat leak.

Outer jackets are likewise stainless steel, capable of being evacuated to less than 10?mm absolute pressure for minimum heat leak. Exceptions are taken when the customer requirements deviates from standard practices.

The evacuated space between the inner line and the outer jacket are super-insulated using aluminized mylar as a radiation barrier.

All tubes are helium mass spectrometer leak tested for a leak rate of less than 10^{6} micron cubic feet per hour, and are fully evacuated before shipping to insure that unit is ready for immediate use upon receipt. An evacuation valve is provided and can be used for occasional re-evacuation of the insulation space by the user.

SPECIAL FEATURES (at extra cost)

1. **Bayonet Connectors**
   Bayonet connectors can be provided for disassembly of the tube at any convenient location. These connectors can be easily assembled and disassembled in the laboratory, and do not require re-pumping of the insulating vacuum after each usage.

2. **Flexible Sections**
   Chart can provide flexible sections on the horizontal legs of these tubes. This section can be from 12" to 12' long as required by the customer. Bayonet couplings are also available with the flexible line sections.

3. **Vacuum Insulated Valve**
   Chart can provide 1/4" angle pattern super-insulated valves on the supply leg of these transfer tubes. This allows the on/off transfer type operation without loss of head pressure in the supply container.

4. **Exchangeable Tips**
   Interchangeable un-insulated leg extensions with threaded connectors can be provided for versatile operation with different size containers and dewars.

When ordering, specify options required and specify dimensions A through E. Recommended combination of B/D and C/E to fit Ultra Dewar containers are:

	B	D	C	E
Ultra Dewar 60	29"	13"	29"	13"
Ultra Dewar 100	29"	22"	29"	22"
Ultra Dewar 250	33"	30"	33"	30"
Ultra Dewar 350	33"	34"	33"	34"
Ultra Dewar 500	30"	35"	30"	35"
Ultra Dewar 1000	26"	47"	26"	47"

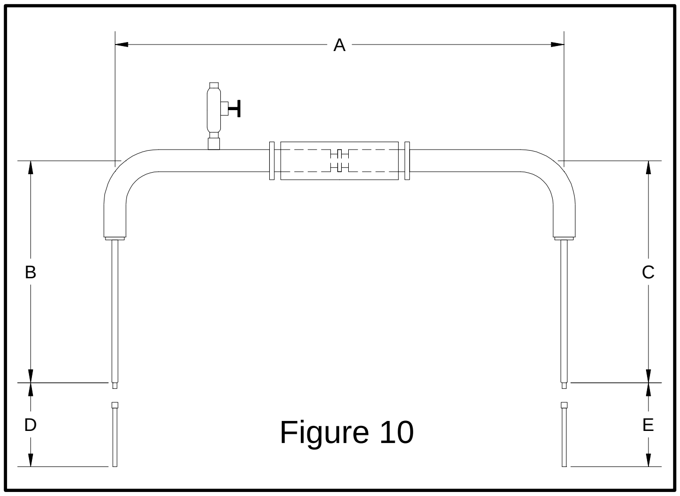
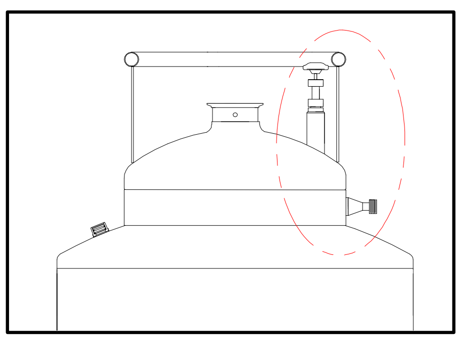


Figure 10

5. **Optional Side Transfer Tube**



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