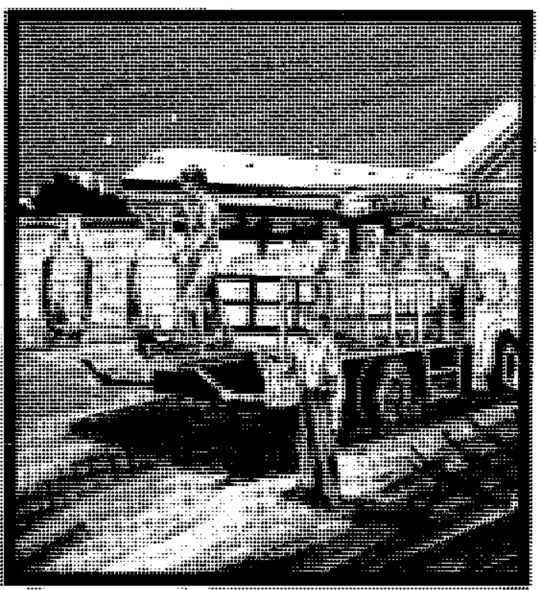
MVE Cryogenics®

DURA-SHIELD
30
60
100
250
500
1000
TRANSPORTABLE LIQUID HELIUM CONTAINERS

User Manual



REVISION LOG

REVISION	REVISION DESCRIPTION
A	Manual released. All pages at revision level A. This manual supersedes all previous editions.

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PREFACE

This edition documents Release 1 and all subsequent releases of the Minnesota Valley Engineering (MVE) DURA-SHIELD cryogenic containers, unless otherwise indicated by MVE representatives or specified in new editions.

This manual is intended to provide the user with the information necessary to operate and maintain the DURA-SHIELD containers. Section 1 provides a general introduction to the DURA-SHIELD containers. Section 2 describes operator handling of liquid helium. Descriptions and characteristics are contained in Section 3. Section 4 provides filling instructions. Section 5 describes recommended procedures for determining content. Section 6 contains recommended spare/repair parts lists and schematic diagrams, respectively. Appendix A describes optional equipment. Appendix B lists all abbreviations and acronyms used in this manual. Appendix C contains applicable oxygen and inert gases (nitrogen and argon) safety bulletins, and a DOT specification summary.

Any comments or suggestions related to this manual are encouraged and should be forwarded in writing to:

Minnesota Valley Engineering, Inc.
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SAFETY SUMMARY

MVE has conducted a rigid test program for cryogenic containers, both internally and through an independent testing laboratory, to verify the safety of MVE equipment. MVE is justifiably proud of its reputation of providing equipment of unquestioned integrity for many years. MVE cylinders are safely designed with the following features:

(1) Stainless steel construction designed to withstand many years of rugged service.

(2) A stainless steel neck tube which will not break under normal usage.

(3) A vacuum maintenance system specifically designed to provide long life and all possible safety provisions.

(4) Safety relief devices to protect the pressure vessel and vacuum casing, sized and selected in accordance with CGA Pamphlet S1.1 "Safety Relief Devices for Cylinders." To include pressure control valves to protect the inner vessel and to protect the vacuum casing from overpressure. While MVE equipment is designed and built to the most rigid standards, no piece of mechanical equipment can ever be made 100% foolproof. Strict compliance with proper safety and handling practices is necessary when using a liquid cylinder or other compressed gas container. We recommend that all our customers re-emphasize safety and safe handling practices to all their employees and customers. While every possible safety feature has been designed into the unit and safe operations are anticipated, it is essential that the user of these containers carefully read to fully understand all WARNING and CAUTION notes listed in this safety summary and enumerated below. Also read to fully understand the information provided in the Safety Bulletins for Inert Gases located in Appendix C of this Manual. Periodic review of the Safety Summary is recommended.

WARNING

Helium and nitrogen 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.

WARNING

The DURA-SHIELD containers are designed, manufactured, and tested to function normally for many years of rugged service. MVE does not suggest or warrant that it is ever safe to drop a full liquid cylinder or let it fall over in helium or any other cryogenic service. In the event a container is inadvertently dropped, tipped over, or unreasonably 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. Visually inspect the container for internal damage which would make the cylinder unsafe. If no damage is found, return to normal service. If damage is evident, return to MVE prominently marked "CONTAINER DROPPED, INSPECT FOR DAMAGE".

WARNING

Before removing cylinder parts or loosening fittings, empty the container of liquid and release the vapor pressure in a safe manner. External valves and fittings can become extremely cold and may cause painful burns to personnel unless properly protected. Personnel must wear protective gloves and eye protection whenever removing parts or loosening fittings. Failure to do so may result in personal injury because of the extreme cold and pressure in the cylinder.

CAUTION

DURA-SHIELD containers must be used and stored in a vertical position. Do not lay, store, or ship a container on its side. DURA-SHIELD containers are equipped with casters for ease in movement. The small sizes (30-100 liter) may also be moved using a rubber tired liquid cylinder cart (Harper). When necessary to transport a container by truck, use a power lift gate, crane, or inclined ramp to lower the container. If the truck bed and dolly are not at the same height, do not attempt to manually lift or slide a container on or off a truck bed. Failure to comply with these procedures may result in damage to the container.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

TABLES

1-1. GENERAL

Liquid helium has unique properties. Its extreme cold makes it invaluable for cryogenic investigations and for cryogenics industrial applications. At one atmospheric pressure, liquid helium has a boiling point of −452.1°F (4.2°K above absolute zero). Helium is the only known substance which remains liquid under ordinary pressure at temperatures near absolute zero.

After the discovery of helium on earth, a number of scientists started investigations hoping to bask in the helium limelight. H. Kamerlingh Onnes determined many of its properties and in 1908 was the first to liquefy it.

CAUTION

Before proceeding, read all material in this book. To prevent personal injury, acknowledge and understand all safety precautions.

2-1. GENERAL

The potential hazards in handling liquid helium stem mainly from its physical properties;

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

In addition, there are potential hazards due to the mandatory use of vacuum-insulated vessels and transfer lines and to changes in physical properties of materials between ambient and low temperatures.

2-2. PRECAUTIONS

Prior to using liquid helium, the specific operations should be reviewed with respect to the following list of precautions.

Cover eyes and exposed skin. Accidental contact of liquid helium or cold issuing gas with the skin or eyes may cause a freezing injury similar to a burn. Protect your eyes and cover the skin where possibility of contact with cold fluids exists.

Keep air and other gases away from liquid helium. The low temperature of liquid helium or cold gaseous helium can solidify any other gas. Solidified gases and liquid allowed to form and collect can plug pressure-relief passages and foul relief valves. Plugged passages are hazardous because of the continual need to relieve excess pressure produced when heat leaks into the cold helium. Therefore, *always* store and handle liquid helium under positive pressure and in closed systems to prevent the infiltration and solidification of air and other gases.

Keep exterior surfaces clean to prevent combustion. Atmostpheric air will condense on exposed helium-cooled piping. Nitrogen, having a lower boiling point than oxygen, will evaporate first from condensed air leaving an oxygen-enriched liquid. This liquid may drip or flow to nearby surfaces. To prevent the possible ignition of grease, oil, or other combustible materials which come into contact with the air-condensing surfaces, such areas must be cleaned to "oxygen-clean" standards. Any combustible foam-type organic polymer insulation should be carefully applied to reduce the possibility of this air condensation-oxygen enrichment process which, if followed by an impact, could set off an explosive burning of the foam.

