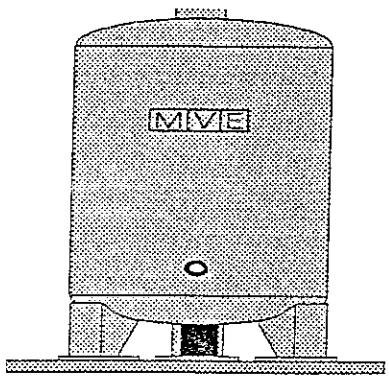
MVE, Inc.

TECHNICAL MANUAL

VERTICAL STORAGE SYSTEMS

VCS/VLS
SERIES



MANUAL # AAA0429

REVISION LOG

REVISION	REVISION DESCRIPTION
E (08/30/86)	All pages at revision E. This edition obsoletes all previous editions.
F (12/11/87)	Manual revised. Changes on pages iii, 1-2, 3-2, 3-4, and Tables 6-1, 6-3, 6-5, 6-7, 6-9, 6-11, 6-13, 6-15 and 6-17.
G (04/90)	Manual revised, added 2 schematics on 1-3; added outline and dimension drawings 4-4, 4-5.
H	Inside Covers, P G.1 new addresses, P 4-6 add note P 1-2, 1-3. Revise Weights Table 1-3, 1-3A

REVISION LETTERS I, O, Q, AND X ARE NOT USED.

Address all comments concerning this manual to:

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PREFACE

This edition documents Release F and all subsequent releases of the Minnesota Valley Engineering, Inc. (MVE) VCS and VLS cryogenic containers, unless otherwise indicated by MVE representatives or specified in new editions.

This manual is intended to provide the user with adequate information necessary to operate and maintain the containers. Chapter 1 provides a general introduction to the VCS and VLS containers. Chapter 2 describes operator controls and indicators. Operating procedures are contained in Chapter 3. Chapter 4 provides recommended handling and site preparation procedures. Chapter 5 describes recommended maintenance, troubleshooting, and repair procedures. Chapter 6 contains recommended spare/repair parts lists. Appendix A describes VCS optional equipment and accessories. Appendix B lists all abbreviations and acronyms used in this manual. Appendix C contains safety bulletins for applicable oxygen and inert gases (nitrogen and argon).

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

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SAFETY SUMMARY

MVE customer stations are safely designed with the following features:

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

2. Safety relief devices to protect the pressure vessel and vacuum casing, sized and selected in accordance with ASME standards to include a pressure control valve and rupture disc to protect the pressure vessel and a reverse buckling rupture disc or lift plate 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 Vertical Customer Station (VCS) or Vertical Liquid Station (VLS). We recommend that all our customers 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 carefully read and 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 Oxygen and Inert Gases located in Appendix C 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%). In an oxygen enriched atmosphere, flammable items burn vigorously and could explode. Certain items considered non-combustible in air may burn rapidly in such an environment Keep all organic materials and other flammable substances away from possible contact with oxygen; particularly oil, grease, kerosene, cloth, wood, paint, tar, coal dust, and dirt which may contain oil or grease. 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 parts or loosening fittings, empty the container contents 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 vessel.

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 outside boots or over the shoes to shed spilled liquid

WARNING

If clothing should be splashed with liquid oxygen or otherwise saturated with the gas, air out clothing immediately, removing the clothing if possible. Such clothing will be highly flammable and easily ignited while concentrated oxygen remains, and should not be considered safe for at least 30 minutes.

WARNING

Periodically check for excessive ice build-up. Should ice build-up be visible, let vessel thaw before re-starting. Failure to comply could result in vessel damage.

CAUTION

Only use replacement equipment which is compatible with liquid oxygen and has been cleaned for oxygen use. Do not use regulators, fittings, hoses, etc., which have been previously used in 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

Before locating oxygen equipment, become familiar with the National Fire Protection Association (NFPA) Standard No. 50, "Bulk Oxygen Systems at Consumer 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.

