HORIZONTAL LIQUID DELIVERY UNITS

OPERATION AND MAINTENANCE

User Manual # 10562710

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PREFACE

This manual is intended to provide the user with adequate information necessary to operate and maintain the HLD containers. Chapter 1 provides a general introduction to the HLD containers, Chapter 2 describes all operator controls and indicators. HLD operating procedures are contained in Chapter 3. Chapter 4 describes recommended maintenance, troubleshooting, and repair procedures. Chapter 5 contain HLD recommended spare/repair parts lists and schematic diagrams, respectively. Chapter 6 contains Appendix A applicable oxygen and inert gases (nitrogen and argon safety bulletins. Appendix B provides related DOT instructions.

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SAFETY SUMMARY SHEET

Horizontal Liquid Delivery (HLD) cryogenic containers consist of a stainless steel inner container encased within an outer carbon steel vacuum shell. The HLD operates under medium pressure, but is protected from overpressurization by use of rupture discs and relief valves. HLD's are designed and engineered for safe, reliable operations, and are durable enough to provide many years of trouble-free operation. While every possible safety feature has been designed into the units and safe operations are anticipated, it is essential that the user of the HLD carefully read all WARNING and CAUTION notes listed and enumerated in this safety summary sheet. Also read the information provided in the safety bulletins for oxygen and inert gases located in Chapter 6, Appendix A of this manual. Periodic review of the safety summary is recommended.

WARNING

Excess accumulation of oxygen creates an oxygen enriched atmosphere (defined by the Compressed Gas Association as an oxygen concentration above 23%). Certain items considered non-combustible in air may burn rapidly in such an environment. Keep all organic materials and other flammable substances away from possible contact with oxygen; particularly oil, grease, kerosene, cloth, wood, paint, tar, coal, dust, and dirt which may contain oil or grease. Do not permit smoking or open flame in any area where oxygen is stored, handled, or used. Failure to comply with this warning may result in serious personal injury.

WARNING

Nitrogen and argon vapors in air may dilute the concentration of oxygen necessary to support or sustain life. Exposure to such an oxygen deficient atmosphere can lead to unconsciousness and serious injury, including death.

WARNING

Before removing HLD parts or loosening fittings, empty a cryogenic container of liquid contents and release any vapor pressure in a safe manner. 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 high pressure in a HLD.

WARNING

Accidental contact of liquid gases with skin or eyes may cause a freezing injury similar to a burn. Handle liquid so that it will not splash or spill. Protect your eyes and cover skin where the possibility of contact with liquid, cold pipes and cold equipment, or cold gas exists. Safety goggles or a face shield should be worn if liquid ejection or splashing may occur or cold gas may issue forcefully from equipment. Clean, insulated gloves that can easily be removed and long sleeves are recommended for arm protection. Cuffless trousers should be worn over the shoes to shed spilled liquid. If clothing should be splashed with liquid oxygen it will become highly flammable and easily ignited while concentrated oxygen remains. Such clothing must be aired out immediately, removing the clothing if possible, and should not be considered safe for at least 30 minutes.

CAUTION

Use only replacement parts that are compatible with liquid oxygen and have been cleaned for oxygen use. Do not use regulators, fittings, hoses, etc., which have been previously used in a compressed air environment. Similarly, do not use oxygen equipment for compressed air. Failure to comply with these instructions may result in serious damage to the container.

CAUTION

Many materials, especially some non-metallic gaskets and seals, constitute a combustion hazard when in oxygen service, although they may be acceptable for use with other cryogenic liquids. Make no substitutions for recommended spare parts. Also, be sure all replacement parts are thoroughly **cleaned for oxygen service**.

CAUTION

Before locating oxygen equipment, become familiar with the National Fire Protection Association (NFPA) standard No. 50, "Bulk Oxygen Systems at Customer Sites", and with all local safety codes. The NFPA standard covers general principles recommended for installing bulk oxygen systems on industrial and institutional consumer premises.

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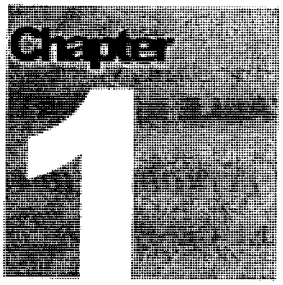


1 INTRODUCTION

1.1 GENERAL

The CHART Horizontal Liquid Delivery (HLD) units are vacuum and multi-layered, insulated, lightweight cryogenic containers for transporting liquid oxygen, nitrogen or argon. The units serve as a means of distribution for liquid products into customer stations.

The HLD-500G, HLD-800G and HLD-1530N models designations indicate that the units are Horizontal Liquid Delivery cryogenic containers intended for liquid delivery. The number following the HLD indicates its nominal holding capacity. HLD's provide a reliable, convenient, and economical method for the distribution of the liquid argon, nitrogen or oxygen to customer stations.

1.2 DESCRIPTION

The CHART HLD cryogenic containers are designed to store, transport and dispense liquefied gases under pressure in the range of zero (0) to approximately 250 psi. Depending upon customer preference, the HLD may be used solely for the transportation of liquid gas products or stationed as a permanent liquid withdrawal station.

The HLD's are designed with a stainless steel inner container encased within an outer carbon steel vacuum shell. The highly efficient insulating system consists of multiple layer insulation and high vacuum to ensure long holding time. The insulating system is designed for long-term vacuum retention and is permanently sealed at the factory.

To protect the inner container from overpressurization, the HLD's are equipped with a relief valve set at 250 PSI. As a secondary pressure relief device, the container is further protected from overpressurization by a 400 PSIG bursting disc. In addition, the HLD's are constructed with an all stainless internal system designed to ensure suitable durability. The vacuum space is protected from overpressurization by the use of a pressure relief device that meets the requirements of CGA Pamphlet S-1.3, Pressure Relief Device Standards - Part 1 - Cylinders For Compressed Gases.

The HLD's have a built-in pressurizing system to develop and maintain pressure for liquid withdrawal. Liquid flows through the bottom withdrawal line into the customer station. Liquid also passes through another line into the heat exchanger (PBC), is vaporized, and the gas is returned to the vapor space above the liquid in the supply unit. The pressure

building system continues in operation until it is shut off. No pumps or electrical hook-ups are required for pressurized liquid transfer.

The CHART HLD's are completely self-contained, super insulated, lightweight and skid or chassis mounted for ready installation on nearly any truck body of proper weight capacity. No special truck equipment is necessary. All controls and the instrumentation for safe operation is mounted on the front of the tank and enclosed in a cabinet. Doors, which are factory installed, are mounted on the cabinet. The outer tank is supported on legs connected to skids. Lifting lugs are fitted to the outer tank to facilitate handling.

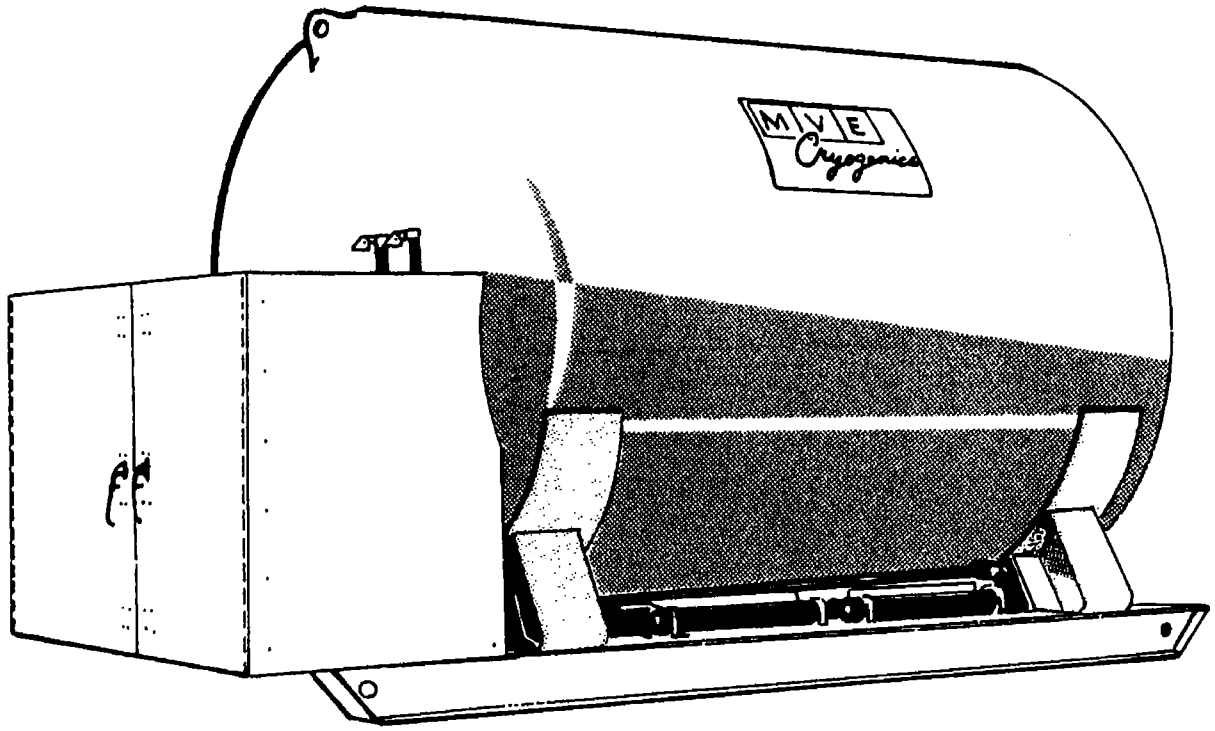


Figure 1-1. Horizontal Liquid Delivery Unit

1.3 FEATURES

The CHART HLD cryogenic containers are designed to furnish a convenient, reliable, and economical method for the transportation and delivery of liquid oxygen, nitrogen and argon. Important features include:

- Large storage capacity, decreasing refill trips, and ensuring a ready liquid supply.
- Gas stored in liquid form, decreasing contamination possibilities over gas stored in conventional containers.

- Long-term hold time due to highly efficient insulating systems.
- An integral pressure building system.
- Simple and convenient piping controls.
- Transverse baffle system to reduce sloshing during travel.

1.4 CONFIGURATION AND SPECIFICATIONS

The HLD cryogenic containers are constructed with all operating controls situated at the front for ease in liquid dispensing operations. In stand alone, operating environments, the container enables the user, through use of the vent, liquid, pressure building, and pressure relief devices, to completely control container operation.

A complete listing of individual HLD container specifications is provided in Table 1-1 and 1-2. The liquid level gauge, a differential gauge, indicates the amount of liquid remaining in a tank by comparing the hydrostatic head of liquid between the top and bottom of the tank.

NOTE

The liquid level charts were compiled using the density of each liquid at zero (0) atmospheric pressure. These charts should only be used to approximate the amount of liquid in the vessel and should not be used as an accurate measure of liquid delivery.

1.5 OPERATOR

The HLD's are designed for safe and simple operation. The operator is expected to be knowledgeable as to the nature of the gases with which he is working, as well as all applicable safety requirements. HLD operating instructions can be found in Chapter 3 and maintenance procedures in Chapter 4. To fully understand these procedures we recommend the operator first familiarize himself with the HLD controls and indicators described in Chapter 2.

NOTE

Weights and gas capacities are based on DOT maximum filling capacities when operated at or below 55 PSIG as specified in DOT-E-6299.