Pressure-relief devices must be adequately sized. Most cryogenic liquids require considerable heat for evaporation. Liquid helium, however, has a very low latent heat of vaporization. Consequently, it evaporates rapidly when heat is introduced or when liquid helium is first transferred into warm or partially cooled equipment. Failure of the container vacuum can occur adding appreciable heat. Pressure-relief devices for liquid helium equipment must, therefore, be of adequate capacity to release helium vapor resulting from such heat inputs and thus prevent excessive pressure hazards.

Keep equipment area well ventilated. Although helium is non-toxic, it can cause asphyxiation in a confined area without adequate ventilation. Any atmosphere which does not contain enough oxygen for breathing can cause dizziness, unconsciousness, or even death. Helium, being colorless, odorless, and tasteless, cannot be detected by the human senses and will be inhaled normally as if it were air. (The pitch of the human voice is raised by high helium content, but this should not be used to gauge environments.) Without adequate ventilation, the helium will displace the normal air and give no warning that a non-life-supporting atmosphere is present. Store liquid containers in well-ventilated areas.

Source: *Technology of Liquid Helium,* National Bureau of Standards Monograph III, issued October, 1968.

Figure 2-1. DURA-SHIELD Containers 30 liters-1000 liters

3-1. DESCRIPTION

The DURA-SHIELD transportable liquid helium containers are designed for the transporting and storage of liquid helium and are used under liquefiers. These containers **do not** require liquid nitrogen shielding. They employ superinsulation and recover sensible heat by an ultra-shielding system in a high vacuum to achieve good thermal performance.

For mobility these containers are equipped with swivel casters. The casters may be removed on the large size containers for stationary applications such as liquefiers.

In addition, the DURA-SHIELD 30, 60 and 100 are designed to be moved using a Harper cart.

All models are equipped with slots in the handling ring brackets for three point chain lifting.

DURA-SHIELD 30, 60, 100

Operating Pressure Control:
- $\frac{1}{4}$" relief valve rated at 0.5 PSI
- $\frac{1}{2}$" relief valve rated at 8 PSI on outer neck
- $\frac{1}{2}$" relief valve rated at 10 PSI on inner neck
- Pressure gauge $3\frac{1}{2}$" dial VAC-0-30 PSI

Vacuum Safety Device:
- Combination pump out port and vacuum relief valve with polyvinyl chloride protective cap

Liquid Transfer Equipment:
- Ball valve with $\frac{1}{2}$" and $\frac{3}{8}$" quick coupling

DURA-SHIELD 250, 500, 1000

Operating Pressure Control:
- $\frac{1}{4}$" relief valve rated at 0.5 PSI
- $\frac{3}{4}$" relief valve rated at 8 PSI on outer neck
- $\frac{3}{4}$" relief valve rated at 10 PSI on inner neck
- Pressure gauge $3\frac{1}{2}$" dial VAC-0-30 PSI

Vacuum Safety Device:
- Combination pump out port and vacuum relief valve with polyvinyl chloride protective cap

Liquid Transfer Equipment:
- Ball valve with $\frac{3}{4}$", $\frac{5}{8}$", $\frac{1}{2}$" and $\frac{3}{8}$" quick coupling
- Optional: Dual entry quick couplings $\frac{5}{8}$" and $\frac{1}{2}$"
- Optional: Ball valve with $\frac{3}{4}$", $\frac{5}{8}$", $\frac{1}{2}$", and $\frac{3}{8}$" quick coupling with second entry quick coupling $\frac{5}{8}$" and $\frac{1}{2}$"

3-2. CHARACTERISTICS

DURA-SHIELD	30	60	100	250	500	1000
Gross Capacity—Liters	33	66	108	263	525	1050
Diameter	18"	22"	26"	34"	42"	52"
Height with Casters	$50\frac{13}{16}$"	$52\frac{3}{4}$"	$59\frac{3}{4}$"	65"	$73\frac{1}{2}$"	$77\frac{3}{8}$"
Empty Weight	105 lb.	135 lb.	185 lb.	325 lb.	510 lb	1050 lb.
Neck Inside Diameter	1.43"	1.43"	1.43"	2.40"	2.90"	3.37"
Static Loss Rate Percent per day	2.75%	1.75%	1.25%	1.0%	1.0%	1.0%
Dip Tube Length	42"	45"	$48\frac{1}{2}$"	55"	65"	$67\frac{1}{4}$"

3-3. PIPING COMPONENTS

The outer stainless steel neck connects the inner container to the outer shell. There is a tube within the neck tube with a low thermal conductivity. The gas produced from the normal evaporation is vented through the space between these necks and allows for a better heat exchange and better overall performance of the container.

The inner neck assembly is equipped with quick couplings with O-rings. The quick couplings are mounted above a ball valve and a 10 PSI relief valve. This enables the transfer line to be inserted without depressurization.

The quick couplings on the DURA-SHIELD 30, 60 and 100 are for use with either a $\frac{3}{8}$" or $\frac{1}{2}$" OD transfer line. The quick couplings on the DURA-SHIELD 250, 500, and 1000 can accept $\frac{3}{8}$", $\frac{1}{2}$", $\frac{5}{8}$" and $\frac{3}{4}$" OD transfer lines. (Refer to Appendix A for transfer line information.)

3-4. GAS PHASE AND CONNECTIONS

A $\frac{1}{2}$" ball valve (Part 2.) is mounted to allow depressurization (or pressurization) as required during the liquid helium transfer operation. This valve *is always* closed except when filling or pressurizing from a helium gas bottle.

A ¼" ball valve (Part 8.) is mounted between the gas phase and the normal relief valve (Part 7.). This valve is rated at 0.5 PSI in normal use; the gas from the evaporation vents through it. This valve is *always* open except when filling or withdrawing at a pressure higher than 0.5 PSI.

3-5. TRANSFER ACCESSORIES

The standard MVE transfer line consists of a vacuum insulated valve (½") attached to a vacuum insulated tube (refer to section A-2). This line is vacuum jacketed its entire length to permit insertion into the container without depressurization on the DURA-SHIELD 30, 60, 100 liter containers. A short removable non-insulated pipe makes it possible to use this transfer line for the 250, 500 and 1000 liter containers.