CAUTION

To prevent possible tip over, do not leave tank standing upright unless it is attached to the foundation (bolted down). Transport and erection of the tank should be performed in accordance with rigging instructions contained in this manual. Failure to comply with these instructions may result in serious damage to the container.

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1-1. GENERAL

The Minnesota Valley Engineering ***(MVE)*** cryogenic container is a compact, self-contained, and stationary liquid gas storage and delivery system. They are multi-layer or perlite insulated, medium pressure containers designed for storage of liquid argon, nitrogen, or oxygen, and for product withdrawal in either gaseous or liquid form.

The model designation **VLS** indicates that the cryogenic container is a "Vertical Liquid Station" intended for liquid withdrawal only. There are 6 standard models currently available, in multi-layer insulation only.

The model designation **VCS** indicates that the cryogenic container is a "Vertical Customer Station" intended for either gaseous or liquid withdrawal. The model numbers, i.e., 300, 500, 900, etc., indicate the approximate net capacity (in gallons) of the particular VCS.

1-2. PHYSICAL DESCRIPTION

An MVE Station is designed for long-term storage of cryogenic liquefied gases under pressure in the range of 5 to 250 PSIG. Operation of the station is fully automatic with the unit's regulator systems set to maintain preset pressure and flow conditions into a customer's pipeline. While hardware may vary slightly from model to model, each unit essentially performs the same functions.

The VCS or VLS is comprised of an alloy steel inner tank encased in an outer carbon steel vacuum shell. The insulation system between the inner and outer containers consists of multiple layer or powder insulation and high vacuum to ensure long holding time. The insulation system, designed for long- term vacuum retention, is permanently sealed at the factory to ensure vacuum integrity. The units have a tank pressure relief device which is set at the factory As a secondary pressure relief device, the container is further protected from overpressurization by a rupture disc. The bursting disc will rupture completely to relieve inner tank pressure in the event the tank relief valve fails and pressure exceeds the rupture disc setting. The vacuum space is protected from overpressurization by use of a tank annulus rupture disc assembly. Pressure relief devices used on VCS' or VLS' meet the requirements of CGA Pamphlet S1.3, "Pressure Relief Device Standards, Part 1, for Stationary Vessels."

The VCS or VLS is leg mounted. On the smaller units (300-1500 gallon), lifting lugs are secured to one leg and to the top head of the container. On units larger than 1500 gallon, the lifting lugs are located on the top and bottom heads. The lifting lugs are provided to facilitate handling. Moving requires the use of a crane and adherence to specific rigging instructions (see Chapter 4 in this manual for details on handling).

Controls used to operate the system are mounted under the customer station. The pressure gauge and liquid level gauge are located at eye level on the container for ease of viewing.

The VCS has a dual regulator system which uses both an economizer regulator and a pressure building regulator. The economizer regulator automatically allows vapor space gas to be introduced preferentially into the final line or gas use circuit when the customer station pressure exceeds the regulator setting. The pressure building regulator is used to maintain a minimum set pressure in the vessel. An optional third regulator, the final line regulator, can be used to control pressure and gas flow into the customer's line.

The VLS units only have a pressure building system, since they are designed for liquid use exclusively.

The vessels also contain a pressure building coil and a strainer assembly. The pressure building coil vaporizes the liquid to build up pressure in the tank. The strainer assembly protects the pressure building system from damage by contaminants.

Some VCS containers are shipped with an ambient air vaporizer. Containers are ready for service as soon as they are erected, bolted to the foundation, and have the process pipeline connected to the vaporizer outlet. VCS Models 315 through 1500 are shipped with the vaporizer mounted on the side of the tank (unless a tank is ordered without the vaporizer). Due to dimensional limitations for shipping, vaporizers are not factory installed on VCS's larger than Model 1500. On VCS's larger than Model 1500, the vaporizer is located adjacent to the container on the foundation.