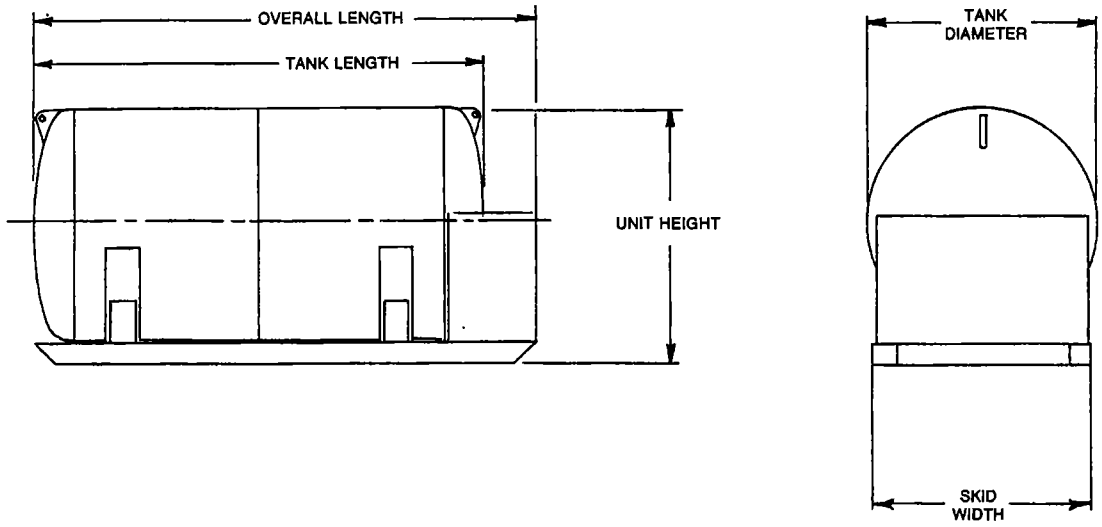


Figure 1-2. Outline Drawing Skid Mounted Liquid Delivery Units

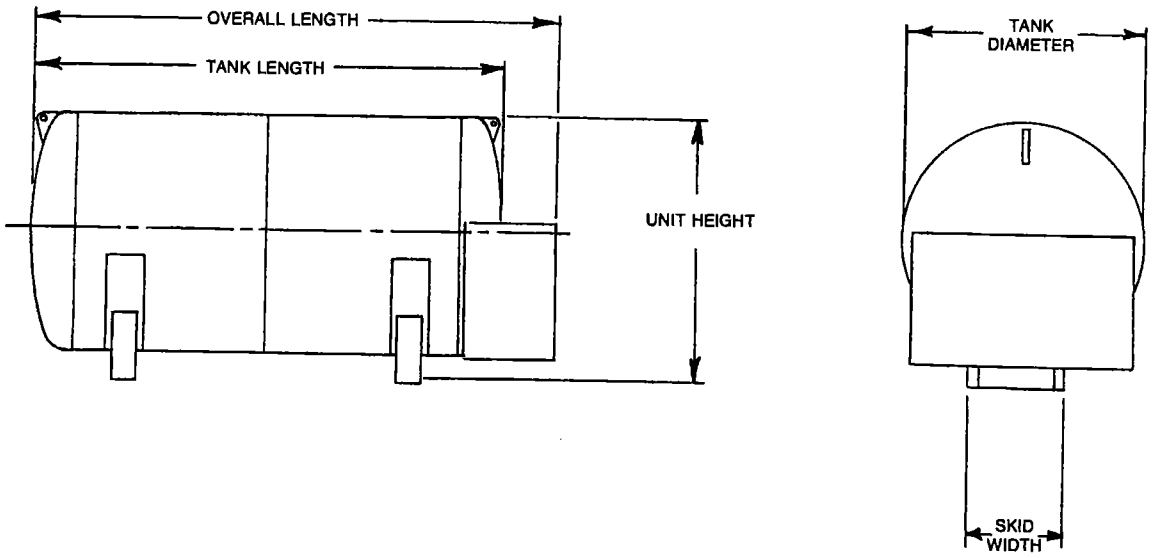


Figure 1-3. Outline Drawing Chassis Mounting Liquid Delivery Units

Table 1-1. HLD Skid Mounted Transport Physical Characteristics & Specifications

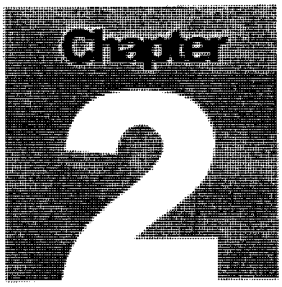
		HLD-500	HLD-800	HLD-1200	HLD-1530N	HLD-2072S	HLD-3084S
GROSS CAP.	GAL.	550	880	1333	1530	2276	3300
	Liters	2082	3331	5045	5791	8615	12491
NET CAP.	Gal.	500	800	1200	1377	2072	3000
	Liters	1893	3028	4542	5213	7843	11355
TANK LENGTH	IN	70	99	119	135	186	190
	CM	178	252	302	343	471	483
OVERALL LENGTH	IN	90	119	138	149	205	209
	CM	227	301	351	378	522	531
TANK DIAMETER	IN	66	66	72	72	72	84
	CM	168	168	183	183	183	213
UNIT HEIGHT	IN	73	73	82	82	76	92
	CM	185	185	208	208	193	233
SKID WIDTH	IN	60	60	64	64	66	80
	CM	152	152	163	163	168	203
EMPTY WEIGHT	LBS	3600	5500	5910	7000	9752	18000
	KG	1633	2494	2680	3175	4423	7483
FULL WEIGHT - N2	LBS	6853	10704	13793	16048	23212	36016
	KG	3162	4941	6351	7151	10761	16660
FULL WEIGHT - O2	LBS	8273	12977	17235	19999	29089	44537
	KG	3793	5951	7865	8791	13375	20445
FULL WEIGHT - AR	LBS	9327	14662	19789	22930	33449	50859
	KG	4270	6714	9010	10031	15351	23306
GAS CAP. - N2	SCF	44897	71835	108813	124894	185791	269380
	CU. M	1318	2110	3164	3428	5464	7911
GAS CAP - O2	SCF	56429	90287	136764	156976	233515	338576
	CU. M	1630	2608	3912	4238	6754	9779
GAS CAP - AR	SCF	55381	88610	134224	154061	229178	332288
	CU. M	1593	2549	3823	4142	6601	9558
MAWP	PSIG	250	250	250	250	250	250
	BARS	17.2	17.2	17.2	17.2	17.2	17.2
RELEIF VALVE	PSIG	250	250	250	250	250	250
	BARS	17.2	17.2	17.2	17.2	17.2	17.2
ROAD RELIEF	PSIG	55	55	55	55	55	55
	BARS	3.8	3.8	3.8	3.8	3.8	3.8
RUPTURE DISC	PSIG	350	350	350	350	350	350
	BARS	24.1	24.1	24.1	24.1	24.1	24.1
NER (%/DAY - LOX)		1.0	0.8	0.6	0.6	0.6	0.6
* PRESSURE BUILDER CAP. (GPM NITROGEN)		7 GPM	14 GPM	21 GPM	21 GPM	28 GPM	35 GPM

* This valve represents the withdrawal rate of nitrogen that the pressure builder can support with no loss of pressure based on HLD pressure of 150 psig and ambient temperature of 70^{0}F. Actual withdrawal rates may differ substantially with different HLD pressure, receiver conditions, etc.

Table 1-2. HLD Chassis Mounting Transports Physical Characteristics & Specifications

		HLD-1200T	HLD-1530N	HLD-2072T	HLD-3084T
GROSS CAP.	GAL.	1333	1530	2276	3300
	Liters	5045	5791	8615	12491
NET CAP.	Gal.	1200	1377	2072	3000
	Liters	4542	5213	7843	11355
TANK LENGTH	IN	119	135	186	192
	CM	302	343	471	488
OVERALL LENGTH	IN	138	149	205	230
	CM	351	378	522	584
TANK DIAMETER	IN	72	72	72	84
	CM	183	183	183	213
OVERALL HEIGHT	IN	82	82	76	92
	CM	208	208	193	233
PAD WIDTH	IN	34	34	34	38
	CM	86	86	86	97
EMPTY WEIGHT	LBS	5910	7000	9752	16500
	KG	2680	3175	4423	8463
FULL WEIGHT - N2	LBS	13793	16048	23212	37516
	KG	6351	7151	10761	17340
FULL WEIGHT - O2	LBS	17235	19999	29089	46037
	KG	7865	8791	13375	21125
FULL WEIGHT - AR	LBS	19789	22930	33449	52359
	KG	9010	10031	15351	23986
GAS CAP. - N2	SCF	108813	124894	185791	269380
	CU. M	3164	3428	5464	7911
GAS CAP - O2	SCF	136764	156976	233515	338576
	CU. M	3912	4238	6754	9779
GAS CAP - AR	SCF	134224	154061	229178	332288
	CU. M	3823	4142	6601	9558
MAWP	PSIG	250	250	250	250
	BARS	17.2	17.2	17.2	17.2
RELEIF VALVE	PSIG	250	250	250	250
	BARS	17.2	17.2	17.2	17.2
ROAD RELIEF	PSIG	55	55	55	55
	BARS	3.8	3.8	3.8	3.8
RUPTURE DISC	PSIG	350	350	350	350
	BARS	24.1	24.1	24.1	24.1
NER (%/DAY - LOX)		0.6	0.6	0.6	0.6
* PRESSURE BUILDER CAP. (GPM NITROGEN)		21 GPM	21 GPM	28 GPM	35 GPM

* This valve represents the withdrawal rate of nitrogen that the pressure builder can support with no loss of pressure based on HLD pressure of 150 psig and ambient temperature of 70^{0}F. Actual withdrawal rates may differ substantially with different HLD pressure, receiver conditions, etc.



2 OPERATOR CONTROLS AND INDICATORS

2.1 GENERAL

HLD cryogenic container operating procedures specify that the operator be familiar with the controls and indicators mounted under the customer station and the pressure gauge and liquid level gauge mounted on the instrumentation panel. All HLD controls and indicators are illustrated on the flow diagrams (Figures 2-1 and 2-2) and are functionally described in Tables 2-1 and 2-2. While system piping and hardware layout can vary from model to model, the pictorial representation provided in Figures 2-1 and 2-2 are typical for CHART HLD cryogenic containers. Components functions are provided in this section. Refer to Figure 2-1.

Table 2-1. Component Description HLD-500, HLD-800, HLD-1200 and HLD-2072

ITEM	VALVE	DESCRIPTION
		NOTE **Manually actuated valve positions indicated below are for normal delivery unit operation during liquid delivery**
V-1	Bottom Fill Valve	Used to transfer liquid into the delivery unit for filling. Normally closed.
V-2	Top Fill Valve	Used to transfer liquid into the top of the delivery unit, thus preventing excess pressure buildup when filling the unit partially full and pressurized. Normally closed.
V-3	Pressure Building Valve	Used to control flow into PB system. Open as required to maintain tank pressure.
V-4	Vent Valve	Used to vent pressure from the inner tank vapor space. Normally closed.
V-6	Full Trycock	Used to determine when the delivery unit is full during fill operation. Liquid will spit from the trycock when the unit is full. Normally closed.
V-7	High Pressure Valve	Used to control pressure from the bottom of the delivery unit to the liquid level gauge. Normally open.
V-8	Low Pressure Valve	Controls pressure from the top of the delivery unit to the liquid level gauge . Normally open.
V-9	Balance Valve	Used to check the calibration of the liquid level gauge. Normally closed.
V-10	Evacuation Valve	Used to pump the vacuum for the insulating space. Always closed.
V-11	Vacuum Probe Valve (Optional)	Used to isolate vacuum probe from vacuum space. Always closed.
V-12	Flow Meter Inlet Valve	Used to control liquid flow through the meter before going on through the customer connection. Normally open
V-13	Liquid Delivery Valve	Used to control the liquid flow meter, and to control the flow rate going to the customer connection. Normally open.
V-14	Meter By-Pass Valve	Used to deliver liquid to the customer connection by by-passing the meter loop. Normally closed.

ITEM	VALVE	DESCRIPTION
V-15	Meter Cool Down Valve	Used to cool down the meter prior to delivery to the customer. The meter must be cooled down prior to liquid transfer to indicate the correct quantity of liquid delivered and to prevent damage to the meter. Normally closed.
V-17	Drain Valve	Used to relieve trapped liquid and gas between the fill connection and V-1 and/or V-2. Normally closed.
V-18	Isolation Valve (HLD 500, HLD 800)	Used to isolate road relief from inner tank when vessel is not being transported.
V-19	Isolation Valve (HLD 1200, HLD 2072)	Used to isolate road relief from inner tank when vessel is not being transported.
CV-1	Fill Check Valve	Used to prevent liquid spill if hose is disconnected before fill valve is closed.
CV-2	Liquid Check Valve	Used to prevent liquid back flow to the vessel from the customer connection.
PG-1	Tank Pressure gauge	Shows inner vessel vapor pressure.
LL-1	Liquid Level Gauge	Shows the quantity of liquid in the delivery unit in inches of water. A conversion chart is provided to convert the readings to gallons of oxygen, nitrogen or argon.
S-1	Strainer	Used to prevent foreign particles from damaging the flow meter.
FM-1	Flow Meter	Used to record the amount of product delivered to the customer.
PBC	pressure Building Coil	Used to convert liquid into vapor and return it to the vapor space to maintain pressure during delivery.
RV-1	Tank Relief Valve	Automatically relieves inner tank pressure if it reaches 250 PSI level.
RV-2	Road Relief Valve	Automatically relieves inner tank pressure at 55 PSIG.
RV-3	Top Fill Line Relief Valve	Automatically relieves line pressure when it exceeds 350 PSI.
RV-4	Meter Relief Valve	Automatically relieves pressure in the flow meter or adjacent lines when it exceeds 350 PSI.
VP-1	Vacuum Probe (Optional)	Used to measure vacuum level.
BD-1	Tank Burst Disc	Ruptures completely to relieve inner tank pressure In the event the pressure reaches 400 PSI level.
C-1	Fill Connection	Provides a service connection for filling the vessel and liquid delivery.
SH-1	Safety Head	Protects vacuum casing from over-pressurization in case of vacuum loss.
GU-1	Gas Use Line	Provides for conversion to delivery unit to customer station. Normally capped.
PC-1	Pump Connection	Provides a port for liquid suction to high pressure pump for filling of high pressure gas bottles. Normally plugged.

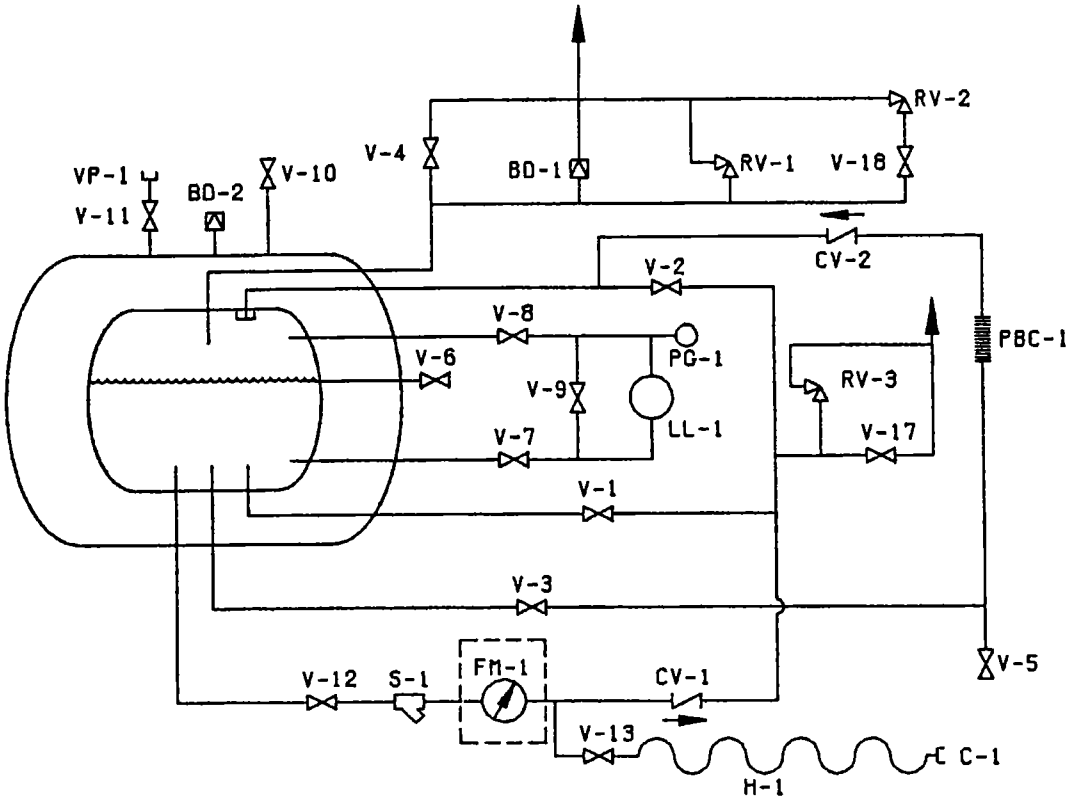


Figure 2-1. Flow Diagram HLD 500, 800, 1200, and 2072

System Nomenclature

V-1	Valve, Bottom Fill	V-14	Valve, Meter Bypass	R-1	Regulator, Economizer (Optional)
V-2	Valve, Top Fill	V-15	Valve, Meter Cooldown	R-2	Regulator, Pressure Building (Optional)
V-3	Valve, Press. Building	V-17	Valve, Drain	RV-1	Relief Valve, Tank, 250 PSI
V-4	Valve, Vent	V-18	Valve, Relief, Isolation	RV-2	Road Relief Valve, 55 PSI Over Road
V-6	Valve, Full Trycock	V-19	Valve, Gas Use (Optional)	RV-3	Relief Valve, Fill Line, 350 PSI
V-7	Valve, High Pressure	CV-1	Check Valve, Fill	RV-4	Relief Valve, Meter, 350 PSI
V-8	Valve, Low Pressure	CV-2	Check Valve, Liquid	VP-1	Vacuum Probe
V-9	Valve, Gauge Balance	PG-1	Pressure Gauge, Tank	BD-1	Burst Disc, Tank, 400 PSI
V-10	Valve, Evacuation	LL-1	Liquid Level Gauge	C-1	Connection, Fill & Delivery
V-11	Vacuum Probe Valve	S-1	Strainer	SH-1	Safety Head, Tank Annulus
V-12	Valve, Meter Inlet	FM-1	Flow Meter (Optional)	GU-1	Gas Use, Capped
V-13	Valve, Liquid Delivery	PBC	Pressure Building Coil	PC-1	Pump Connection