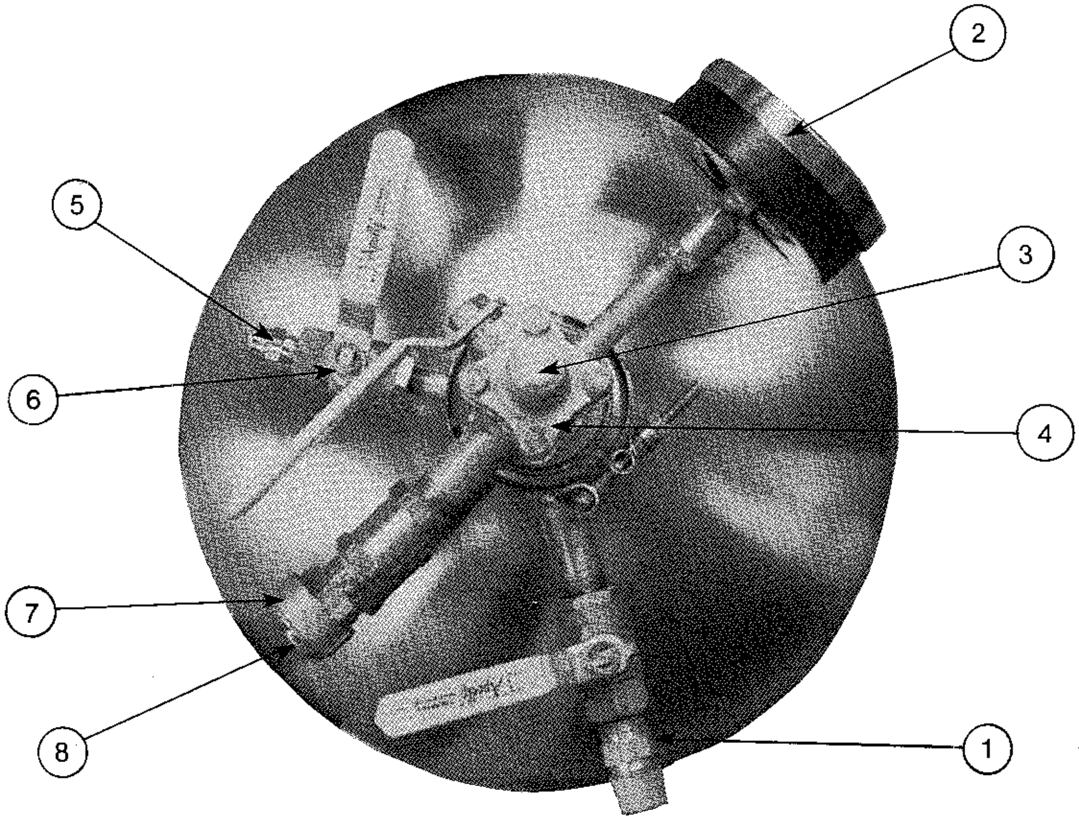


Table 3-1. Operator Controls or Indications

Number	Control or Indication	Description
1	Vent Valve and Fittings	Used in conjunction with liquid during filling operation. May be connected to helium recovery system.
2	Pressure Gauge	Measures contain pressure vac-0-30 PSI
3	Quick Connection	Allows insertion of transfer line into container.
4	Liquid Valve	Allows insertion of transfer line without depressurizing container.
5	½ PSI Relief Valve	Used to limit pressure in container to ½ PSI
6	Isolation Valve	Used to isolate ½ PSI relief valve. Closed during cylinder operation—open during storage.
7	Inner Neck Relief Valve	Backup pressure control device used to limit pressure in container to 10 PSI during cylinder operations.
8	Outer Neck Relief Valve	Used to limit pressure in container to 8 PSI during cylinder operations.

This container should be operated and handled as a piece of delicate equipment. Rough, careless handling must be avoided. Only competent personnel, thoroughly familiar with the vessel's operation, should be allowed to operate it. *Liquid helium containers and lines must be carefully cleaned and purged before use*

4-1. INITIAL FILLING

For the initial filling, it will be necessary to purge out the air and cool down the tank. Cool gaseous nitrogen and then liquid nitrogen is recommended for initial purging and cooling to liquid nitrogen temperature. Operation will be similar to the "Filling" (Paragraph 4-2). Considerable gas will be evolved and it is recommended that the main vent valve (Part 2.) be opened for venting. Nitrogen may be introduced into the vessel through the neck quick coupling.

Comments

Fill tank to 10-20% of full capacity with liquid nitrogen.

After cooling to liquid nitrogen temperature, *the liquid nitrogen must be withdrawn.* Warm gaseous helium may be used as the pressurant and the majority of the liquid nitrogen withdrawn through a dip tube down the neck passage to the bottom of the inner vessel. All the liquid nitrogen must be removed before proceeding with the final helium purge and cooling to liquid helium temperatures. (Cooling and freezing one liter of liquid nitrogen requires 37 liters of helium.)

Dry gaseous helium is used to purge out all the air or nitrogen gas within the container. The various lines and valves should also be well purged at this stage. Progressively cooler helium gas, then liquid helium can be used to complete the purge and cooling. Finally, only helium gas will be in the container and then liquid helium will begin to fill the container.

If the container is to be filled at a helium facility with a helium recovery system, the initial purge and cool-down with nitrogen may be eliminated. Some facilities evacuate the inner vessel on a vacuum pump and then purge and cool directly with liquid helium. Helium may be introduced through a transfer line inserted down the neck quick coupling to the bottom of the inner vessel and the gas reclaimed at the gas vent (Part 2.) for re-use.

NOTE

> On the initial fill, only 5-10% of the volume will be required to cool the container from LN_2 to helium temperatures because of the lightweight inner design.

4-2. FILLING

This container should be filled through a vacuum jacketed helium transfer tube inserted to the bottom of the neck through the quick coupling provided on the neck passage.

The initial filling requires purging and cooling the container as explained in 4-1. "Initial Filling". Subsequent fillings involve simply the purge-cooldown on the fill line.

Liquid helium is transferred under slight pressure through the transfer tube into the container. Considerable gas will be evolved at first and must be vented through the vent valve (Part 2.) or the evolved gaseous helium can be recovered by the connection of a suitable recovery line to the vent.

Now as the container fills with liquid helium, the liquid level should be checked. Methods of checking liquid level include filling the container by weight* on an accurate platform scale, by use of a vibrating membrane, or electrical resistance level probes inserted down the neck passage.

At completion of filling, remove the helium transfer tube, close the ball valve on the DURA-SHIELD, insert plug in the quick coupling, and see that venting is properly maintained through the relief valve (Part 7.). *Vent valve 2 is closed.*

4-3. LIQUID WITHDRAWAL

Liquid helium should be withdrawn from this container with a vacuum jacketed helium transfer tube inserted into the bottom of the inner vessel through the quick coupling provided on the neck passage.

For DURA-SHIELD ~~30, 60, 100, 250 and 500~~ with Ball Valve Entry

The transfer line must be vacuum jacketed its entire length to enable insertion without depressurization. With the ball valve closed, remove the quick coupling plug and insert the tip of the transfer line into the quick coupling. The quick coupling should now be tightened to seal off around the transfer tube. When this is done, open the ball valve and slide the transfer line into the container.

The boil-off caused by the warm transfer line will cause immediate pressurization and transfer of liquid. Therefore, the transfer line should either have flow valve or be inserted simultaneously into the container to be filled.

*This scale should be accurate to within about .05 pound over the weight range of 100 to 300 pounds to prevent measurement errors in excess of ½ liters. The weight of the empty container, filled with cold helium gas is a function of the pressure. Saturated cold gas density at atmospheric pressure is 0.036 pounds per liter, and 0.045 pounds per liter at 3.5 PSI

At the completion of liquid withdrawal, shut off any external pressurization. The container pressure can be vented or, if desired, the container can be left pressurized. To do this, pull the transfer tube from the dewar until the tip is clear of the ball valve but the quick coupling still seals against the transfer tube. Close the ball valve and loosen the quick coupling and remove the transfer tube the remainder of the way. Replace the plug in the quick coupling. Store with only the relief shut-off valve open to allow venting through the relief valve rated at 0.5 PSI.