The normal operating pressure range of a VCS is from approximately 50 to approximately 150 PSI, with a maximum working pressure of approximately 250 PSI. Operating pressure can be increased or decreased as desired by adjusting the regulators. Vessels with a higher pressure rating are available.

1-3. OPERATING DESCRIPTION

VCS operation is governed by the pressure build-up system, economizer system, and final line regulator system.

Pressure Build-Up System

The pressure build-up system consists of an ambient air vaporizer (PB-1) and pressure building regulator (R-1). When tank pressure becomes lower than the set point of the regulator (R-1), the regulator will open. As a result, liquid will be able to flow through the vapor trap in the annulus, through isolation valve V-5, strainer S-1, through R-1, to be expanded to vapor in P.B.-1. The vapor accumulates in the inner tank vapor space to increase pressure. This flow continues until inner tank pressure is equal to regulator R-1 setting. When the pressures are equal, R-1 closes. This system thus automatically maintains station pressure as required.

Economizer System

The economizer system allows the excess gas which accumulates in the vapor space during periods of low or no use to be consumed preferentially. In effect, it acts like an adjustable in-line relief valve, venting the tank into the customer use line (V-7). When vessel pressure is high, above the set point of R-2, R-2 opens. This allows gas, which flows more easily than the liquid, to flow out of the vapor space, through valve V-13, R-2, CV-2, and back into the tank to connect to the gas use line exiting through V-7. This preferential flow continues until R-2 closes. The VLS model does not have an economizer system, as it is not designed for gaseous use.

NOMENCLATURE

- V-1 VALVE, TOP FILL
- V-2 VALVE, BOTTOM FILL
- V-3 VALVE, FULL TRYCOCK
- V-4 VALVE, VENT
- V-5 VALVE, PRESSURE BUILDING, INLET
- V-6 VALVE, PRESSURE BUILDING, OUTLET
- V-7 VALVE, GAS USE
- V-8 VALVE, LIQUID PHASE (HIGH)
- V-9 VALVE, GAS PHASE (LOW)
- V-10 VALVE, EQUALIZATION
- V-11 VALVE, DRAIN
- V-12 VALVE, EVACUATION
- V-13 VALVE, ECONOMIZER ISOLATION
- V-16 VALVE, VACUUM PROBE SHUTOFF
- V-17 VALVE, LIQUID WITHDRAWAL FROM C-8 (OPTIONAL)
- V-18 VALVE, VAPOR RETURN TO C-9 (OPTIONAL)
- V-19 VALVE, LIQUID WITHDRAWAL FROM C-5 (OPTIONAL)
- V-20 VALVE, DUAL RELIEF 3-WAY
- V-21 BACK PRESSURE REGULATOR ISOLATION (OPTIONAL)
- V-22A SV-1A TEST
- V-22B SV-1B TEST
- CV-1 CHECK VALVE, FILL
- CV-2 ECONOMIZER ISOLATION CHECK VALVE
- R-1 REGULATOR, PRESSURE BUILDING (PRESSURE CONTROL VALVE 1)
- R-2 REGULATOR, ECONOMIZER (PRESSURE CONTROL VALVE 2)
- R-4 REGULATOR, BACK PRESSURE (OPTIONAL)
- RV-1 RELIEF VALVE, LINE
- RV-2A RELIEF VALVE, INNER VESSEL
- RV-2B RELIEF VALVE, INNER VESSEL
- BD-1A BURST DISC, INNER VESSEL
- BD-1B BURST DISC, INNER VESSEL
- BD-2 RELIEF DEVICE, OUTER VESSEL
- PB-1 PRESSURE BUILDING COIL
- LL-1 GAUGE, LIQUID LEVEL
- G-1 GAUGE, PRESSURE
- S-1 STRAINER
- C-1 CONNECTION, FILL (CGA)
- C-2 CONNECTION, GAS USE
- C-3 CONNECTION, FULL TRYCOCK
- C-4 CONNECTION, VENT
- C-5 CONNECTION, LIQUID (CAPPED)
- C-6 CONNECTION, VENT (CAPPED)
- C-7 CONNECTION, DRAIN
- C-8 CONNECTION, PUMP FEED (CAPPED)
- C-9 CONNECTION, PUMP RETURN (CAPPED)
- C-10 CONNECTION, VAPOR (CAPPED)
- C-11 CONNECTION, LIQUID (VACUUM INSULATED PIPE) (OPTIONAL)
- TC-1 VACUUM PROBE