Table 2-2. Component Description HLD 1530

ITEM	VALVE	DESCRIPTION
V-1	Top Fill and Meter Cooldown Valve	A dual function valve that is: (1) used to transfer liquid into the top of the delivery unit, thus preventing excess pressure buildup when filling the unit partially full. (2) used to cool down the flow meter prior to delivering gas to the customer. The flow meter must be cooled down prior to liquid transfer to indicate the correct quantity of liquid delivered and prevent damage to the meter. Normally closed.
V-2	Bottom Fill Valve	Used to transfer liquid into the bottom of the delivery unit for filling. Normally closed.
V-3	Vent Valve	Used to vent pressure from the inner tank vapor space. Normally closed.
V-4	Liquid Delivery Valve	Used to control the liquid flow meter and to control the flow rate going to the customer connection. Normally open.
V-5	Pressure Building Valve	Used to control flow in the pressure building system. Open as required to maintain tank pressure.
V-6	Tank Drain and Product Sample Valve	Used to relieve trapped liquid and gas and to obtain product samples. Normally closed.
V-7	Hose Drain Valve	Used to relieve trapped liquid and gas between the fill connection and V-1 and/or V-2. Normally closed.
V-8	Full Trycock Valve	Used to determine when the delivery unit is full during fill operation. Liquid will issue from the trycock when the unit is full. Normally closed.
V-9	Liquid Phase Shut-Off Valve	Used to control pressure from the bottom of the delivery unit to the liquid level gauge. Normally open.
V-10	Gas Phase Shut-Off Valve	Used to control pressure from the top of the delivery unit to the liquid level gauge . Normally open.
V-11	Gauge Balance Valve	Used to check the calibration of the liquid level gauge. Normally closed.
V-12	Road Relief Shut-Off Valve	Used to isolate road relief after 250 PSIG fill density is reached.
V-13	Annulus Evacuation Valve	Used to control flow between the vacuum annulus and the vacuum pump flange. Normally closed.
CV-1	Fill Check Valve	Used to prevent liquid spill if hose is disconnected before fill valve is closed.
CV-2	Pressure Building Check Valve	used to prevent vent loss in case of a break in the pressure building line or coil.
S-1	Strainer	Used to prevent foreign particles from damaging the flow meter or entering customer station.
H-1	Hose	Used for liquid transfer into and out of HLD. 15 feet long.
PBC	Pressure Building Coil	Used to convert liquid into vapor and return it to the vapor space to maintain pressure during delivery.
C-1	Connection, Fill and Withdrawal	Provides a service connection for filling the vessel and liquid delivery.
M-1	Flow Meter	Used to record the number of gallons of liquid delivered to the customer.
RV-1	Tank Relief Valve	Automatically relieves inner tank pressure if it reaches 250 PSI level.
RV-2	Road Relief Valve	Automatically relieves inner tank pressure at 55 PSIG.
RV-3	Line Relief Valve	Automatically relieves line pressure when it exceeds 350 PSI.
BD-1	Tank Burst Disc	Ruptures completely to relieve inner tank pressure In the event RV-1 fails and pressure reaches 375 PSI level.
BD-2	Vacuum Burst Disc	Protects vacuum casing from over-pressurization in case of vacuum loss.
LL-1	Liquid Level Gauge	Shows the quantity of liquid in the HLD in inches of water. A conversion chart is provided to convert the readings to gallons of oxygen, nitrogen or argon.
PG-1	Tank Pressure Gauge	Shows inner vessel vapor pressure.

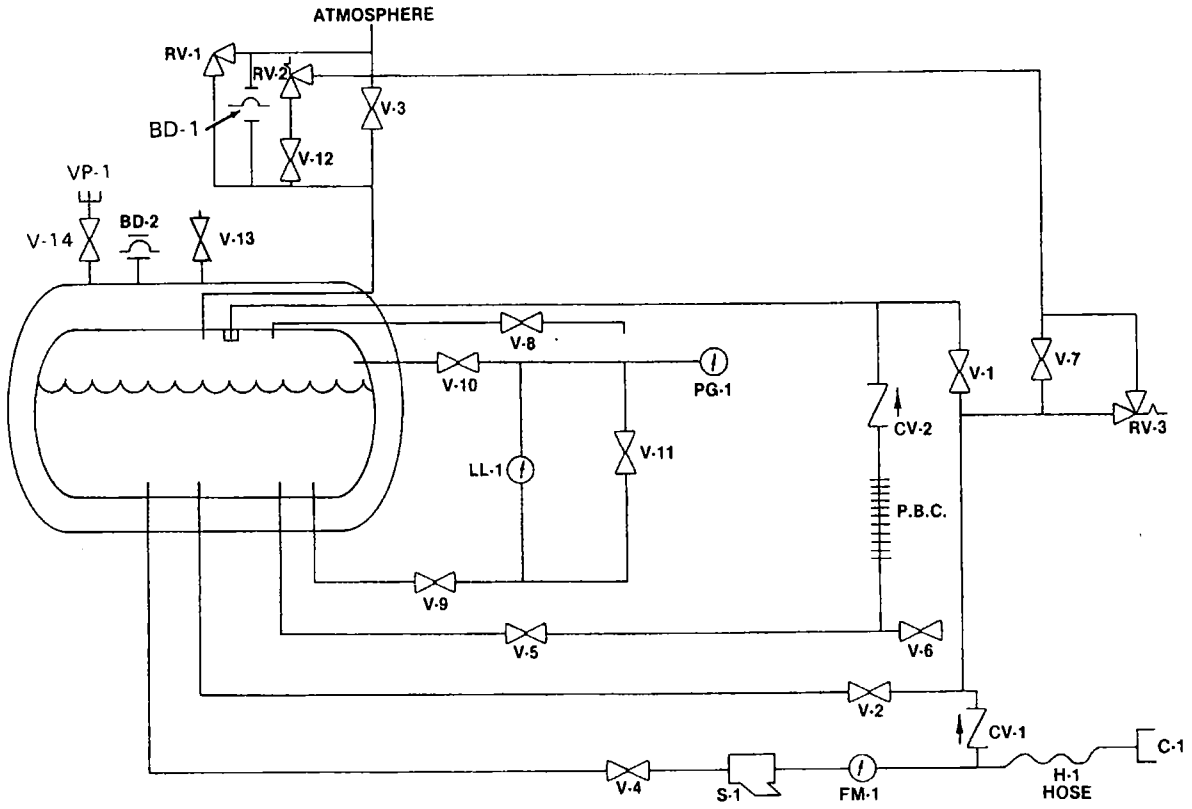


Figure 2-2. Flow Diagram HLD 1530

V-1	Top Fill and Meter Cooldown	CV-2	Pressure Building Check Valve
V-2	Bottom Fill	S-1	Strainer
V-3	Vent Valve	H-1	Hose, 15 Feet
V-4	Liquid Delivery	PBC	Pressure Building Coil
V-5	Pressure Building	C-1	Connection, Fill and Withdrawal
V-6	Tank Drain and Product Sample	M-1	Meter, Flow
V-7	Hose Drain	RV-1	Tank Relief , 250 PSI
V-8	Full Trycock	RV-2	Road Relief, 55 PSI
V-9	Liquid Phase Shut-Off	RV-3	Line Relief, 350 PSI
V-10	Gas Phase Shut-Off	BD-1	Tank Burst Disc, 375 PSI
V-11	Gauge Balance	BD-2	Vacuum Burst Disc, 2.5 Inches
V-12	Road Relief Shut-Off	LL-1	Liquid Level Gauge
V-13	Annulus Evacuation	PG-1	Tank Pressure Gauge
V-14	Vacuum Probe Valve (Optional)	VP-1	Vacuum Probe (Optional)
CV-1	Fill Check Valve		

Table 2-3. Component Description HLD 3084T

ITEM	VALVE	DESCRIPTION
V-1	Top Fill and Meter Cooldown Valve	A dual function valve that is: (1) used to transfer liquid into the top of the delivery unit, thus preventing excess pressure buildup when filling the unit partially full. (2) used to cool down the flow meter prior to delivering gas to the customer. The flow meter must be cooled down prior to liquid transfer to indicate the correct quantity of liquid delivered and prevent damage to the meter. Normally closed.
V-2	Bottom Fill Valve	Used to transfer liquid into the bottom of the delivery unit for filling. Normally closed.
V-3	Vent Valve	Used to vent pressure from the inner tank vapor space. Normally closed.
V-4	Liquid Delivery Valve	Used to control the liquid flow meter and to control the flow rate going to the customer connection. Normally open.
V-5	Pressure Building Valve	Used to control flow in the pressure building system. Open as required to maintain tank pressure.
V-6	Hose Drain Valve	Used to relieve trapped liquid and gas between the fill connection and V-1 and/or V-2. Normally closed.
V-7	Full Trycock Valve	Used to determine when the delivery unit is full during fill operation. Liquid will issue from the trycock when the unit is full. Normally closed.
V-8	Liquid Phase Shut-Off Valve	Used to control pressure from the bottom of the delivery unit to the liquid level gauge. Normally open.
V-9	Gas Phase Shut-Off Valve	Used to control pressure from the top of the delivery unit to the liquid level gauge . Normally open.
V-10	Gauge Balance Valve	Used to check the calibration of the liquid level gauge. Normally closed.
V-11	Road Relief Shut-Off Valve	Used to isolate road relief after 250 PSIG fill density is reached.
V-12	Annulus Evacuation Valve	Used to control flow between the vacuum annulus and the vacuum pump flange. Normally closed.
V-13	Vacuum Probe Valve(Optional)	Used to isolate vacuum probe from vacuum space. Always closed except during vacuum reading.
CV-1	Fill Check Valve	Used to prevent liquid spill if hose is disconnected before fill valve is closed.
CV-2	Pressure Building Check Valve	Used to prevent vent loss in case of a break in the pressure building line or coil.
S-1	Strainer	Used to prevent foreign particles from damaging the flow meter or entering customer station.
H-1	Hose	Used for liquid transfer into and out of HLD. 15 feet long.
PBC	Pressure Building Coil	Used to convert liquid into vapor and return it to the vapor space to maintain pressure during delivery.
C-1	Connection, Fill and Withdrawal	Provides a service connection for filling the vessel and liquid delivery.
M-1	Flow Meter	Used to record the number of gallons of liquid delivered to the customer.
RV-1	Tank Relief Valve	Automatically relieves inner tank pressure if it reaches 250 PSI level.
RV-2	Road Relief Valve	Automatically relieves inner tank pressure at 55 PSIG.
RV-3	Line Relief Valve	Automatically relieves line pressure when it exceeds 350 PSI.
BD-1	Tank Burst Disc	Ruptures completely to relieve inner tank pressure In the event RV-1 fails and pressure reaches 375 PSI level.
BD-2	Vacuum Burst Disc	Protects vacuum casing from over-pressurization in case of vacuum loss.
LL-1	Liquid Level Gauge	Shows the quantity of liquid in the HLD in inches of water. A conversion chart is provided to convert the readings to gallons of oxygen, nitrogen or argon.
PG-1	Tank Pressure Gauge	Shows inner vessel vapor pressure.

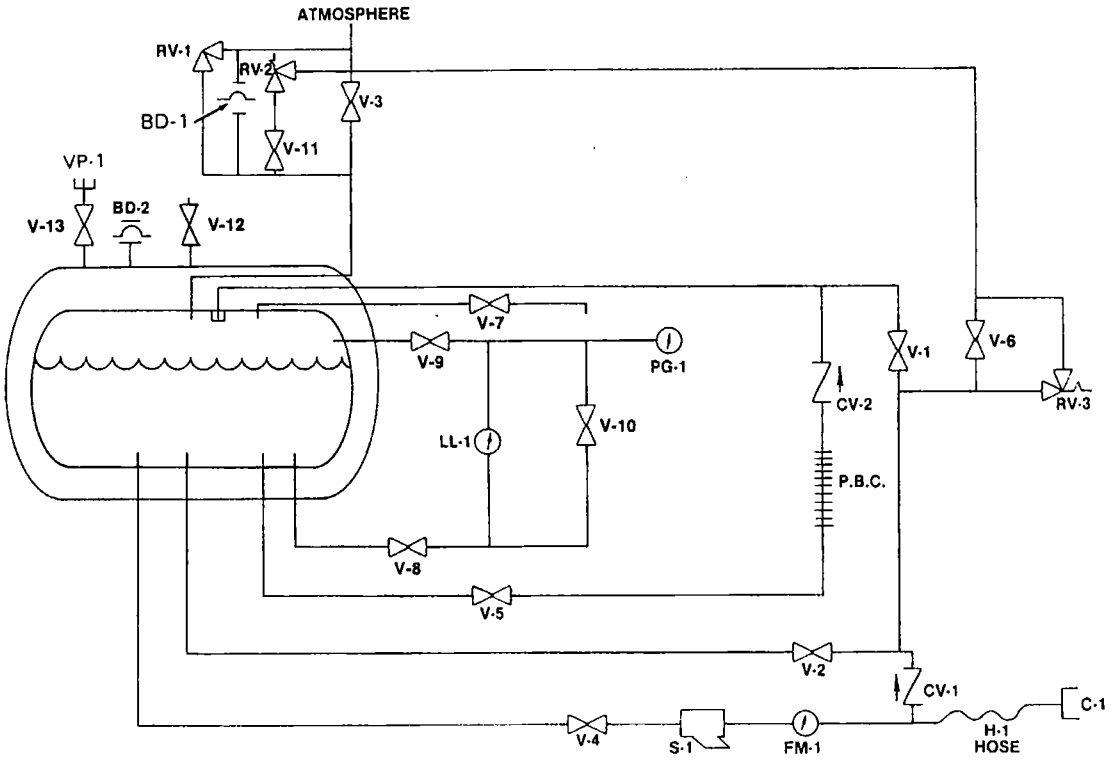
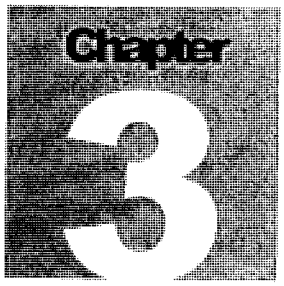


Figure 2-3. Flow Diagram HLD 3084

V-1	Top Fill and Meter Cooldown	CV-2	Pressure Building Check Valve
V-2	Bottom Fill	S-1	Strainer
V-3	Vent Valve	H-1	Hose, 15 Feet
V-4	Liquid Delivery	PBC	Pressure Building Coil
V-5	Pressure Building	C-1	Connection, Fill and Withdrawal
V-6	Hose Drain	M-1	Meter, Flow
V-7	Full Trycock	RV-1	Tank Relief , 250 PSI
V-8	Liquid Phase Shut-Off	RV-2	Road Relief, 55 PSI
V-9	Gas Phase Shut-Off	RV-3	Line Relief, 350 PSI
V-10	Gauge Balance	BD-1	Tank Burst Disc, 375 PSI
V-11	Road Relief Shut-Off	BD-2	Vacuum Burst Disc, 2.5 Inches
V-12	Annulus Evacuation	LL-1	Liquid Level Gauge
V-13	Vacuum Probe Valve (Optional)	PG-1	Tank Pressure Gauge
CV-1	Fill Check Valve	VP-1	Vacuum Probe (Optional)



3 OPERATING PROCEDURES

3.1 GENERAL

The HLD cryogenic containers are designed to operate in liquid dispensing operations. Liquids and gases used in such operations include oxygen, argon and nitrogen. Prior to operation it is important that the user consider the following: (1) ventilation and (2) service change. Each of these aspects are explained in the following paragraphs. (It is also recommended that the use review and fully understand the safety summary prior to performing any operations described in the following paragraphs.)