For DURA-SHIELD ~~250 and 500~~ with Optional Dual Port Entry

Before the coupling plug is removed, relieve the container pressure by opening the vent valve (~~Part~~ 2, Fig. 3-3). Then remove the coupling plug and slowly insert the transfer tube through the quick coupling to the bottom of the inner vessel. The quick coupling should be tightened to seal off around the transfer tube.

Pressure is needed to push the liquid helium up and out of the transfer tube. One to two pounds gauge pressure is usually sufficient and it is recommended that pressurization be minimized to achieve maximum transfer efficiency. Sufficient pressure may be obtained by closing all the container vent valves and allowing the liquid helium to pressurize itself through normal heat leak. External pressurization may also be used for faster transfer from this container. Pure dry helium gas from a source such as a gas cylinder or boil-off from another liquid helium container, may be supplied to the container by suitable connection at the vent valve. All other vents should be closed and the pressurizing gas flow may be controlled by throttling through the vent valve.

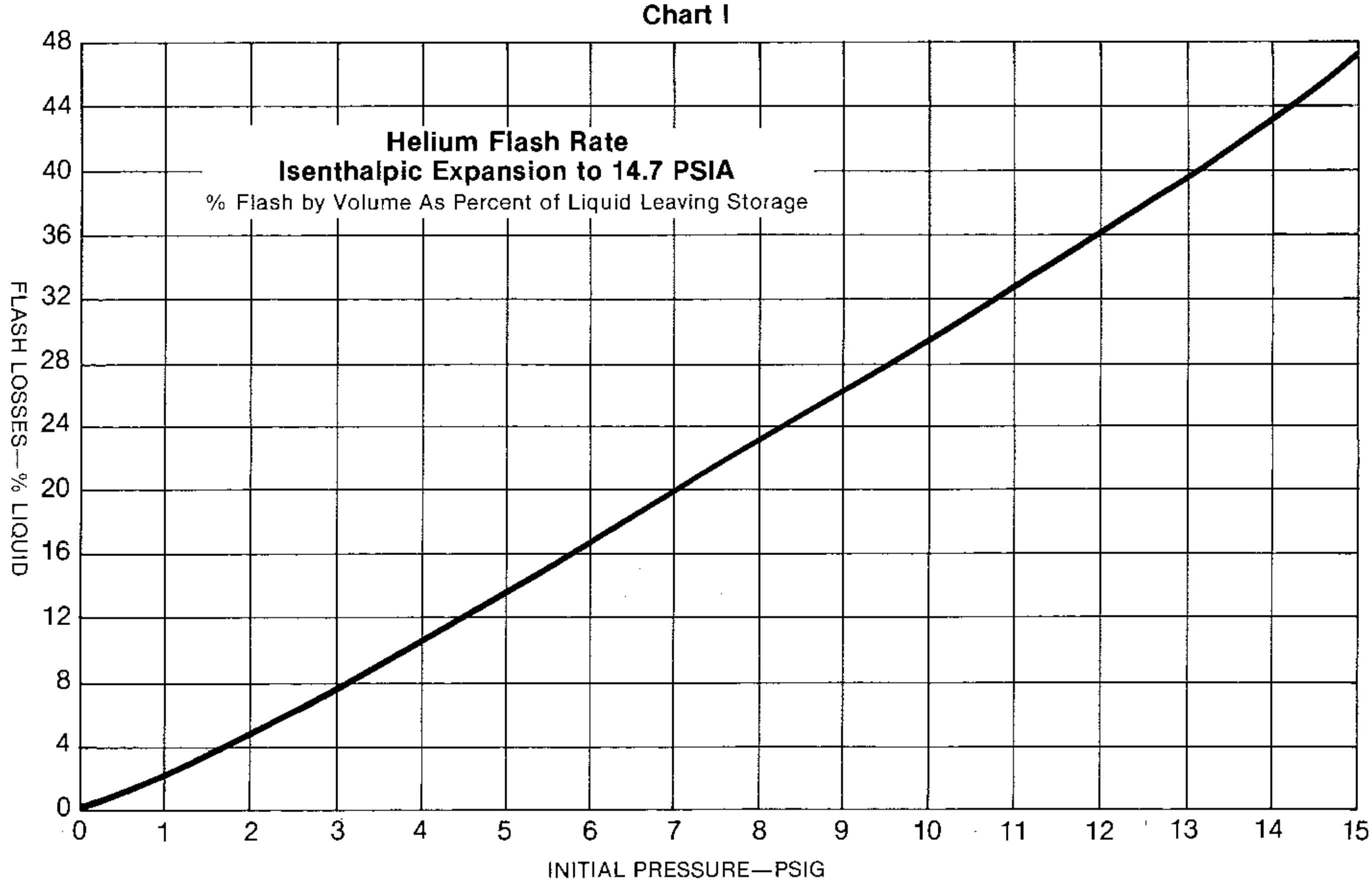
At the completion of liquid withdrawal, shut-off any external pressurization and relieve container pressure by venting through the vent valve. Then loosen the quick coupling, remove the helium transfer tube, and replace the coupling plug and close the vent valve. Store with only the relief shut-off valve open to allow venting through the relief valve rated at 0.5 PSI.

NOTE

> During liquid filling and withdrawal operations frost may appear on the neck assembly and the top head of the tank. This phenomenom is normal and is an indication that cold helium gas is passing out the relief valve or vent.

Figure 4-1. Helium Flash Rate

Chart I



Vapor Release from Depressurized Liquid Helium

In addition to liquid losses due to container and transfer tube normal heat leak, tube and receiving vessel cool down, boil-off in the container resulting from heat input of the pressurizing gas and saturated vapor equilization, there is a flash loss from the pressure drop in a transfer line and a loss from depressurizing a container after making a partial withdrawal.