Figure 1-2. VCS Flow Diagram for VCS-3000 and larger

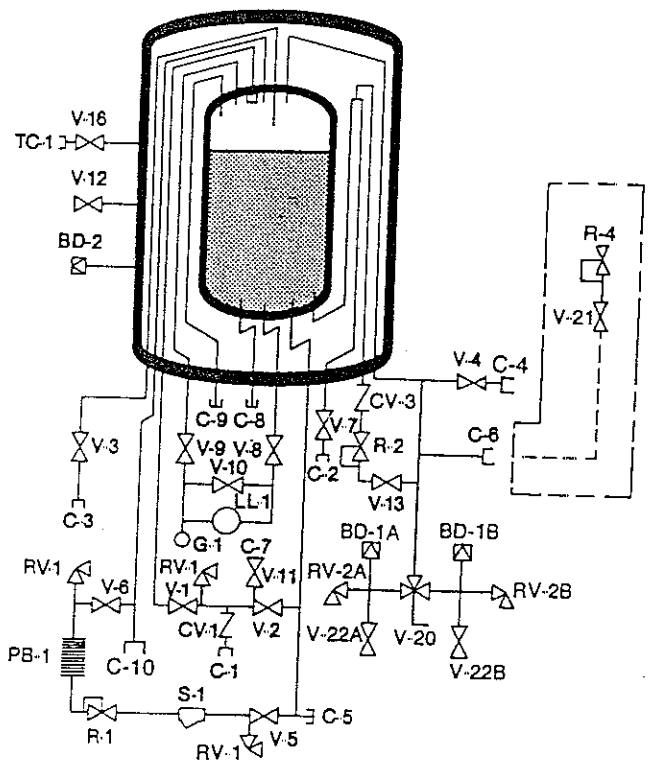


Figure 1-1. VLS Flow Diagram

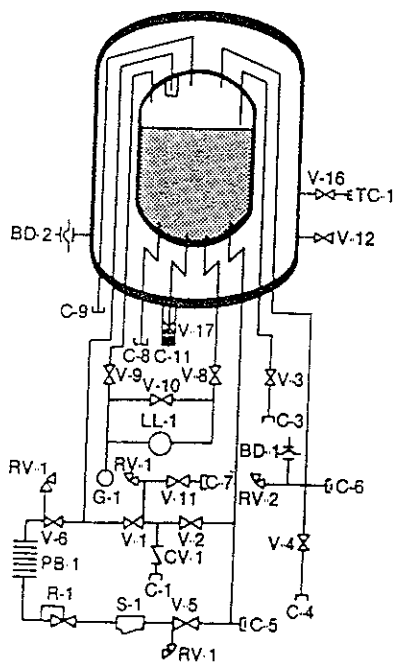
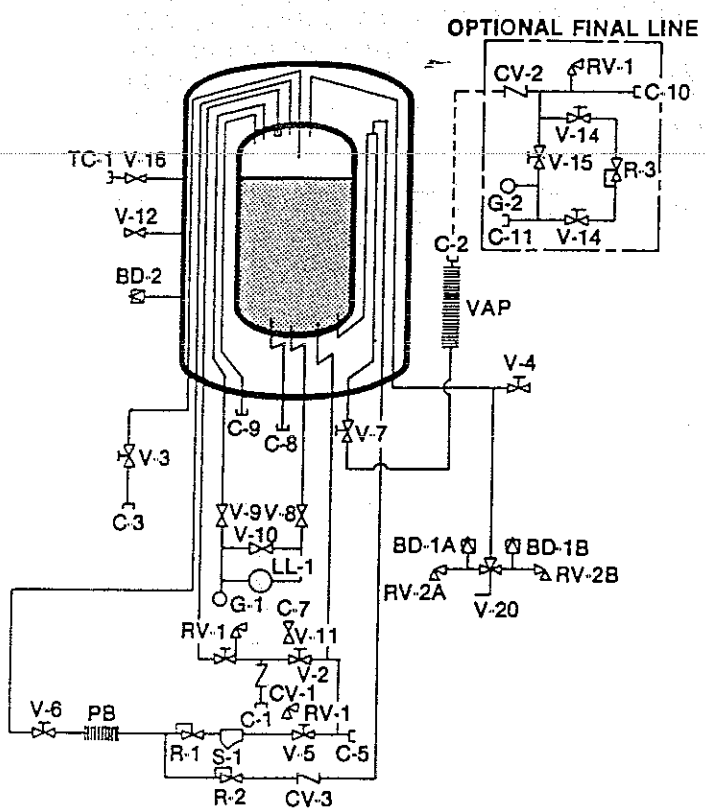