3.2 VENTILATION

There are two matters to be considered by the user with respect to ventilation. An excess accumulation of oxygen can create an oxygen enriched atmosphere (oxygen concentration above 23 percent). In such an environment, flammable objects burn very vigorously and may explode. Also, in such an atmosphere, some objects considered non-combustible in air may readily burn.

In addition, inert gases used in HLD (argon and nitrogen) may create an oxygen deficient atmosphere if used in poorly ventilated areas. Exposure to such an atmosphere can lead to unconsciousness and serious injury including death.

To avoid possible hazards, always use the HLD in an area having adequate ventilation. For further information concerning ventilation, refer to the Compressed Gas Association Inc.'s Safety Bulletin SB-2, dated March, 1966.

3.3 SERVICE CHANGES

The HLD is designed and engineered to be used for liquid or gaseous oxygen, nitrogen, or argon service. CHART (and the Compressed Gas Association) does not encourage unnecessary and frequent changing of service of the container. However, if it is necessary to make a service change, to ensure product purity, or to remove any moisture or foreign material from the tank and tank lines, the HLD must be purged. To purge the HLD use the following procedures.

The maximum purge pressure should be equal to 50 percent of the maximum operating pressure of the tank or 30 PSIG, whichever is less. The maximum purge pressure should be determined before starting the purge procedure.

NOTE

To Prevent drawing atmospheric contaminates back into the tank, a positive pressure of at least 5 PSIG must be maintained in the tank.

To accomplish the purge, put a small amount of the new product (or same product is the purge is being conducted to ensure purity or to remove contaminants) into the tank through the bottom fill line with the pressure build up valve open and all other valves closed. The purging liquid is introduced slowly so that when the maximum purge pressure is reached, a minimal amount of the liquid will be in the tank. When the maximum purge pressure is reached, liquid flow to the tank is stopped. Liquid in the tank is then drained off and the tank is vented down to the minimum purge pressure of 5 PSIG. This procedure is repeated at least (4) times, unless by analysis or other means, it can be determined that the proper purity level has been attained.

The detailed procedure for purging the HLD is provided in Table 3-1.

3.4 FILLING PROCEDURES

A HLD may be filled with liquid from a liquid supply unit either by pumping or a pressure transfer. If internal HLD pressure is at least 50 PSI less than the maximum allowable pressure of the supply unit, liquid may be transferred by a pressure transfer. If the normal working pressure of the station is equal to or greater than the maximum allowable pressure of the supply unit, liquid must be pumped into the tank.

HLD inner tank pressure determines whether the unit should be top or bottom filled. If tank pressure is well above the set operating pressure (as determined by pressure control valve RV-1 setting), filling through the top fill line is recommended. This procedure recondenses the warm gas phase above the liquid in the tank and tends to decrease the tank pressure. If tank pressure is below or at the set operating pressure, filling can be accomplished through the bottom fill line. Bottom filling causes an increase in tank pressure since the warm vapor above the liquid will be compressed.

Before filling, the HLD should be visually inspected for possible damage or unsuitability for intended use. If damage is detected (e.., serious dents, loose fitting, etc.) remove the unit from service and conduct necessary repairs as soon as possible.

All HLD containers are tested for performance with low purity liquid nitrogen. For this reason HLD's should be thoroughly purged with the applicable gas prior to filling.

Detailed HLD filling procedures are provided in Table 3-2.

Table 3-1. Detailed HLD Purging Procedure

Step Number	Action
1	Attach the source of liquid purge product to HLD fill connection C-1.
2	Close all valves except the pressure build-up valves (V-3, HLD 500 and 800) (V-5, HLD 1530), the liquid level gauge vapor phase, and liquid phase shut-off valves (V-7, V-8, HLD 500 and 800) (V-9, V-10, HLD 1530)
	NOTE **When a pressure building regulator is used, the pressure adjusting screw should be turned in (clockwise) to ensure that the product will flow through the pressure building system.**
3	Open the bottom fill valve (V-1, HLD 500 and 800) (V-2, HLD 1530) enough to allow liquid to flow slowly into the tank through the bottom fill line. (The gradual glow of liquid enables the liquid to vaporize in the lines and pressure build-up coil (PBC), and to slowly build up pressure in the inner tank.)
4	Shut off the liquid supply source when the pressure in the tank reaches the maximum purge pressure as indicated on the tank pressure gauge (PG-1).
5	Open the fill line drain valve (V-17, HLS 500 and 800) (V-6, HLD 1530) slowly to avoid splashing the liquid. Drain all liquid from the tank. The appearance of gas (vapor) at the drain indicates that all liquid has been drained.
	NOTE **On tanks where the drain valve is located between the fill union and check valve, the check valve flapper must be removed before putting liquid into the tank.**
6	Close the drain valve (V-17, HLD 500 and 800) (V-6, HLD 1530) and the bottom fill valve (V-1, HLD 500 and 800) (V-2, HLD 1530).
7	When all liquid is drained, close the liquid level gauge vapor and liquid phase shutoff valves (V-7, V-8, HLD 500 and 800) (V-9, V-10, HLD 1530). Open the liquid level gauge BALANCE valve (V-9, HLD 500 and 800) (V-11, HLD 1530) to prevent damage to the gauge.

Step Number	Action	
8	Break the unions on either side of the liquid level gauge (LL-1). Both the upper and lower liquid level gauge valves should be opened wide and the gas streams visually check for signs of moisture. Provided no moisture is observed after blowing the lines for approximately two minutes, both LL-1 valve should be closed. If moisture is observed in the gas stream, the gas should be discharged until it is clear of all moisture.	
9	Reconnect the liquid level gauge (LL-1), open the liquid level PHASE valves, and close the BALANCE valve.	
10	Open the vapor vent valve (V-4, HLD 500 and 800) (V-3, HLD 1530), full trycock valve (V-6, HLD 500 and 800) (V-8, HLD 1530), and top fill valve (V-2, HLD 500 and 800) (V-1, HLD 1530). Gas from the top fill valve will have to be vented by opening the hose drain valve.	
	CAUTION **While purging through various lines, observe the tank pressure indicating gauge (G-1). Make sure that the pressure does not go below 5 PSIG.**	
11	Repeat purge procedures 2 through 6 and 10 at least three (3) times to ensure product purity.	
	NOTE **After purge is complete check gas in tank for purity.**	
12	After Purging the tank, but before filling, verify that the following valves are open or closed as indicated/	
	Valve	Position
	Bottom Fill Valve	closed
	Top Fill Valve	closed
	Vapor Vent Valve	closed
	Full Trycock Valve	closed
	Liquid Level Gauge Balancing Valve	closed
	Gas Use Valve	closed
	Pressure Building Valve	closed
	Liquid Level Gauge Vapor Phase Valve	open
	Liquid Level Gauge Liquid Phase Valve	open

Table 3-2. Filling An Empty HLD (Warm Unit)

Step Number	Action
1	Start the pressure building system on the liquid supply source to gain sufficient pressure for transfer of liquid to the delivery unit.
2	Cool down the liquid transfer system from the supply source to the delivery unit.
3	Open vent valve (V-3, HLD 1530) (V-4, HLD 500 and 800) to fully dissipate any residual pressure in the delivery unit.
4	Connect the transfer hose to the fill connection (C-1).
5	Open the hose drain (V-7, GLD 1530) (V-17, HLD 500 and 800) to expedite cool down of the transfer hose. When liquid starts to spurt from this valve, close it. Open bottom fill valve (V-1, HLD 500 and 800) (V-2, HLD 1530), and top fill valve (V-1, HLD 1530) (V-2, HLD 500 and 800).
6	Gradually close bottom fill valve and continue liquid transfer through the top fill valve.
7	Throttle the vent valve (V-3, HLD 1530) (V-4, HLD 500 and 800) to maintain as low a pressure in the delivery unit as possible (it should be possible to completely shut off the vent valve when filling the unit from a cold, low-pressure supply source).
8	When the unit is about three-quarters full, open the full trycock valve (V-6, HLD 500 and 800) (V-8, HLD 1530). Continue filling until the liquid spurts from this valve.
9	Close top fill valve (V-1, HLD 1530) (V-2, HLD 500 and 800) and full trycock valve (V-6, HLD 500 and 800) (V-8, HLD 1530).
10	Close main shutoff valve on supply source transfer hose.
11	Open drain valve (V-6, HLD 1530) (V-17, HLD 500 and 800) and leave open until all trapped liquid in the hose and lines are blown out. Close drain valve and disconnect the transfer hose from the fill connection (C-1).
12	Check the liquid pressure in the delivery unit. If pressure continues to rise as the result of a warm unit, open vent valve (V-4, HLD 500 and 800) (V-3, HLD 1530) until thermal equilibrium in the delivery unit has been achieved. Close vent valve.

3.5 FILLING A COLD CHART LIQUID SUPPLY UNIT

After the delivery unit has been in service, it will usually be returned to the liquid supply source for refill with a small residual of the pressurized liquid remaining in it. This liquid keeps the inner vessel in a "cold" condition and minimizes the cool down time during refills.

Initial filling via the bottom fill valve (V-1, HLD 500 and 800) (V-2, HLD 1530) is not required and final venting after completion of filling via vent valve (V-4, HLD 500 and 800) (V-3, HLD 1530) is not required. Simply follow all of the other steps outline in Table 3-2.

3.6 INSTRUMENTS

The liquid level gauge (LL-1) indicates liquid level in the delivery unit. The pressure gauge (PG-1) indicates gas phase pressure in the delivery unit. To activate these two gauges, open the low pressure valve (V-8, HLD 500 and 800) (V-10, HLD-1530) coming from the top of the unit, thus activating the pressure gauge (PG-1). Open the high pressure valve (V-

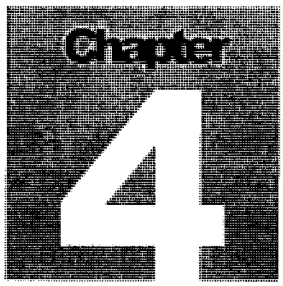
7, HLD 500 and 800) (V-9, HLD 1530) coming from the bottom of the unit to activate the liquid level gauge (LL-1). TO check the zero point of the liquid level gauge (LL-1), close (V-7 and V-8, HLD 500 and 800) (V-9 and V-10, HLD 1530) and open balancing valve (v-9, HLD 500 and 800) (V-11, HLD 1530). The pointer on the liquid level gauge should read "zero".

3.7 PRESSURE BUILD UP

To build pressure for liquid delivery, open pressure building valve (V-3, HLD 500 and 800) (V-5, HLD 1530) to allow liquid to flow into the PB system. When the tank pressure gauge (PG-1) reaches the required pressure (usually 200 PSI or more), initiate liquid flow as described in Table 3-3. Continue to maintain the pressure while delivering liquid. Stop pressure building, close the pressure system building valve.

Table 3-3. Transferring Liquid From HLD to Customer Station

Step Number	Action
1	Connect transfer hose between liquid delivery connection (C-1) and the customer station to be filled.
2	Open pressure building valve (V-3, HLD 500 and 800) (V-5, HLD 1530) to build pressure
3	Open meter cooldown valve (V-15, HLD 500 and 800) (V1, HLD 1530) and flow meter inlet valve (V-12, HLD 500 and 800) (V-4, HLD 1530).
4	Circulate fluid through the meter until it is thoroughly chilled. Frost on the meter will indicate when the meter is properly cooled.
5	Open hose drain on station to purge hose and then open liquid delivery valve (V-13, HLD 500 and 800) (V-4, HLD 1530) and top fill valve on customer station to allow liquid transfer to take place. The customer station level gauge will show full and liquid will spurt from the station trycock valve to indicate that the delivery has been completed.
6	Close liquid delivery valve (V-13, HLD 500 and 800) (V-4, HLD 1530) and pressure building valve (V-3, HLD 500 and 800) (V-5, HLD 1530) on the unit at this time.
7	If it is desired to transfer liquid without going through the flow meter, open meter bypass valve (V-14, HLD 500 and 800 only) and fill the customer station. Close meter bypass valve (V-14) and pressure building valve (V-3) when the customer station is full.
8	Close top fill on customer station and open drain valve (V-17, HLD 500 and 800) (V-6, HLD 1530) and drain any liquid in transfer hose between check valve (CV-2, all models) and the customer station. Close drain valve and disconnect the transfer hose.
	NOTE **Transfer Hose remains attached on HLD 1530.**
	NOTE **Maintain a pressure differential in the delivery unit at least 50 PSIG above the customer station pressure to facilitate a proper flow rate.**



4 MAINTENANCE, TROUBLESHOOTING, AND REPAIR

4.1 GENERAL

This chapter contains information applicable to HLD container maintenance, troubleshooting, and repair. Service and/or repairs are not difficult because parts are easily accessible and replaceable. When performing a procedure described in this chapter, refer to Chapter 5, Parts Lists for pertinent parts location views.

Before implementing any procedures described below, it is recommended that the Safety Summary and Product Safety Bulletins be reviewed and understood fully.

Required maintenance usually becomes apparent during inspection of units before a fill routine, observations during and after a fill, and from improper performance of components. Proper and immediate action to correct any damage or malfunction is advised.