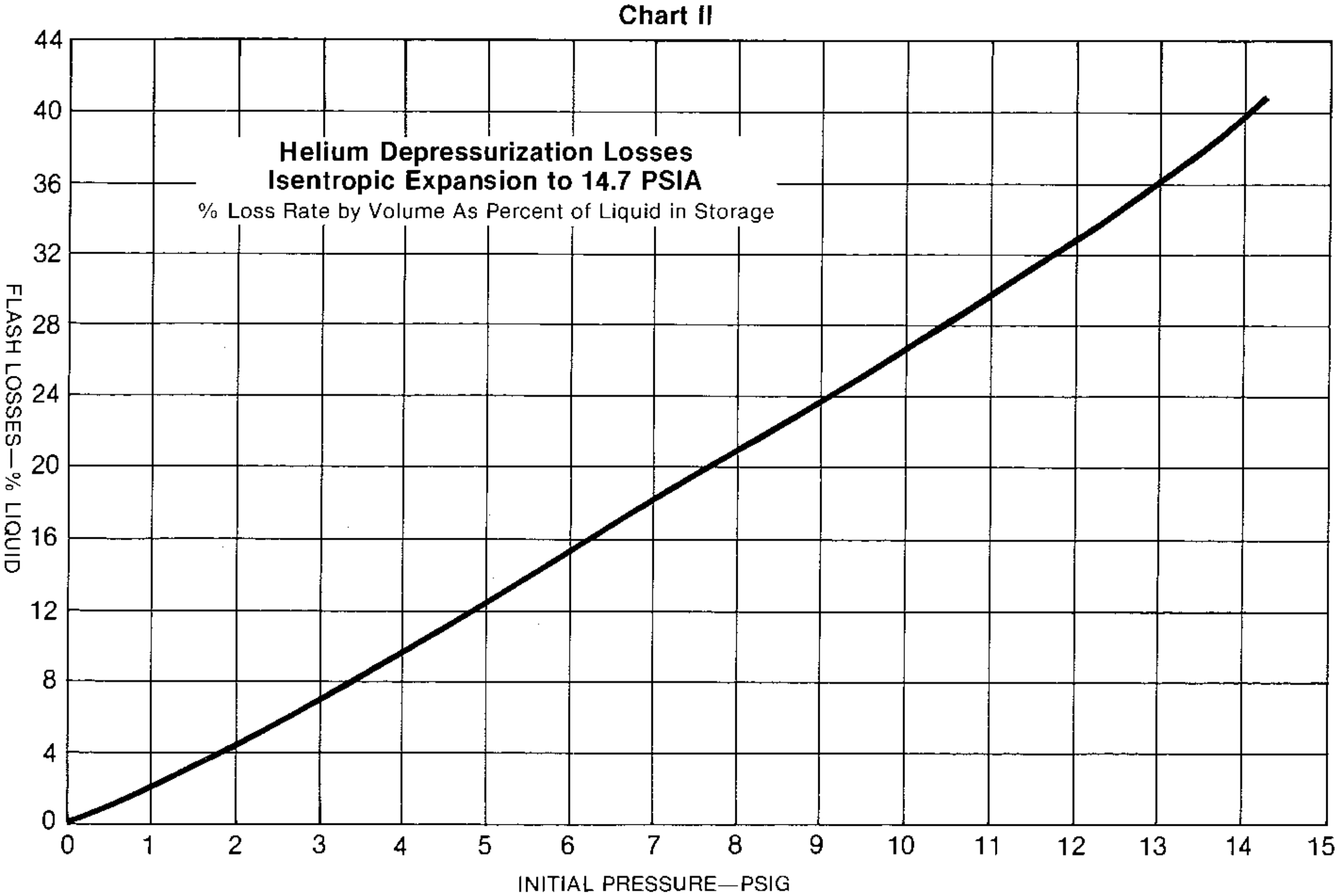
For best transfer efficiency, the withdrawal should be started and maintained with as low a pressure as practical. Too low a pressure will require a longer time to make a transfer and thus permit heat leak in the transfer system to become excessive. A balance between effects of heat leak and depressurization generally may be attained by operating in a pressure range of from 2 to 3 PSIG.

Flash loss due to pressure drop through the transfer line may be estimated by use of Figure 4-2 "Helium Flash Rate". Depressurization loss of liquid in the container may be estimated by use of Figure 4-3 "Helium Depressurization Losses."

For example: Assume a helium container is discharging at a constant pressure of 5 PSIG. From Figure 4-2 the flash loss is approximatley 13.8% of the liquid entering the transfer tube. From Figure 4-3 the loss from depressurizing the container is approximately 12.5% of the liquid remaining in the container.

Figure 4-2. Helium Depressurization Losses

Chart II



4-4. STORAGE

Maximum storage efficiency is obtained when the liquid helium is maintained at 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. 4-1).

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 ½ 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.

4-5. TRANSPORTING

This container has been structurally designed to withstand the handling conditions of commercial transportation. The all-welded design, together with the unique suspension system, provides for superior structural integrity.

Before transporting this container, make sure the gas is venting properly. The relief shut-off valve must be open and all other vent valves must be closed so that the boil-off gas is circulated between the neck tubes and vented out the relief valve.

The 0.5 PSIG relief valve is suitable for use if the container is to be handled by in-plant or commercial surface transportation. For transporation by air carriers, an absolute pressure relief valve set at 15.2 PSIA must be provided and this is available at extra cost from MVE ~~(see Section 6).~~

Swivel casters on the base allow easy movement of the container within a facility.

Special care is required when transporting or moving this container. Ropes must be run through the handles or lifting lugs to prevent relative vertical or horizontal movement. Please note that this container is designed to withstand normal commercial handling, but it must be handled with care and precautions should be taken so that it will not be exposed to more than normal loads. For example, the container should not be allowed to fall over or roll freely against the sides of a truck, etc. It is the best possible design thermodynamically and structurally....take care of it!

4-6. OPTIONAL EQUIPMENT

Liquid Level Gauge

A superconducting continuous reading liquid level gauge is available from MVE. The sensor is hung by the electrical leads and the bottom of the sensor engages in a bracket at the bottom of the container. This unit can be factory installed or can be added later. If the unit is to be installed later in the field, a special kit with installation instructions will be supplied along with the liquid level gauge.

There are two types of units available. One type is 110-220 volt 50-60 Hz operated and the other type is battery operated and comes complete with battery charger. Both units come with five-foot lead cable and mating plug. See the Appendix for level meter information.

DURA-SHIELD 30 CALIBRATION CHART

Inches from Bottom	Liters of Liquid Helium
0	0
1	1
2	3
3	5
4	7
5	10
6	12
7	15
8	17
9	20
10	22
11	25
12	27
13	29
14	31
15	32

DURA-SHIELD 60 CALIBRATION CHART

Inches from Bottom	Liters of Liquid Helium
0	0
1	1
2	4
3	7
4	11
5	14
6	19
7	23
8	27
9	31
10	35
11	39
12	43
13	47
14	52
15	55
16	59
17	62
18	65

DURA-SHIELD 100 CALIBRATION CHART

Inches from Bottom	Liters of Liquid Helium
0	0
1	1
2	5
3	9
4	14
5	20
6	26
7	32
8	39
9	45
10	51
11	57
12	63
13	69
14	76
15	82
16	88
17	94
18	99
19	103
20	107
21	108

DURA-SHIELD 250 CALIBRATION CHART

Inches from Bottom	Liters of Liquid Helium
0	0
1	2
2	6
3	12
4	20
5	30
6	41
7	52
8	64
9	75
10	87
11	98
12	110
13	122
14	133
15	145
16	156
17	168
18	180
19	191
20	203
21	214
22	226
23	236
24	245
25	253
26	259
27	263

DURA-SHIELD 500 CALIBRATION CHART

Inches from Bottom	Liters of Liquid Helium
0	0
1	2
2	7
3	15
4	26
5	39
6	54
7	70
8	87
9	104
10	122
11	140
12	157
13	175
14	192
15	210
16	228
17	245
18	263
19	280
20	298
21	316
22	333
23	351
24	369
25	386
26	404
27	421
28	439
29	456
30	472
31	487
32	499
33	510
34	518
35	524
36	525

DURA-SHIELD 1000 CALIBRATION CHART

Inches from Bottom	Liters of Liquid Helium
0.0	0
1.0	2
2.0	9
3.0	20
4.0	35
5.0	53
6.0	74
7.0	97
8.0	123
9.0	150
10.0	178
11.0	207
12.0	237
13.0	266
14.0	296
15.0	325
16.0	355
17.0	385
18.0	414
19.0	444
20.0	473
21.0	503
22.0	532
23.0	562
24.0	591
25.0	621
26.0	651
27.0	680
28.0	710
29.0	739
30.0	769
31.0	798
32.0	828
33.0	857
34.0	886
35.0	914
36.0	940
37.0	965
38.0	987
39.0	1006
40.0	1023
41.0	1036
42.0	1045
43.0	1049
43.5	1050

6-1. GENERAL

This section contains recommended spare and repair parts data for DURA-SHIELD containers. Spare parts can be obtained from your local MVE distributor or the factory. When ordering parts always specify the container name, size and the complete part number with the nomenclature identified in the parts list.