Figure 1-3. Schematic for VCS 315-VCS 1500



NOMENCLATURE

V-1	VALVE, TOP FILL
V-2	VALVE, BOTTOM FILL
V-3	VALVE, FULL TRYCOCK
V-4	VALVE, MANUAL VENT
V-5	VALVE, PRESSURE BUILDING
V-6	VALVE, PRESSURE BUILDING AND ECONOMIZER ISOLATION
V-7	VALVE, GAS USE
V-8	VALVE, LIQUID PHASE (HIGH)
V-9	VALVE, GAS PHASE (LOW)
V-10	VALVE, EQUALIZER
V-11	VALVE, DRAIN
V-12	EVACUATION
V-14	VALVE, ISOLATION FINAL LINE
V-15	VALVE, BY-PASS FINAL LINE
V-16	VALVE, SHUTOFF VACUUM PROBE
V-20	VALVE, DUAL RELIEF 3-WAY
CV-1	CHECK VALVE, FILL
CV-2	CHECK VALVE, FINAL LINE
CV-3	CHECK VALVE, PRESSURE BUILDING
S-1	STRAINER, P.B. FEED
RV-1	RELIEF VALVE, LINE
RV-2A	RELIEF VALVE, INNER VESSEL
RV-2B	RELIEF VALVE, INNER VESSEL
R-1	REGULATOR, PRESSURE BUILDING
R-2	REGULATOR, ECONOMIZER
R-3	REGULATOR, FINAL LINE
BD-1A	BURST DISC, INNER VESSEL
BD-1B	BURST DISC, INNER VESSEL
BD-2	BURST DISC, ANNULUS
PB	PRESSURE BUILDING COIL
G-1	GAUGE, INNER VESSEL
G-2	GAUGE, FINAL LINE
LL-1	GAUGE, LIQUID LEVEL
C-1	CONNECTION, FILL
C-2	CONNECTION, GAS USE
C-3	CONNECTION, FULL TRYCOCK
C-5	CONNECTION, AUXILIARY LIQUID (CAPPED)
C-7	CONNECTION, DRAIN
C-8	CONNECTION, LIQUID WITHDRAWAL (CAPPED)
C-9	CONNECTION, VAPOR (CAPPED)
C-10	CONNECTION, FINAL LINE (CAPPED)
C-11	CONNECTION, CUSTOMER HOUSE LINE
TC-1	VACUUM PROBE
VAP	VAPORIZER

Final Line Regulator System

The optional final line regulator system is used to automatically control the pressure and flow of gas into the customer's pipeline. Check valves in this assembly prevent surging or back pressure conditions downstream from reaching the station.

For best results, a 20 PSIG pressure differential should exist between the optional final line regulator, the pressure building regulator, and the economizer regulator. The normal operating range of the tank is then between 20 to 40 PSIG above the final line set point.