Persons making repairs to piping, valves, and gauges should be fully familiar with cleanliness requirements for components used in nitrogen, oxygen, or argon service (see cleaning instruction).

4.2 MAINTENANCE

A. Compatibility and Cleaning

Always keep the HLD clean and free from grease and oil. This applies not only to containers used in oxygen service, but also to containers used in nitrogen and argon service. With respect to units used in nitrogen and argon service, this is very important because temperature of liquid nitrogen is below the liquefaction temperature of air, thus making it possible to condense liquid air on the piping and vaporizer surfaces.

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

When degreasing parts, trichloroethlene 1-1-1 trichloroethane (methyl chloroform), or other suitable solvent should be used.

CAUTION

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

B. Periodic Inspection

In order to maintain the HLD container in a good operating condition, certain system components must be inspected on a periodic basis. These components requiring periodic inspection are listed in Table 4-1. If the HLD is being operated in areas having either extreme hot or cold climates, the inspection intervals should be shortened. (Refer to the section on repair procedures in this chapter for corrective procedures when a malfunctioning component is found during an inspection.)

Table 4-1. HLD Periodic Inspection Intervals

Inspection Item	Interval
Valves and fittings for leaks, malfunction, etc.	Quarterly
Strainer for clogged condition	Annually
Indicating gauges for malfunction	Semi-annually
Relief valves to verify proper settings	2 Years
Tank burst disc (BD-1)	2 Years *

* Requires replacement, see the section on tank burst disc replacement in this chapter.

C. Soldering

Before performing any soldering work on a HLD, always exhaust oxygen from oxygen lines and purge with nitrogen gas.

D. Vacuum Integrity

Since all HLD containers are superinsulated, any deterioration or loss of vacuum will be apparent by cold spots, frost or condensation on the jacket, or abnormally rapid pressure build up. Unless one of these conditions is evidenced, vacuum level should not be suspect.

In the event one of the above conditions exists, remove the unit from service as soon as possible and contact the factory for advise on vessel vacuum testing. (On units equipped with a vacuum thermocouple gauge your CHART regional sales office has a readout to check the vacuum.)

4.3 TROUBLESHOOTING

Use Table 4-2 for troubleshooting a HLD system should problems develop. The table consists of the TROUBLE, PROBABLE CAUSE, and REMEDY columns. Note that probable causes for a specific problem are listed in a descending order of significance. That is, check out the first cause listed before proceeding to the next. Repair procedures required, as listed in the REMEDY column, may be found in the section on repair in this chapter. Refer to Chapter 5, Parts List, as required to locate system components identified in the troubleshooting table. Valves referenced by callouts in the troubleshooting table are arranged as follows: the first valve referenced in a set of two parenthesis () () applies to the HLD 500 and 800, the second set applies to the HLD 1530. A single reference in parenthesis applies to all models.

Table 4-2. HLD Container Troubleshooting Table

Trouble	Probable Cause	Remedy
A. Excessive tank pressure.	Excessive shutdown time.	Consult local CHART distributor or factory.
	Low withdrawal rate.	Consult local CHART distributor or factory.
	Tank pressure gauge (PG-1) in error.	Reset. If error continues replace gauge.
	Inadequate vacuum.	See Step C in this table
B. Failure to maintain tank at desired pressure.	Relief valve RV-1, RV-2, or RV-4 leaking or frozen over.	Replace defective valve.
	Tank bursting disc (BD-1) ruptures.	Replace disc.
	Piping leak.	Soap test and repair.
	Low liquid level.	Refill tank.
	Excessive withdrawal.	Reduce withdrawal rate.

Trouble	Probable Cause	Remedy
C. Inability to hold vacuum. (Consult factory before attempting any type of vacuum repair.)	Rupture annulus bursting disc (BD-2).	Replace disc. (Consult local CHART distributor or the factory for vacuum test procedures.) Repump vacuum (consult factory).
	Leaking at bursting disc casing caused by corrosion.	Inspect and replace disc as necessary. Repump vacuum (consult factory).
	Leak at evacuation valve (V-10) (V-13) or connection.	Replace diaphragm or reseal connection. Repump vacuum (consult factory).
	Positive pressure in vacuum space caused by container or internal piping, leakage, but not great enough to rupture disc.	Consult local CHART distributor or the factory.
	Leakage through casing or at piping where it passes through casing.	Inspect and repair as necessary to stop leak. Repump vacuum (consult factory).
D. Erratic or erroneous contents gauge readings.	Gauge needle is stuck. Bypass valve open or leaking.	Tap gauge; inspect needle and bend slightly if necessary.
	Needle is not zero adjusted. Line blocked or frozen.	Adjust gauge (see Chapter 3, Operating Procedures for procedures).
	Gauge damaged or faulty.	Replace gauge.
	Leaking gauge lines.	Soap test and repair leaks.
E. Leaking safety relief valve.	Dirt or ice under disc.	Replace valve.
	Valve improperly seated.	Reseat or replace valve as may be required.
	Damaged seat or disc.	Replace valve.,
F. Ruptured tank bursting disc (BD-1).	Excessive tank pressure.	See Step A in this table. Replace disc.
	Atmospheric corrosion and/or fatigue.	Replace disc.
	Interior corrosion.	Replace disc after blowing out the line.
	Improper disc.	Replace with proper disc.
	Defective disc.	Replace disc.

4.4 REPAIR

Replacement of damaged components with CHART approved parts, rather than repair, is recommended. However, when repair is required (in those instances when a spare part is not readily available), follow the instructions provided below.

When disassembly of a HLD assembly is required, parts removed should be coded to facilitate reassembly. Reassembly of parts should always be performed in the reverse manner in which they were disassembled.

CAUTION

The HLD should always be allowed to return to ambient temperature before any maintenance or repair work is performed. Vent or drain the HLD as necessary before replacing any component(s) exposed to pressure or to cryogenic liquid.

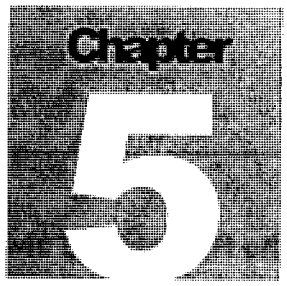
Parts removed during disassembly should be protected from damage, thoroughly cleaned, and stored in protective polyethylene bags if not immediately reinstalled.

Clean all metal parts with a good industrial cleaning solvent. Air dry all cleaned parts using a clean, low-pressure air source. Before assembling, make sure that all parts are thoroughly clean and have been degreased. Cleaning will prevent valves and regulators from freezing while in service, and also prevent contamination of the liquid product.

When replacing assemblies from an HLD, remember to always plug pipe openings as soon as they are exposed. Plastic pipe plugs or a clear plastic film may be used for this purpose.

NOTE

Always have a adequate number of HLD spare parts in your inventory. Refer to Chapter 5, Parts List for recommended components to maintain in inventory.



5 PARTS LIST

5.1 GENERAL

This chapter provides information for replacing HLD parts in the event that they should fail. Plumbing sketches of each HLD are found in this section and corresponding parts lists are found in the following tables. Liquid level gauge calibration charts are also included in this section.

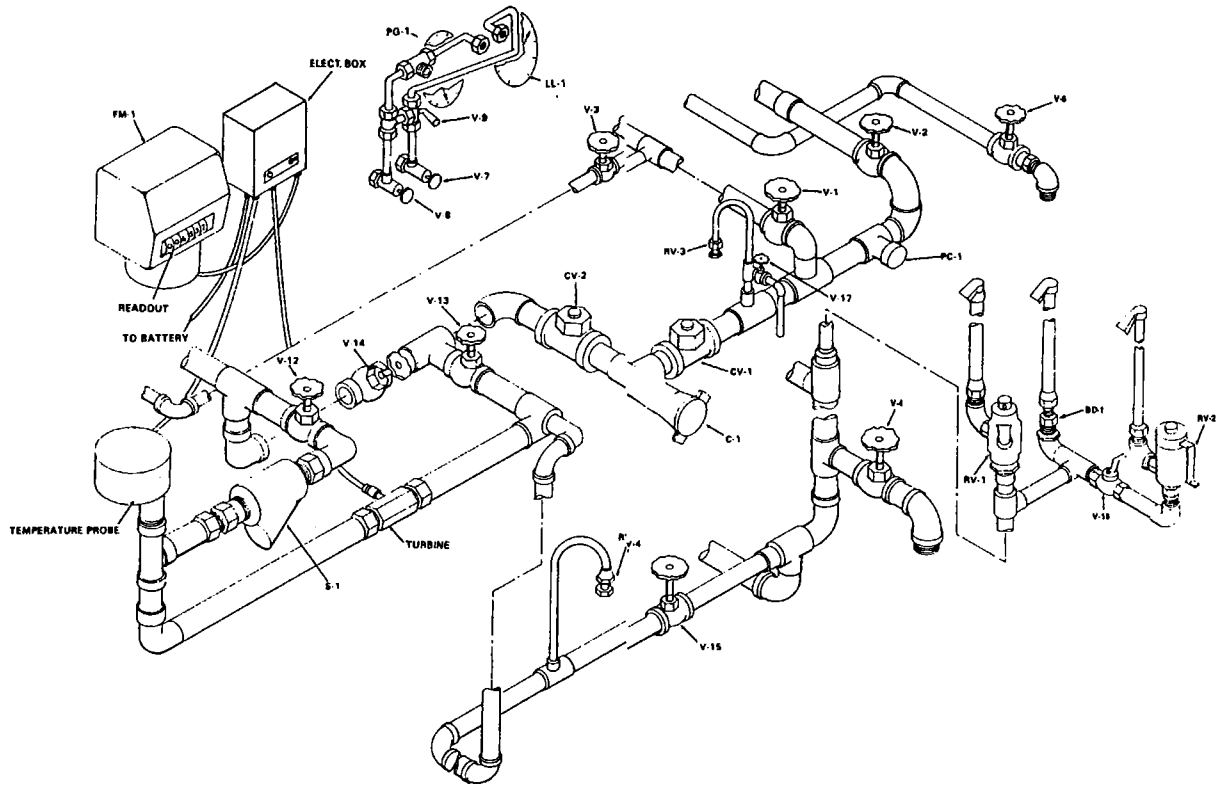


Figure 5-1. Controls and Indicators (HLD 500)

Table 5-1. HLD 500 Parts List

TAG	NOMENCLATURE	PART NO.	DESCRIPTION
V-1	Valve, Bottom Fill	1710672	Globe Valve, 1" Nom. Extended Packing
V-2	Valve, Top Fill	1710672	Globe Valve, 1" Nom. Extended Packing
V-3	Valve, Pres. Builder	1713232	Globe Valve, 1/2" Nom. Extended Stem
V-4	Valve, Vent	1710662	Globe Valve, 1-1/4" Nom. Extended Stem
V-6	Valve, Full Trycock	1713202	Globe Valve, 3/8" FPT
V-7	Valve, High Pressure	1711862	Angle Valve, 1/4" ODT x 1/4" FPT
V-8	Valve, Low Pressure	1711862	Angle Valve, 1/4" ODT x 1/4" FPT
V-9	Valve, Gauge Balance	1711952	Angle Valve, 1/4" FPT
V-10	Valve, Evacuation	1713224	Diaphragm Valve, 1-1/2" Nom
V-11	Valve, Vacuum Probe	1712672	Bellows Valve, 1/8" MPT
V-12	Valve, Meter Inlet	1711809	Globe Valve, 1" Nom. Extended Packing
V-13	Valve, Liquid Delivery	1711809	Globe Valve, 1" Nom. Extended Packing
V-14	Valve, Meter Bypass	1711809	Globe Valve, 1" Nom. Extended Packing
V-15	Valve, Meter Cooldown	1710112	Globe Valve, 3/4" Nom. Extended Packing
V-17	Valve, Drain	1710972	Globe Valve, 3/8" NPT
V-18	Valve, Relief Isolation	1714202	Ball Valve, 1/2" Nom
CV-1	Check Valve, Fill	1713712	Swing Check Valve, 3/4" NPT
CV-2	Check Valve, Liquid	1713712	Swing Check Valve, 3/4" NPT
PG-1	Pressure Gauge	2010312	Pressure Gauge, 0-400 PSIG, 1/4" CBM
LL-1	Liquid Level Gauge	2010322	Diff Pressure Gauge, 0-100 in H_2O
S-1	Strainer	4910142	Strainer, 1" NPT, 100 Mesh Screen
FM-1	Flowmeter	9815239	Oxygen Meter
		9815249	Nitrogen Meter
		9815259	Argon Meter
PBC	Pressure Building Coil	5010013	Larkin Heat Exchanger Coil
RV-1	Relief Valve, Tank	1810482	Relief Valve, 250 PSIG, 3/4" x 3/4" NPT ASME
RV-2	Relief Valve, Road	1810892	Relief Valve, 55 PSIG, 1/2" x 3/4" NPT ASME
RV-3	Relief Valve, Fill	1810462	Relief Valve, 350 PSIG, 1/4" MPT
RV-4	Relief Valve, Meter	1810462	Relief Valve, 350 PSIG, 1/4" MPT
BD-1	Burst Disc, Tank	1910819	Rupture Disc, 1/2", 350 PSIG Nickel
C-1	Connection Fill	See Table 5-13	
SH-1	Safety Head, Annulus	1910641	Vacuum Rupture Disc, 2-1/2"
H-1	Hose, Fill & Withdrawal	3710201	Flex Hose, 1.25" I.D. x 15' OAL, 1-1/2" FPT Ends

Table 5-2. Liquid Level Gauge HLD 500 Calibration Chart*

Reading (Inches)	Liquid Contents (US GALLONS)		
	Ar	O_2	N_2
0	0	0	0
2	2	3	5
4	7	10	17
6	14	19	30
8	21	29	50
10	30	42	70
12	40	54	94
14	51	70	122
16	63	88	148
18	77	106	178
20	90	125	206
22	104	144	238
24	119	165	266
26	136	182	300
28	153	206	332
30	171	227	363
32	186	250	393
34	205	271	420
36	222	294	446
38	239	315	474
40	256	338	495
42	275	358	514
44	295	381	531
46	313	400	
48	327	420	
50	346	439	
52	364	458	
54	380	476	
56	400	491	
58	416	504	
60	432	519	
62	448	530	
64	462		
66	475		
68	489		
70	501		
72	510		
74	522		
76	531		

*Calculated for saturated liquid at atmospheric pressure.