The parts list and drawings are coordinated so that an item number for a part on the parts list is the same number used to identify that part on the supporting drawing.

Figure 6-1. DURA-SHIELD 30, 60, 100

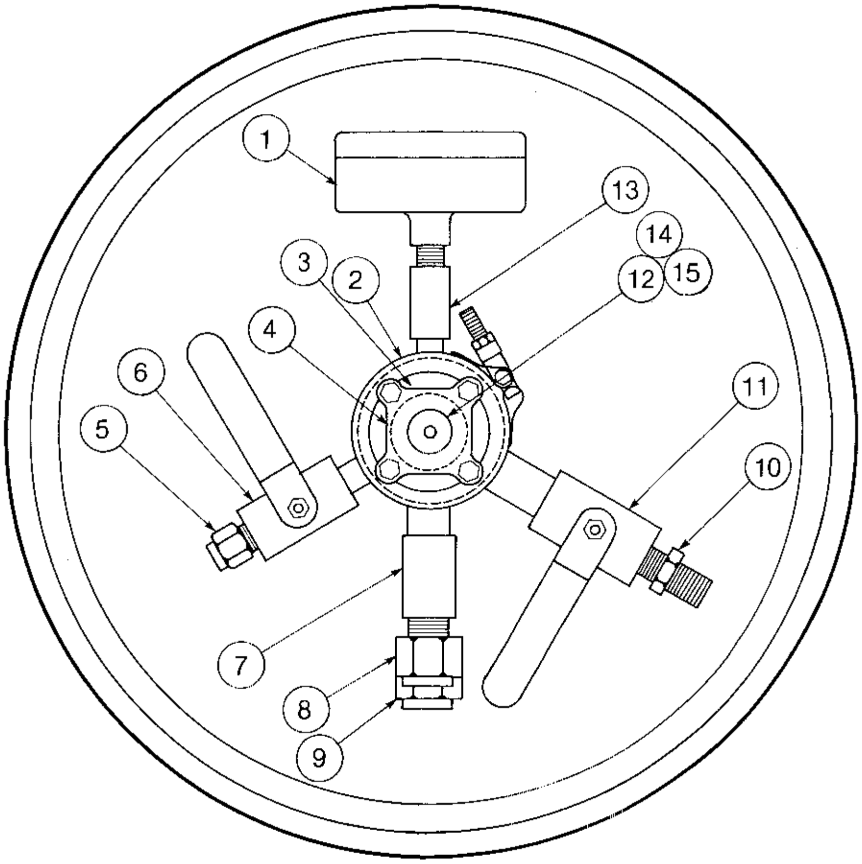


Table 6-1. DURA-SHIELD 30, 60, 100 Final Assembly Parts

Item No.	Part No.	Qty. Per Assembly	Recommended Spares Qty.	Part Name
1	20-1169-9	1	—	Pressure Gauge 4" 30" Hg - 30 PSI ¼" MPT
2	35-1475-1	1	—	V-Retainer ½" x 1½"
3	23-2012-4	1	1	O-Ring .375" ID + .500" OD Viton
4	17-1420-2	1	1	Ball Valve ½" Nominal Modified
5	18-1134-2	1	1	Relief Valve ½ PSI ¼" MPT
6	17-1114-2	1	1	Ball Valve ¼" NPT
7	12-1023-2	2	—	Coupling ½" NPT
8	18-1061-2	1	0	Relief Valve 10 PSI ½" MPT
9	18-1135-2	—	—	Relief Valve 8 PSI ½" MPT
10	13-1010-2	—	—	Nipple ½" NPT Hex 1⅞" Lg
11	17-1115-2	1	—	Ball Valve ½" NPT
12	22-1037-2	1	1 for 3	Vacuum Coupling Assembly ½" + + +
13	12-1021-2	1	—	Coupling ¼" NPT
14	22-1007-2	1	1 for 3	Vacuum Coupling Assembly ⅜"
15	22-1021-2	1	1 for 3	Vacuum Coupling Plug ⅜" OD + + +