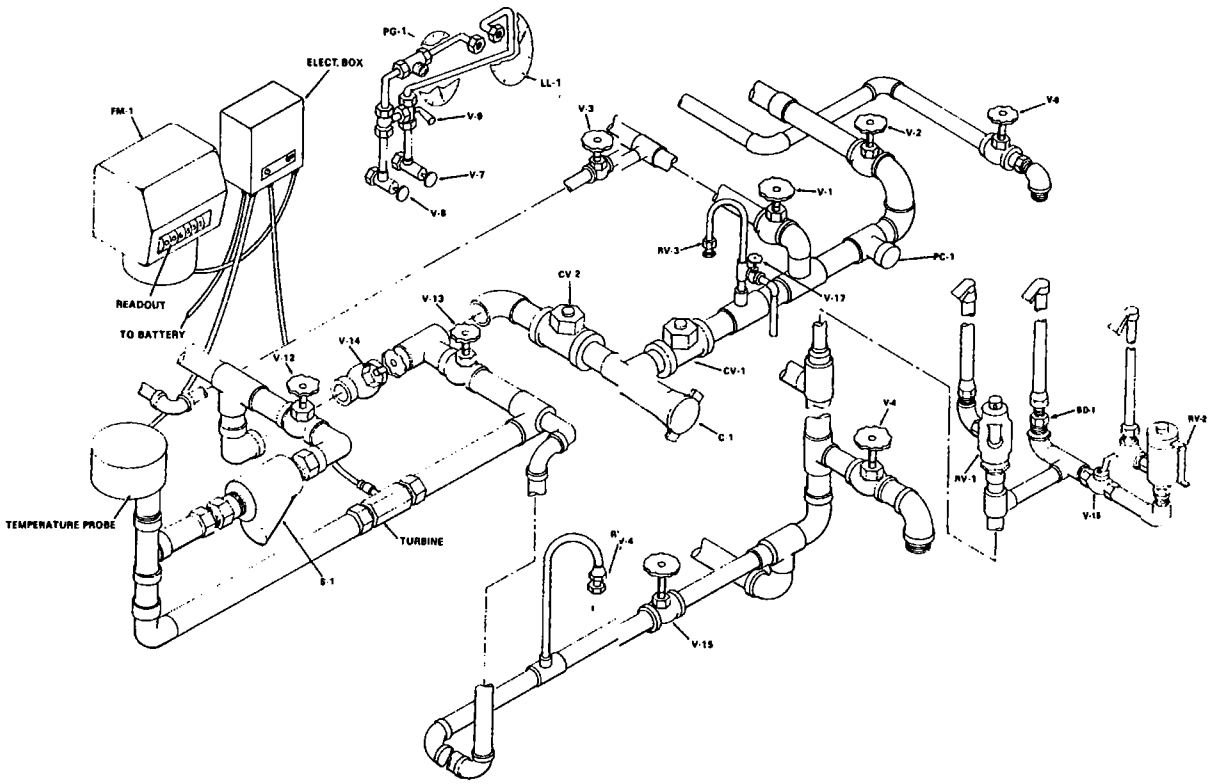


Figure 5-2. Controls and Indicators (HLD 800)

Table 5-3. HLD 800 Parts List

TAG	NOMENCLATURE	PART NO.	DESCRIPTION
V-1	Valve, Bottom Fill	1710672	Globe Valve, 1" Nom. Extended Packing
V-2	Valve, Top Fill	1710672	Globe Valve, 1" Nom. Extended Packing
V-3	Valve, Pres. Builder	1713232	Globe Valve, 1/2" Nom. Extended Stem
V-4	Valve, Vent	1710662	Globe Valve, 1-1/4" Nom. Extended Stem
V-6	Valve, Full Trycock	1713202	Globe Valve, 3/8" FPT
V-7	Valve, High Pressure	1711862	Angle Valve, 1/4" ODT x 1/4" FPT
V-8	Valve, Low Pressure	1711862	Angle Valve, 1/4" ODT x 1/4" FPT
V-9	Valve, Gauge Balance	1711952	Angle Valve, 1/4" FPT
V-10	Valve, Evacuation	1713224	Diaphragm Valve, 1-1/2" Nom
V-11	Valve, Vacuum Probe	1712672	Bellows Valve, 1/8" MPT
V-12	Valve, Meter Inlet	1711809	Globe Valve, 1" Nom. Extended Packing
V-13	Valve, Liquid Delivery	1711809	Globe Valve, 1" Nom. Extended Packing
V-14	Valve, Meter Bypass	1711809	Globe Valve, 1" Nom. Extended Packing
V-15	Valve, Meter Cooldown	1710112	Globe Valve, 3/4" Nom. Extended Packing
V-17	Valve, Drain	1710972	Globe Valve, 3/8" NPT
V-18	Valve, Relief Isolation	1714202	Ball Valve, 1/2" Nom
CV-1	Check Valve, Fill	1713712	Swing Check Valve, 3/4" NPT
CV-2	Check Valve, Liquid	1713712	Swing Check Valve, 3/4" NPT
PG-1	Pressure Gauge	2010312	Pressure Gauge, 0-400 PSIG, 1/4" CBM
LL-1	Liquid Level Gauge	2010322	Diff Pressure Gauge, 0-100 in H_2O
S-1	Strainer	4910142	Strainer, 1" NPT, 100 Mesh Screen
FM-1	Flowmeter	9815239	Oxygen Meter
		9815249	Nitrogen Meter
		9815259	Argon Meter
PBC	Pressure Building Coil	5010013	Larkin Heat Exchanger Coil
RV-1	Relief Valve, Tank	1810482	Relief Valve, 250 PSIG, 3/4" x 3/4" NPT ASME
RV-2	Relief Valve, Road	1810892	Relief Valve, 55 PSIG, 1/2" x 3/4" NPT ASME
RV-3	Relief Valve, Fill	1810462	Relief Valve, 350 PSIG, 1/4" MPT
RV-4	Relief Valve, Meter	1810462	Relief Valve, 350 PSIG, 1/4" MPT
BD-1	Burst Disc, Tank	1910819	Rupture Disc, 1/2", 350 PSIG Nickel
C-1	Connection Fill	See Table 5-13	
SH-1	Safety Head, Annulus	1910641	Vacuum Rupture Disc, 2-1/2"
H-1	Hose, Fill & Withdrawal	3710201	Flex Hose, 1.25" I.D. x 15' OAL, 1-1/2" FPT Ends

Table 5-4. Liquid Level Gauge HLD 800 Calibration Chart*

Reading (Inches)	Liquid Contents (US GALLONS)		
	Ar	O_2	N_2
0	0	0	0
2	4	6	10
4	12	17	28
6	28	32	55
8	37	50	87
10	51	71	122
12	69	94	160
14	83	118	201
16	108	146	245
18	130	177	290
20	152	204	335
22	177	239	383
24	200	266	434
26	224	300	482
28	249	336	531
30	275	365	577
32	303	401	625
34	329	438	667
36	358	471	710
38	386	508	750
40	414	539	786
42	440	575	817
44	471	605	844
46	500	638	
48	528	667	
50	555	700	
52	583	726	
54	608	752	
56	635	779	
58	661	803	
60	685	823	
62	710	844	
64	733		
66	755		
68	778		
70	795		
72	813		
74	830		
76	845		

*Calculated for saturated liquid at atmospheric pressure.

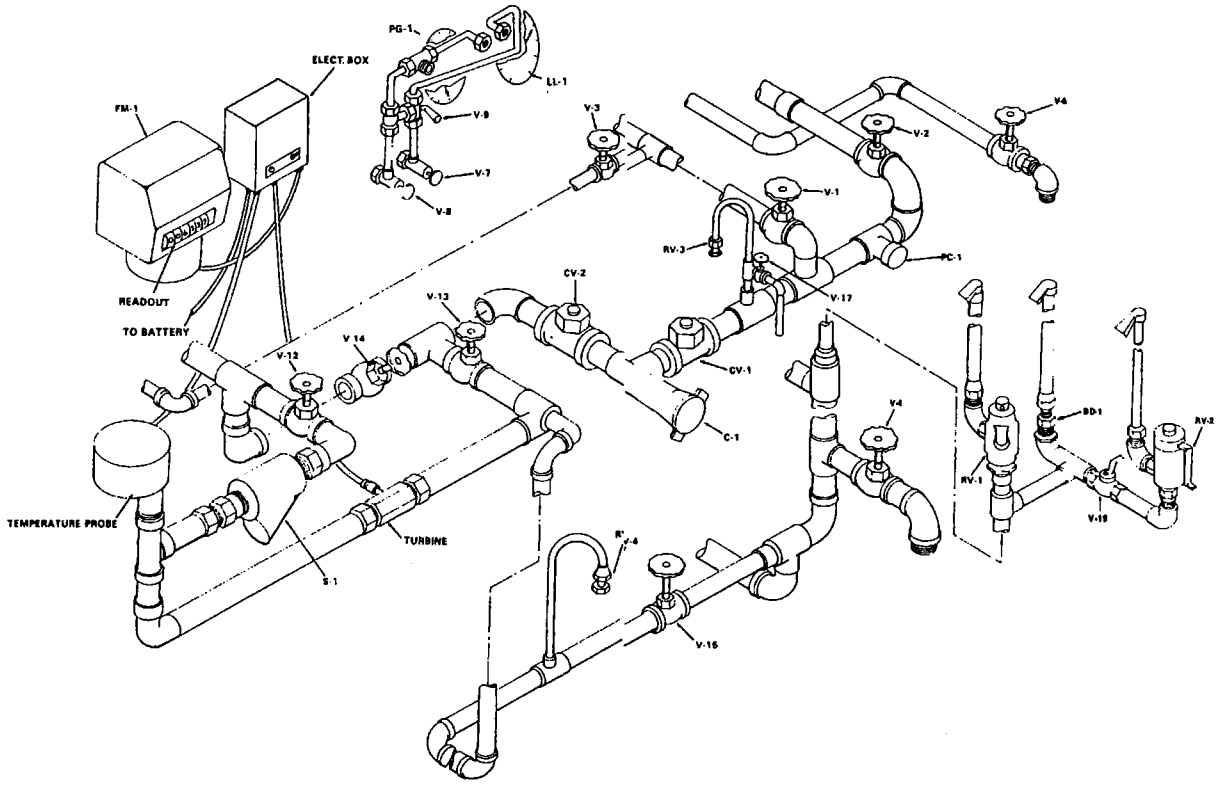


Figure 5-3. Controls and Indicators (HLD 1200)

Table 5-5. HLD 1200 Parts List

TAG	NOMENCLATURE	PART NO.	DESCRIPTION
V-1	Valve, Bottom Fill	1711812	Globe Valve, 1-1/2" Nom. Extended Packing
V-2	Valve, Top Fill	1711812	Globe Valve, 1-1/2" Nom. Extended Packing
V-3	Valve, Pres. Builder	1711802	Globe Valve, 1" Nom. Extended Packing
V-4	Valve, Vent	1718742	Globe Valve, 1-1/2" Nom. Extended Packing
V-6	Valve, Full Trycock	1711772	Globe Valve, 1/2" Nom Extended Packing
V-7	Valve, High Pressure	1711862	Angle Valve, 1/4" ODT x 1/4" FPT
V-8	Valve, Low Pressure	1711862	Angle Valve, 1/4" ODT x 1/4" FPT
V-9	Valve, Gauge Balance	1711952	Angle Valve, 1/4" FPT
V-10	Valve, Evacuation	1713224	Diaphragm Valve, 1-1/2" Nom
V-11	Valve, Vacuum Probe	1712672	Bellows Valve, 1/8" MPT
V-12	Valve, Meter Inlet	1710672	Globe Valve, 1" Nom. Extended Packing
V-13	Valve, Liquid Delivery	1710672	Globe Valve, 1" Nom. Extended Packing
V-14	Valve, Meter Bypass	1710142	Globe Valve, 1" NPT. Extended Stem
V-15	Valve, Meter Cooldown	1711772	Globe Valve, 1/2" Nom. Extended Packing
V-17	Valve, Drain	1710972	Globe Valve, 3/8" NPT
V-19	Valve, Relief Isolation	1711842	Ball Valve, 1/2" Nom
CV-1	Check Valve, Fill	1711302	Swing Check Valve, 1-1/2" Nom
CV-2	Check Valve, Liquid	1711002	Swing Check Valve, 1" Nom
PG-1	Pressure Gauge	2010312	Pressure Gauge, 0-400 PSIG, 1/4" CBM
LL-1	Liquid Level Gauge	2010322	Diff Pressure Gauge, 0-100 in H_2O
S-1	Strainer	4910142	Strainer, 1" NPT, 100 Mesh Screen
FM-1	Flowmeter	9815239	Oxygen Meter
		9815249	Nitrogen Meter
		9815259	Argon Meter
PBC	Pressure Building Coil	5010013	Larkin Heat Exchanger Coil
RV-1	Relief Valve, Tank	1810282	Relief Valve, 250 PSIG, 1" x 1-1/4" NPT ASME
RV-2	Relief Valve, Road	1810892	Relief Valve, 55 PSIG, 1/2" x 3/4" NPT ASME
RV-3	Relief Valve, Fill	1810462	Relief Valve, 350 PSIG, 1/4" MPT
RV-4	Relief Valve, Meter	1810462	Relief Valve, 350 PSIG, 1/4" MPT
BD-1	Burst Disc, Tank	1910829	Rupture Disc, 1", 350 PSIG Nickel
C-1	Connection Fill	See Table 5-13	
SH-1	Safety Head, Annulus	1910641	Vacuum Rupture Disc, 2-1/2"
H-1	Hose, Fill & Withdrawal	3710201	Flex Hose, 1.25" I.D. x 15' OAL, 1-1/2" FPT Ends

Table 5-6. Liquid Level Gauge HLD 1200 Calibration Chart*

Reading (Inches)	Liquid Contents (US GALLONS)		
	Ar	O_2	N_2
0	0	0	0
2	5	8	13
4	17	23	39
6	31	43	73
8	49	67	114
10	69	94	160
12	92	125	211
14	117	158	265
16	143	193	323
18	171	231	384
20	200	270	447
22	231	311	511
24	263	353	576
26	296	397	643
28	331	441	709
30	366	487	775
32	401	533	840
34	438	579	904
36	475	626	966
38	512	573	1026
40	550	720	1083
42	589	767	1136
44	627	813	1186
46	665	859	1230
48	704	904	1269
50	742	948	1301
52	780	991	1324
54	818	1033	
56	856	1074	
58	893	1112	
60	929	1149	
62	965	1184	
64	1000	1216	
66	1034	1246	
68	1067	1272	
70	1099	1295	
72	1130	1314	
74	1160	1327	
76	1188		
78	1214		
80	1239		
82	1261		
84	1282		
86	1299		
88	1314		
90	1325		
92	1331		

*Calculated for saturated liquid at atmospheric pressure.