+ + + Includes tube, nut washer, O-ring

Figure 6-2. DURA-SHIELD 250 and 500

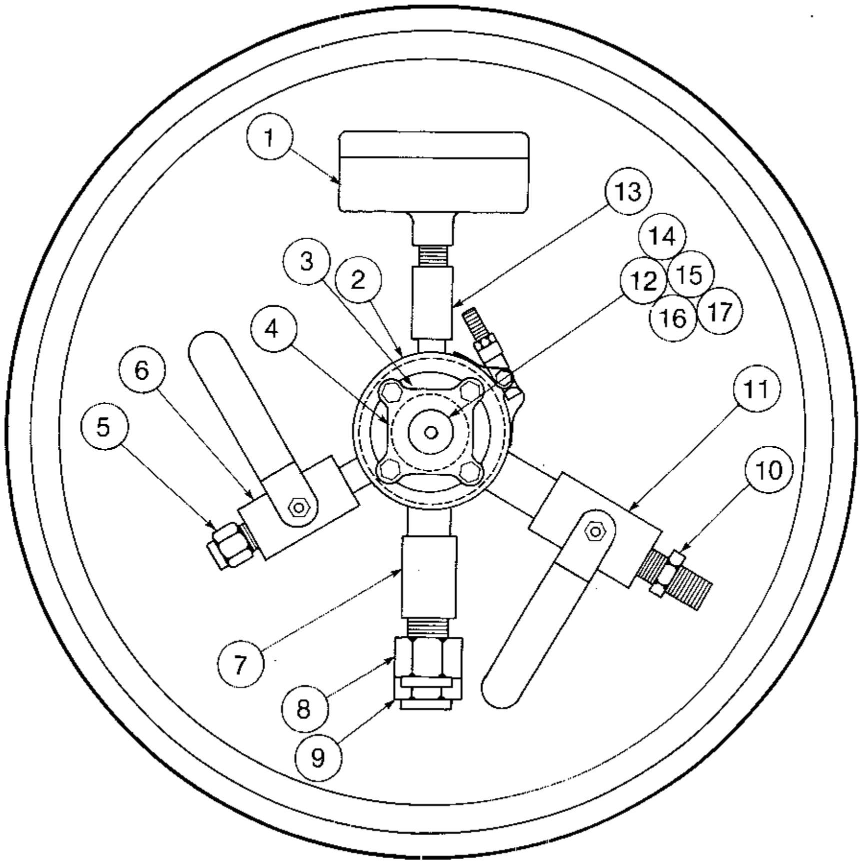


Table 6-2. DURA-SHIELD 250 and 500 Final Assembly Parts

Item No.	Part No.	Qty. Per Assembly	Recommended Spares Qty.	Part Name
1	20-1169-1	1	—	Pressure Gauge 4" 30" Hg - 30 PSI ¼" MPT
2	35-1478-1	1	—	V-Retainer 1½" × 3"
3	23-2234-1	1	1	O-Ring 3" ID × 3.25" OD
4	17-1429-2*	1*	1	Ball Valve ¾" Nominal Modified
5	18-1134-2	1	1	Relief Valve ½ PSI ¼" MPT
6	17-1114-2	1	1	Ball Valve ¼" NPT
7	12-1023-2	1	—	Coupling ½" NPT
8	18-1019-2	1	1	Relief Valve 10 PSI ¾" MPT
9	18-1062-2	1	1	Relief Valve 8 PSI ¾" NPT
10	13-1010-2	1	—	Nipple ½" NPT Hex 1⅞" Lg
11	17-1115-2	1	1	Ball Valve ½" NPT
12	22-1037-2	1	1 for 3	Vacuum Coupling Assembly ½" + + +
13	12-1021-2	1	—	Coupling ¼" NPT
14	22-1007-2	1	1 for 3	Vacuum Coupling Assembly ⅜" + + +
15	22-1021-2	1	1 for 3	Vacuum Coupling Plug
16	22-1039-2	1	1 for 3	Vacuum Coupling Assembly ⅝" + + +
17	22-1038-2	1	1 for 3	Vacuum Coupling Assembly ¾" + + +

+ + + Includes tube, nut washer, O-ring

Figure 6-3. DURA-SHIELD 1000

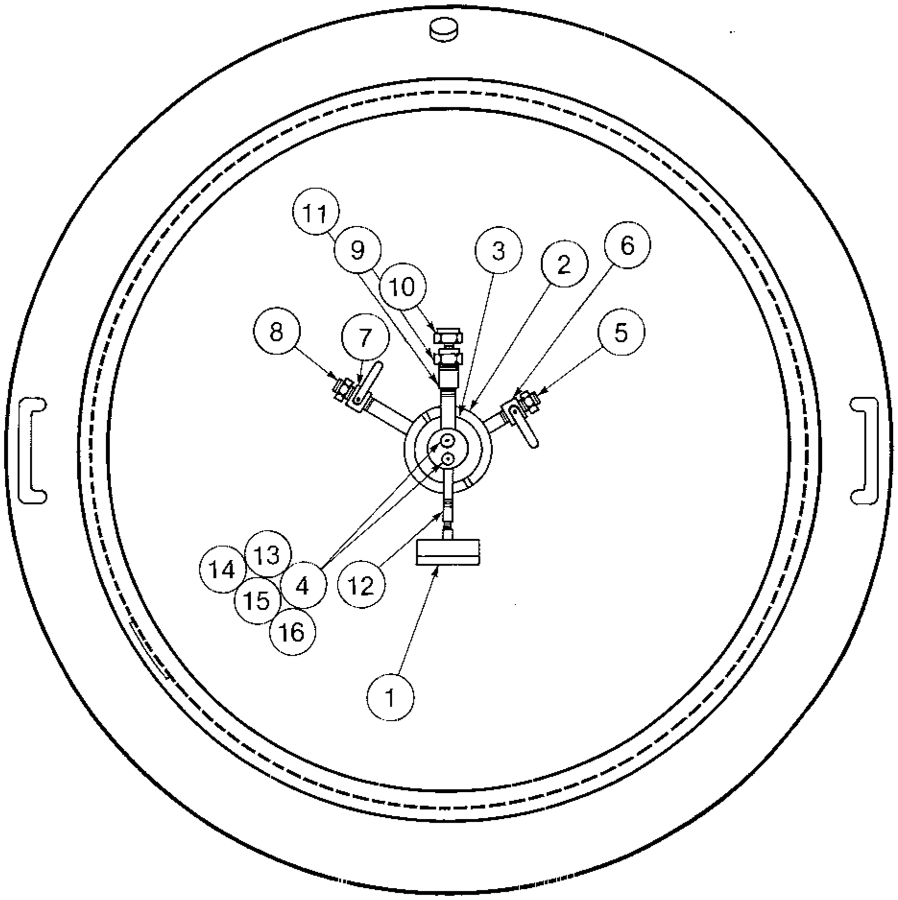


Table 6-3. DURA-SHIELD 1000 Final Assembly Parts

Item No.	Part No.	Qty. Per Assembly	Recommended Spares Qty.	Part Name
1	20-1169-1	1	—	Pressure Gauge 4" 30" Hg - 30 PSI ¼" MPT
2	35-1476-1	1	—	V-Retainer 2" × 3½"
3	23-2238-1	1	1	O-Ring 3.5" ID × 3.75" OD
4	22-1037-2	2	1 for 3	Vacuum Coupling Assembly ½" + + +
5	13-1010-2	1	—	Nipple ½" NPT Hex 1⅞" Lg
6	17-1115-2	1	1	Ball Valve ½" NPT
7	17-1114-2	1	1	Ball Valve ¼ NPT
8	18-1134-2	1	1	Relief Valve ½ PSI ¼" MPT
9	18-1062-2	1	1	Relief Valve 8 PSI ¾" MPT
10	18-1019-2	1	1	Relief Valve 10 PSI ¾" NPT
11	12-1023-2	1	—	Coupling ½" NPT
12	12-1021-2	1	—	Coupling ¼" NPT
13	22-1007-2	2	1 for 3	Vacuum Coupling Assembly ⅜" + + +
14	22-1021-2	2	1 for 3	Vacuum Coupling Plug ⅜"
15	22-1039-2	2	1 for 3	Vacuum Coupling Assembly ⅝" + + +
16	22-1038-2	2	1 for 3	Vacuum Coupling Assembly ¾" + + +

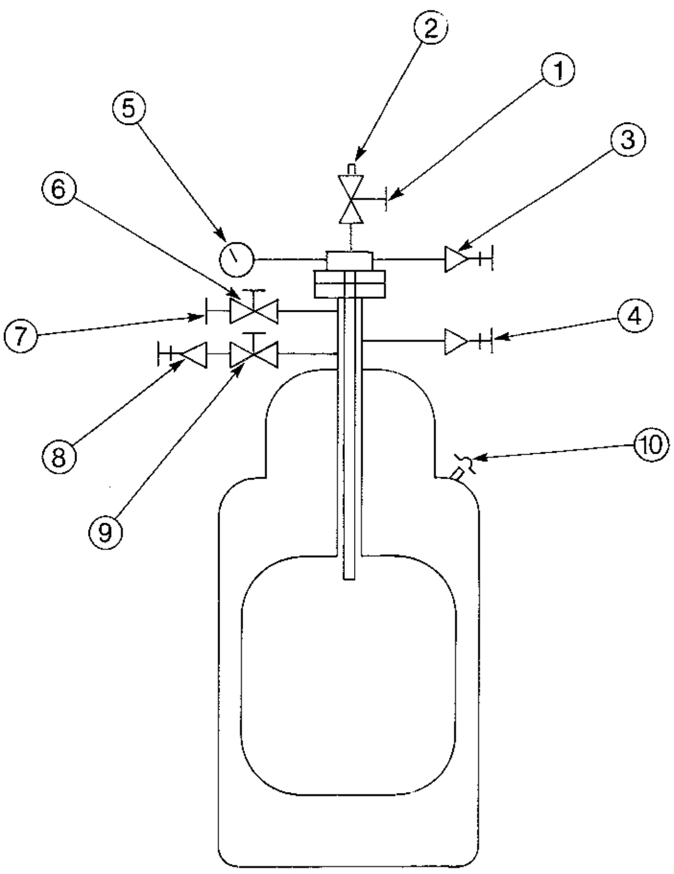
+ + + Includes tube, nut washer, O-ring

7-1. GENERAL

This section provides the operator with a detailed flow schematic of the DURA-SHIELD containers. Refer to this diagram (figure 7-1) if necessary during container troubleshooting or maintenance.