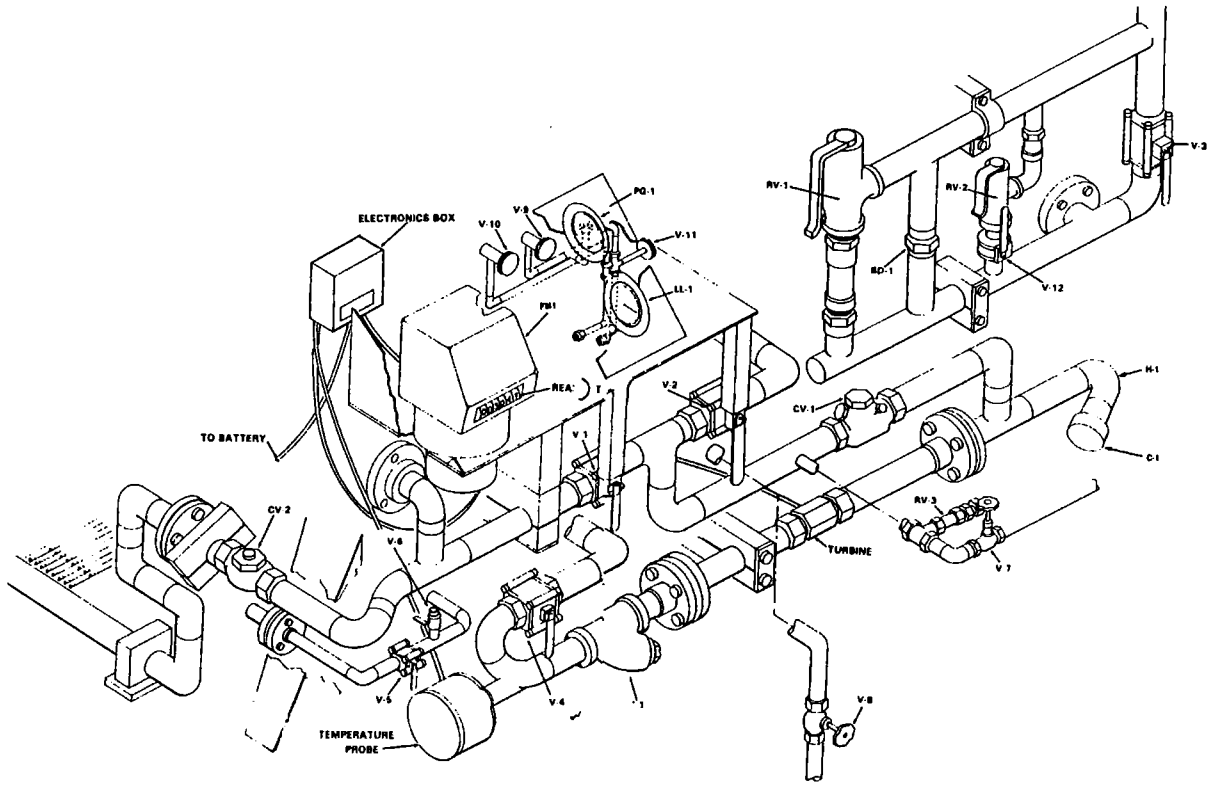


Figure 5-4. Controls and Indicators (HLD 1530)

Table 5-7. HLD 1530 Parts List

TAG	NOMENCLATURE	PART NO.	DESCRIPTION
V-1	Valve, Top Fill	1712002	Ball Valve, 1-1/2" PS
V-2	Valve, Bottom Fill	1712002	Ball Valve, 1-1/2" PS
V-3	Valve, Vent	1712002	Ball Valve, 1-1/2" PS
V-4	Valve, Liquid Delivery	1712002	Ball Valve, 1-1/2" PS
V-5	Valve, Pres. Builder	1712222	Ball Valve, 1" PS
V-6	Valve, Drain	1710972	Globe Valve, 3/8" NPT
V-7	Valve, Drain	1710972	Globe Valve, 3/8" NPT
V-8	Valve, Full Trycock	1710972	Globe Valve, 3/8" NPT
V-9	Valve, High Pressure	1711862	Angle Valve, 1/4" ODT x 1/4" FPT
V-10	Valve, Low Pressure	1711862	Angle Valve, 1/4" ODT x 1/4" FPT
V-11	Valve, Gauge Balance	1711952	Angle Valve, 1/4" FPT
V-12	Valve, Relief Isolation	1712202	Ball Valve, 1/2" NPT
V-13	Valve, Evacuation	1713224	Diaphragm Valve, 1-1/2" Nom
V-14	Valve, Thermo. Isolation	1712672	Bellows Valve, 1/8" MPT
CV-1	Check Valve, Fill	1712702	Check Valve, 1-1/2" NPT, Teflon Disc
CV-2	Check Valve, Liquid	1712702	Check Valve, 1-1/2" NPT, Teflon Disc
PG-1	Pressure Gauge	2010312	Pressure Gauge, 0-400 PSIG, 1/4" CBM
LL-1	Liquid Level Gauge	2010322	Diff Pressure Gauge, 0-100 in H_2O
S-1	Strainer	4910162	Strainer, 1" NPT, 100 Mesh Screen
FM-1	Flowmeter	9815179	Nitrogen Meter
		9815729	Oxygen Meter
		9815739	Argon Meter
PBC	Pressure Building Coil	5010013	Larkin Heat Exchanger Coil
RV-1	Relief Valve, Tank	1810282	Relief Valve, 250 PSIG, 1" x 1-1/4" NPT ASME
RV-2	Relief Valve, Road	1810892	Relief Valve, 55 PSIG, 1/2" x 3/4" NPT ASME
RV-3	Relief Valve, Fill	1810792	Relief Valve, 350 PSIG, 1/2" In-Line
RV-4		1810092	Relief Valve Adaptor
BD-1	Burst Disc, Tank	1910835	Rupture Disc, 1", 350 PSIG, Nickel
C-1	Connection Fill	See Table 5-13	
SH-1	Safety Head, Annulus	1910641	Vacuum Rupture Disc, 2-1/2"
H-1	Hose, Fill & Withdrawal	3710201	Flex Hose, 1.25" I.D. x 15' OAL, 1-1/2" FPT Ends

Table 5-8. Liquid Level Gauge HLD 1530 Calibration Chart*

Reading (Inches)	Liquid Contents (US GALLONS)		
	Ar	O_2	N_2
0	0	0	0
2	9	12	19
4	23	31	50
6	41	55	91
8	62	84	139
10	86	116	193
12	113	152	252
14	141	190	315
16	172	231	382
18	205	275	452
20	239	320	524
22	274	367	598
24	311	416	673
26	349	466	748
28	389	517	824
30	429	568	899
32	470	612	973
34	511	674	1046
36	554	727	1117
38	596	781	1185
40	640	834	1249
42	683	888	1310
44	727	940	1365
46	771	992	
48	814	1044	
50	858	1094	
52	901	1143	
54	944	1190	
56	987	1236	
58	1029	1280	
60	1070	1322	
62	1111	1361	
64	1151		
66	1189		
68	1227		
70	1263		
72	1289		
74	1332		
76	1363		

*Calculated for saturated liquid at atmospheric pressure.

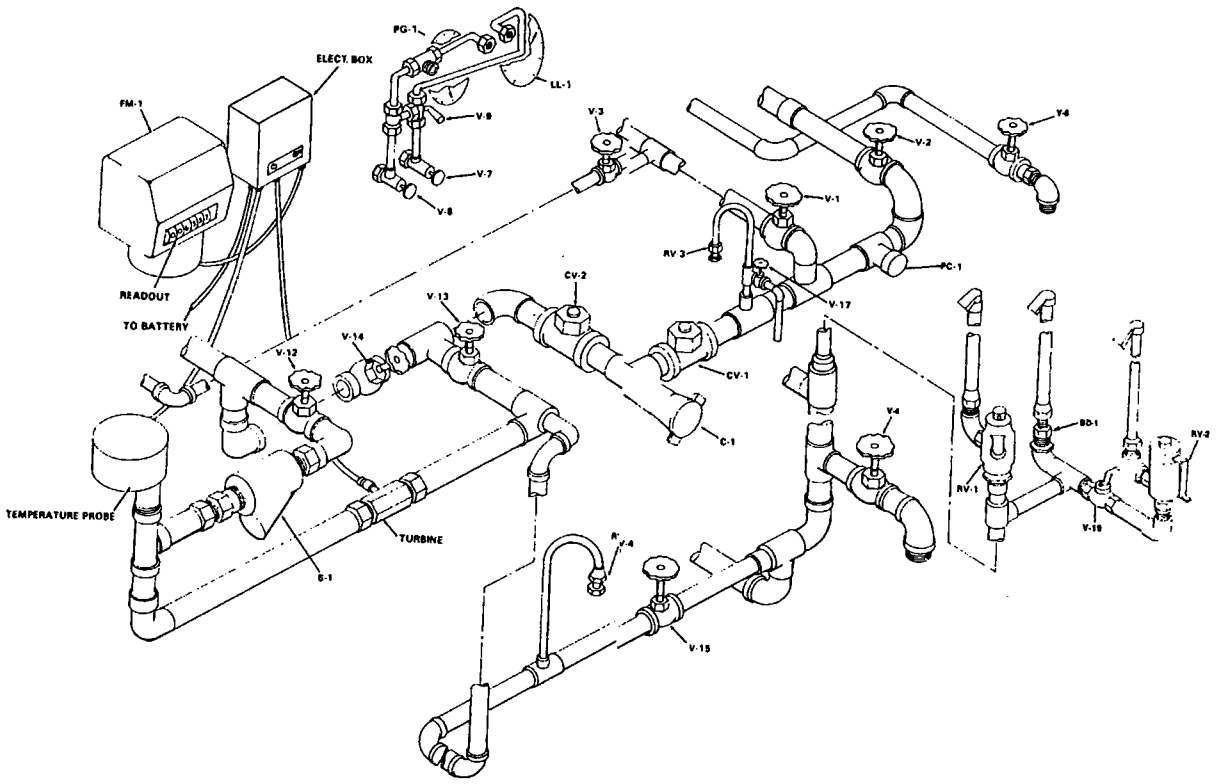


Figure 5-5. Controls and Indicators (HLD 2072)

Table 5-9. HLD 2072 Parts List

TAG	NOMENCLATURE	PART NO.	DESCRIPTION
V-1	Valve, Bottom Fill	1711812	Globe Valve, 1-1/2" Nom. Extended Packing
V-2	Valve, Top Fill	1711812	Globe Valve, 1-1/2" Nom. Extended Packing
V-3	Valve, Pres. Builder	1711802	Globe Valve, 1" Nom. Extended Packing
V-4	Valve, Vent	1711812	Globe Valve, 1-1/2" Nom. Extended Packing
V-6	Valve, Full Trycock	1711772	Globe Valve, 1/2" Nom Extended Packing
V-7	Valve, High Pressure	1711862	Angle Valve, 1/4" ODT x 1/4" FPT
V-8	Valve, Low Pressure	1711862	Angle Valve, 1/4" ODT x 1/4" FPT
V-9	Valve, Gauge Balance	1711952	Angle Valve, 1/4" FPT
V-10	Valve, Evacuation	1713224	Diaphragm Valve, 1-1/2" Nom
V-11	Valve, Vacuum Probe	1712672	Bellows Valve, 1/8" MPT
V-12	Valve, Meter Inlet	1711802	Globe Valve, 1" Nom. Extended Packing
V-13	Valve, Liquid Delivery	1711802	Globe Valve, 1" Nom. Extended Packing
V-14	Valve, Meter Bypass	1711802	Globe Valve, 1" Nom. Extended Packing
V-15	Valve, Meter Cooldown	1713282	Globe Valve, 3/4" Nom. Extended Stem
V-17	Valve, Drain	1710972	Globe Valve, 3/8" NPT
V-19	Valve, Relief Isolation	1711842	Ball Valve, 1/2" Nom
CV-1	Check Valve, Fill	1711302	Swing Check Valve, 1-1/2" Nom
CV-2	Check Valve, Liquid	1711002	Swing Check Valve, 1" Nom
PG-1	Pressure Gauge	2010312	Pressure Gauge, 0-400 PSIG, 1/4" CBM
LL-1	Liquid Level Gauge	2010322	Diff Pressure Gauge, 0-100 in H_2O
S-1	Strainer	4910142	Strainer, 1" NPT, 100 Mesh Screen
FM-1	Flowmeter	9815239	Oxygen Meter
		9815249	Nitrogen Meter
		9815259	Argon Meter
PBC	Pressure Building Coil	5010013	Larkin Heat Exchanger Coil
RV-1	Relief Valve, Tank	1810282	Relief Valve, 250 PSIG, 1" x 1-1/4" NPT ASME
RV-2	Relief Valve, Road	1810892	Relief Valve, 55 PSIG, 1/2" x 3/4" NPT ASME
RV-3	Relief Valve, Fill	1810462	Relief Valve, 350 PSIG, 1/4" MPT
RV-4	Relief Valve, Meter	1810462	Relief Valve, 350 PSIG, 1/4" MPT
BD-1	Burst Disc, Tank	1910829	Rupture Disc, 1", 350 PSIG Nickel
C-1	Connection Fill	See Table 5-13	
SH-1	Safety Head, Annulus	1910641	Vacuum Rupture Disc, 2-1/2"
H-1	Hose, Fill & Withdrawal	3710201	Flex Hose, 1.25" I.D. x 15' OAL, 1-1/2" FPT Ends

Table 5-10. Liquid Level Gauge HLD 2072 Calibration Chart*

Reading (Inches)	Liquid Contents (US GALLONS) Ar	O_2	N_2
0	0	0	0
2	10	14	24
4	30	41	70
6	56	76	129
8	87	118	199
10	123	166	277
12	161	218	363
14	203	274	454
16	248	333	551
18	295	396	652
20	345	462	755
22	397	530	865
24	451	601	970
26	506	673	1079
28	563	747	1188
30	621	822	1297
32	680	898	1405
34	741	975	1510
36	802	1052	1614
38	864	1129	1713
40	927	1207	1808
42	990	1284	1898
44	1053	1360	1982
46	1116	1436	2057
48	1180	1511	2124
50	1243	1584	2180
52	1306	1656	2220
54	1369	1725	
56	1431	1793	
58	1492	1858	
60	1552	1920	
62	1612	1978	
64	1670	2033	
66	1727	2084	
68	1782	2129	
70	1836	2169	
72	1888	2202	
74	1938	2226	
76	1985		
78	2030		
80	2072		
82	2111		
84	2146		
86	2177		
88	2203		
90	2223		
92	2234		

*Calculated for saturated liquid at atmospheric pressure.