1. Liquid Withdrawal Valve
2. Quick Couplings
3. Relief Valve 10 PSI
4. Relief Valve 8 PSI
5. Pressure Gauge
6. Vent Valve
7. Vent Connection
8. Relief Valve ½ PSI
9. Isolation Valve
10. Vacuum Casing Pumpout Plug

Figure 7-1.



A-1. LIQUID HELIUM LEVEL METER

A-1-1. DESCRIPTION

The heart of all superconducting liquid helium level detection systems is the sensor which goes in the liquid helium dewar. It consists of a very fine filament of NbTi wire suspended in a rugged ¼" diameter tube. When the filament is energized with a small current the length which is below the liquid helium will be superconducting while the length above the liquid will be resistive. Thus, the resistance of the sensor varies in a linear fashion as the helium level rises and falls.

A meter is used to indicate the helium level in the container. Both 110 VAC and battery operated models are available.

A-1-2. INSTALLATION

1. For minimum losses, mount the liquid helium sensor so that warm helium gas rising from the sensor can pass directly out of the dewar without contacting surfaces at 4.2K. Do not mount the sensor in restricted areas (tubes, etc.) where the liquid level around the sensor might be depressed by pressure differences in the gas. Do not cover the holes in the sensor. The sensor may be mounted by taping or clipping it to an appropriate support structure. It must be mounted with the leads upright.
2. The liquid helium level sensor leads are color coded. Red—positive current, Black—negative current, Blue—positive voltage, Yellow—negative voltage. Connect the sensor to the four terminals at the back of the instrument being careful to match the sensor colors to those indicated on the instrument.
3. Operating the sensor in a vacuum may cause thermal damage and/or destruction of the superconducting filament sensor. Do not inadvertently turn the instrument on with the sensor in an evacuated chamber. Operation in pumped liquid helium environments is okay to 1 °K as long as liquid helium is present. Under some conditions an anomalous behavior is seen at the lambda point of helium.
4. After the sensor is properly installed and connected, operation is achieved by simply turning the power switch on. The instrument is precalibrated. The helium level is read directly from the large panel meter or by recorder from the 0-0.1 volt output terminal on the rear panel.

Consult meter manual for operation.

A-2. 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 super-insulated to provide the optimum in thermal performance.

All MVE 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.

A-2-1. STANDARD FEATURES

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

Outer jackets are likewise stainless steel capable of being evacuated to less than 10^{5} 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 is 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.

A-2-2 SPECIAL FEATURES (at extra cost):

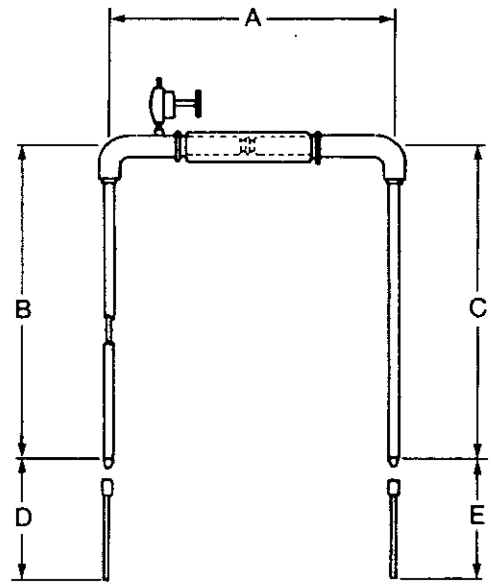
1. **Bayonet Connectors**
   Bayonet connectors can be provided for disassembly of the tube at any convenient location. These connectors can be easily assembled and disassembled in the laboratory, and do not require repumping of the insulating vacuum after each usage.
2. **Flexible Sections**
   MVE 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**
MVE can provide ¼" 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 uninsulated 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 DURA-SHIELD containers are;

DURA-SHIELD 30 .... 42"
DURA-SHIELD 60 .... 45"
DURA-SHIELD 100 .... 48½"
DURA-SHIELD 250 .... 55"
DURA-SHIELD 500 .... 65"
DURA-SHIELD 1000 .... 67¼"
Refer to Form 2052 for details.



Series II

CBM	Center Back Male
CGA	Compressed Gas Association
CO_2	Carbon Dioxide
DOT	Department of Transportation
DTL	Detail
FPT	Female Pipe Thread
MPT	Male Pipe Thread
MVE	Minnesota Valley Engineering
N_2O	Nitrous Oxide
NPT	National Pipe Thread
NR	Not Required
ODT	Outside Diameter-Tube
PKR	Parker
P/N	Part Number
PSI	Pounds per Square Inch
PSIG	Pounds per Square Inch Gauge
SCFH	Standard Cubic Feet per Hour
SCFM	Standard Cubic Feet per Minute
SS	Stainless Steel

C-1. GENERAL

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 that 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 (earthquakes, tornados, 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 MVE 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.

C-2. OXYGEN DEFICIENT ATMOSPHERES

The normal oxygen content of the air is approximately 21%. Depletion of oxygen content in air, either by combustion or by displacement by 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 or 16%, the flame of ordinary combustible materials, including those commonly used as fuel for heat or light, may be extinguished. Somewhat below this concentration, an individual breathing the air is mentally incapable of diagnosing the situation 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 atmospheres containing 12% or less oxygen leads to rapid unconsciousness. Unconsciousness can occur rapidly, rendering the user 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 an 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 the "buddy" should be equipped with self-contained or air-line breathing equipment.

C-3. NITROGEN AND ARGON

Nitrogen and argon (inert gases) are simple asphyxiants. Neither gas will support or sustain life and can produce immediate hazardous conditions through the displacement of oxygen. Under high pressure these gases may produce 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 less than 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 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 the skin or eyes, the affected area should be promptly flooded or soaked with tepid water (105-115°F; 41-46°C). **Do not use hot water.** Cryogenic burns which result in blistering or deeper tissue freezing should be examined promptly by a physician.

Additional information on nitrogen and argon gas is available in CGA Pamphlet P-9. Write to the Compressed Gas Association, Inc., New York, NY 10110.

*** Extracted from *Safety Bulletin SB-2* from the Compressed Gas Association, Inc., New York, dated March, 1966; and from the *Nitrogen Material Safety Data Sheet* published by Air Products and Chemicals, Inc., Allentown, PA 18105, dated 1 June, 1978

Minnesota Valley Engineering, Inc.

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