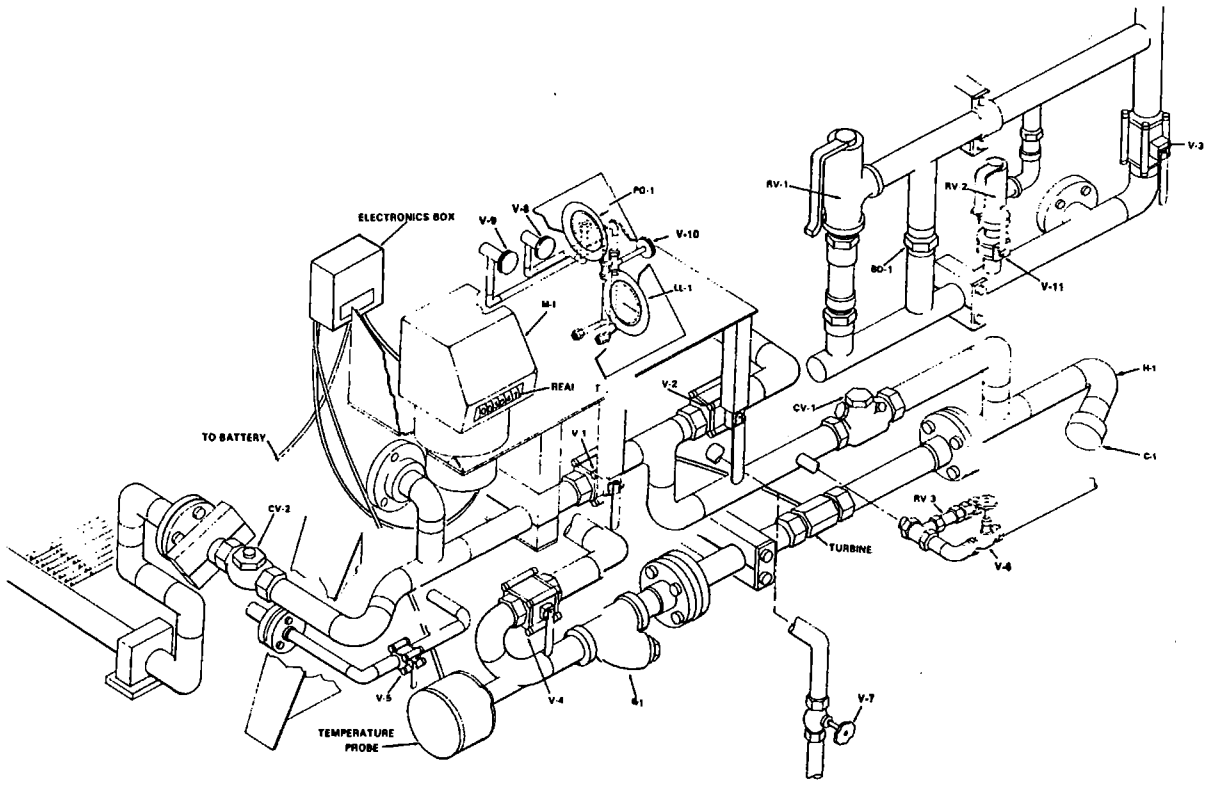


Figure 5-6. Controls and Indicators (HLD 3084)

Table 5-11. HLD 3084 Parts List

TAG	NOMENCLATURE	PART NO.	DESCRIPTION
V-1	Valve, Top Fill	1712992	Globe Valve, 1-1/2" Nom Extended Packing
V-2	Valve, Bottom Fill	1712992	Globe Valve, 1-1/2" Nom Extended Packing
V-3	Valve, Vent	1711809	Globe Valve, 1" Nom Extended Packing
V-4	Valve, Liquid Delivery	1712982	Ball Valve, 1-1/2" Nom
V-5	Valve, Pres. Builder	1710672	Globe Valve, 1" Nom Extended Packing
V-6	Valve, Drain	1710972	Globe Valve, 3/8" NPT
V-7	Valve, Full Trycock	1710972	Globe Valve, 3/8" NPT
V-8	Valve, High Pressure	1711862	Angle Valve, 1/4" ODT x 1/4" FPT
V-9	Valve, Low Pressure	1711862	Angle Valve, 1/4" ODT x 1/4" FPT
V-10	Valve, Gauge Balance	1711952	Angle Valve, 1/4" FPT
V-11	Valve, Relief Isolation	1710972	Globe Valve, 3/8" NPT
V-12	Valve, Evacuation	1712824	Diaphragm Valve, 1-1/2" Nom
V-13	Valve, Thermo. Isolation	1712672	Bellows Valve, 1/8" MPT
CV-1	Check Valve, Fill	1712702	Check Valve, 1-1/2" NPT, Teflon Disc
CV-2	Check Valve, Liquid	1712702	Check Valve, 1-1/2" NPT, Teflon Disc
PG-1	Pressure Gauge	2010312	Pressure Gauge, 0-400 PSIG, 1/4" CBM
LL-1	Liquid Level Gauge	2010322	Diff Pressure Gauge, 0-100 in H_2O
S-1	Strainer	4910162	Strainer, 1" NPT, 100 Mesh Screen
FM-1	Flowmeter	9815789	Nitrogen Meter
		9815799	Oxygen Meter
		9815809	Argon Meter
PBC	Pressure Building Coil	5010013	Larkin Heat Exchanger Coil
RV-1	Relief Valve, Tank	1810282	Relief Valve, 250 PSIG, 1" x 1-1/4" NPT ASME
RV-2	Relief Valve, Road	1810892	Relief Valve, 55 PSIG, 1/2" x 3/4" NPT ASME
RV-3	Relief Valve, Fill	1810792	Relief Valve, 350 PSIG, 1/2" In-Line
RV-4			Relief Valve Adaptor
BD-1	Burst Disc, Tank	1910835	Rupture Disc, 1", 350 PSIG, Nickel
C-1	Connection Fill	See Table 5-13	
SH-1	Safety Head, Annulus	1910641	Vacuum Rupture Disc, 2-1/2"
H-1	Hose, Fill & Withdrawal	3710201	Flex Hose, 1.25" I.D. x 15' OAL, 1-1/2" FPT Ends

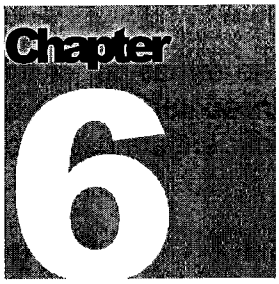
Table 5-12. Liquid Level Gauge HLD 3084 Calibration Chart*

Reading (Inches)	Liquid Contents (US GALLONS)		
	Ar	O_2	N_2
0	0	0	0
3	22	30	50
6	63	85	143
9	116	157	265
12	180	243	407
15	252	339	566
18	331	445	738
21	416	558	921
24	507	679	1112
27	603	805	1308
30	704	936	1508
33	807	1071	1709
36	915	1209	1909
39	1024	1349	2105
42	1136	1490	2296
45	1250	1632	2480
48	1365	1774	2652
51	1481	1916	2812
54	1598	2055	2955
57	1715	2192	3077
60	1831	2326	
63	1946	2456	
66	2060	2580	
69	2173	2699	
72	2283	2811	
75	2391	2914	
78	2496	3007	
81	2597		
84	2694		
87	2786		
90	2873		
93	2954		
96	3028		

*Calculated for saturated liquid at atmospheric pressure.

Table 5-13. Fill & Withdrawal Fitting Parts List

TYPE	PART NO.	DESCRIPTION
CGA	6510472	Oxygen Fixed End, 1-1/2"
CGA	6510572	Nitrogen Fixed End, 1-1/2"
CGA	6510672	Argon Fixed End, 1-1/2"
CGA	6510705	Oxygen Dust Cap, 1-1/2"
CGA	6510585	Nitrogen Dust Cap, 1-1/2"
CGA	6510695	Argon Dust Cap, 1-1/2"
CGA	6510062	Gasket, Teflon.1-1/2" I.D.
CGA	6510142	Oxygen Nut, for Hose
CGA	6510602	Nitrogen Nut, for Hose
CGA	6510642	Argon Nut, for Hose
CGA	6510412	Oxygen Tail Plug, for Hose
CGA	6510592	Nitrogen Tail Plug, for Hose
CGA	6510632	Argon Tail Plug, for Hose
CGA	6510172	Head Piece, for Hose, 1-1/2" CGA x 1-1/2" MPT
Linde	6510362	Fill Fitting
Linde	6510762	Gasket, Cooper, 1.75" I.D.
Linde	6510352	Nut
Linde	6510331	Blank Flange
Linde	6510341	Studs
Linde	6510441	Oxygen Flange, 1-1/2", for Hose
Linde	6510431	Nitrogen/Argon Flange, 1-1/2", for Hose
Linde	6510451	Nipple, 1-1/4", for Hose



6 APPENDIX

6.1 A. SAFETY BULLETIN

6.1.1 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 in water, exposure to extreme heat or fire, and exposure to most adverse weather conditions (earthquakes, tornadoes, etc.). As a rule of thumb, whenever a container is suspected of abnormal operation, or has sustained actual damage, good safety practices must be followed.

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

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

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

6.1.2 Oxygen Deficient Atmospheres

The normal oxygen content of air is approximately 21%. Depletion of oxygen content in air, either by combustion or by displacement with inert gas, is a potential hazard and users should exercise suitable precautions.

One aspect of this possible hazard is the response of humans when exposed to an atmosphere containing only 8 to 12% oxygen. In this environment, unconsciousness can be immediate with virtually no warning.

When the oxygen content of air is reduced to about 15 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 atmosphere containing 12% or less oxygen leads to rapid unconsciousness. Unconsciousness can occur so rapidly that the user is rendered essentially helpless. This can occur if the condition is reached by 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 obtainable 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.

*** Extracted from Safety Bulletin SB-2 from Compressed Gas Association, Inc., New York, dated March 1996; and from the "Nitrogen Material Data Sheet", published by Air Products and Chemicals, Inc., Allentown, PA, 18105, dated 1 June 1978.

If oxygen deficient atmosphere is suspected or known to exist:

1. Use the "buddy system." Use more than one "buddy" if necessary to move a fellow worker in an emergency.

2. Both the worker and "buddy" should be equipped with self-contained or air line breathing equipment.

6.1.3 Oxygen Enriched Atmospheres

An oxygen enriched atmosphere occurs whenever the normal oxygen content of air is allowed to rise above 23%. While oxygen is non-flammable, ignition of combustible materials can occur more readily in an oxygen-rich atmosphere than in air; and combustion proceeds at a faster rate although no more total heat is released. It is important to locate an oxygen system in a well-ventilated location, since oxygen-rich atmospheres may collect temporarily in confined areas during the functioning of a safety relief device or leakage from the system.

Oxygen system components, including but not limited to, containers, valves, valve seats, lubricants, fittings, gaskets and interconnecting equipment including hoses, shall have adequate compatibility with oxygen under the conditions of temperature and pressure to which the components may be exposed in the containment and use of oxygen. Easily ignitable materials shall be avoided unless they are parts of equipments or systems that are approved, listed, or proved suitable by tests or by past experience.

Compatibility involves both combustibility and ease of ignition. Materials that burn in air may burn violently in pure oxygen at normal pressure, and explosively in pressurized oxygen. In addition, many materials that do not burn in air may do so in pure oxygen, particularly when under pressure. Metals for containers and piping must be carefully selected, depending on service conditions. The various steels are acceptable for many applications, but some service conditions may call for other materials (usually copper or its alloys) because of their greater resistance to ignition and lower rate of combustion.

Similarly, materials that can be ignited in air have lower ignition energies in oxygen. Many such materials may be ignited by friction at a valve seat or stem packing, or by adiabatic compression produced when oxygen at high pressure is rapidly introduced into a system initially at low pressure.

6.1.4 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 below 19% unless equipped with a self-contained breathing apparatus. Unconsciousness and death may occur with virtually no warning if the oxygen concentration is below approximately 8%. Contact with cold nitrogen or argon gas or liquid can cause cryogenic (extreme low temperature) burns and freeze body tissue.

Persons suffering from lack of oxygen should be immediately moved to areas with normal atmospheres. SELF CONTAINED BREATHING APPARATUS MAY BE REQUIRED TO PREVENT ASPHYXIATION OF RESCUE WORKERS. Assisted respiration and

supplemental oxygen should be given if the victim is not breathing. If cryogenic liquid or cold boil-off gas contacts a worker's skin or eyes, the affected tissues should be promptly flooded or soaked with tepid water (105-115°; 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 and liquid cylinders is available in CGA Pamphlet P-9. Write to the Compressed Gas Association, New York, NY 10110.

6.2 B. DOT SPECIFICATIONS

6.2.1 One Way Travel Time

One way travel time is a rating established by the department of transportation for portable vessels. One way travel time is defined as "the time required between the loading of the tank and the subsequent unloading of the same tank at its final destination". One way travel time must not exceed the following ratings:

ONE WAY TRAVEL TIMES	
MODEL	**OWTT**
HLD 500	70 Hours
HLD 800	82 Hours
HLD 1200	90 Hours
HLD 1530	95 Hours
HLD 2072	140 Hours
HLD 3084	179 Hours

6.2.2 Retesting

According to the Department of Transportation, "any portable tank authorized for transportation of compressed gases (including liquefied compressed gases), must be retested at least once every five years." Test procedures are as follows:

PRESSURE. Each tank must be tested by a minimum pressure of at least 2 pounds per square inch gauge or at least one and one-half times the design pressure (maximum allowable working pressure, or re-rated pressure) of the tank, whichever is greater. During each pressure test, the entire surface of all joints under pressure must be coated with or immersed in a solution of soap and water, heavy oil, or other material suitable for the purpose of detecting leaks. The pressure must be held for a period of time sufficiently long to ensure detection of leaks. During the pressure test, relief devices may be removed, but all the closure fittings must be in place and the relief device openings plugged. Lagging need not be removed from a lagged tank if it is possible to maintain the required test pressure at constant temperature with the tank disconnected from the source of pressure.

VISUAL. While under the test pressure, the tank must be visually inspected for leakage, defective fittings and welds, defective closures, significant dents, and other defects or abnormalities which indicate a potential or actual weakness that could render the tank unsafe for the transportation of a hazardous material.

REJECTION CRITERIA. A tank fails to meet the requirements of the pressure test if, during the test, there is permanent distortion of the tank exceeding that permitted by the applicable specification, if there is any leakage, or if any deficiencies described in the visual check are found. Any tank that fails must be rejected and may not be used again for the transportation of hazardous material unless the tank is adequately repaired and thereafter a successful test is conducted in accordance with the requirements of this paragraph.

MARKING. The date of the most recent periodic retest must be marked on the tank, on or near the metal certification plate.

RECORDS. The owner of the tank or his authorized agent must retain a written record indicating the date and results of all required tests and the name and address of the tester, until the next retest has been satisfactorily completed and recorded. The date of retest must be stamped on or near the name plate.

NOTE
For further information, refer to Department of Transportation Exemption "DOT-E 6299", a copy of which was supplied with the HLD.