Regulator	Setting
Final line	Customer requirement
Pressure building	20 PSI over final line
Economizer	40 PSI over final line

1-4. FEATURES

The MVE VCS and VLS cryogenic vessel is designed to furnish a convenient, reliable, and economical method for the storage and use of liquid oxygen, nitrogen, or argon. Important features of these containers include:

- Pressure building and economizer circuits automatically maintain customer station pressure as required.
- VCS units 900 gallons and above are configured with additional liquid and vapor withdrawal lines (C-9 and C-8).
- The vessel can be refilled with liquid from a liquid supply unit by either pumping or pressure transfer, without being taken out of service.
- Gas stored in a VCS is usually purer than gas stored in conventional high pressure containers. Ultra clean options for VCS units are available.

1-5. CONFIGURATIONS AND SPECIFICATIONS

VCS and VLS cryogenic containers are constructed with all operating controls and indicators uniquely situated under the customer station or mounted on the container at eye level. In a stand-alone operating environment, the VCS enables the user, through the use of system valves, to completely set various operational parameters.

The VCS may be configured as a hospital service customer station. When used as such, an MVE hospital reserve kit and liquid level gauge with a low-level alarm are added to the system. The MVE hospital reserve kit is designed to control the emergency supply of liquid oxygen available from the VCS. (See Appendix A for further details on this optional assembly.)

Model VLS cryogenic containers are designed for efficient low pressure liquid-only storage and use. An optional vacuum insulated outlet is available for the ultimate efficiency and conditioning in liquid use.

General VCS and VLS specifications are provided in Tables 1-2 and 1-3. Liquid contents charts for the various VCS models are located in Chapter 6. These tables use the readings of the liquid level gauge (inches of water) to calculate the amount of liquid left in the tank (gallons).

Table 1-1. General VCS Specifications

DESCRIPTION	SPECIFICATIONS
Normal Operating Pressure Range	50 through 150 PSIG
Vacuum Jacket Material	Carbon Steel
Pressure Building Regulator Range	50 through 200 PSIG (Factory set at 120 PSIG)
Economizer Regulator Range	50 through 175 PSIG (Factory set at 140 PSIG)
Final Line Regulator Range (Optional)	5 through 120 PSIG, or 100 through 200 PSIG (Factory set at 100 PSIG)
Color	White
Higher pressure custom built models are available.	

1-6. OPERATOR QUALIFICATIONS

The VCS or VLS is designed for safe and simple operation. The operator is expected to be knowledgeable of the nature of the gas(es) with which he is working, as well as all applicable safety requirements. Operating Instructions are described in Chapter 3, Handling Instructions in Chapter 4, and Maintenance Procedures in Chapter 5. To fully understand these procedures, we recommend the operator first become familiar with controls and indicators as described in Chapter 2.

Table 1-2. VCS/VLS Container Specification—Super Insulated

DESCRIPTION	MODEL															
	VCS 315-SS	VCS 525-SS	VCS 900-SS	VCS 1500-SS	VCS 1500-NS	VLS 1500-SS	VCS 3000-SS	VLS 3000-SS	VCS 6000-SS	VLS 6000-SS	VCS 9000-SS	VLS 9000-SS	VCS 11000-SS	VLS 11000-SS	VCS 13000-SS	VLS 13000-SS
	DESIGN															
	250-MVE-0	250-MVE-0	250-MVE-0	250-MVE-0	250-MVE-0	50-MVE-0	250-MVE-0	50-MVE-0	250-MVE-0	75-MVE-0	250-MVE-0	75-MVE-0	250-MVE-0	75-MVE-0	250-MVE-0	75-MVE-0
Physical Characteristics																
• Diameter (Ins)	48	48	60	66	68	66	96	96	96	96	114	114	114	114	120	120
• Height (Ins)	99	137	144	182	182	180	194	182	330	308	372	370	433	425	439	450
• Tare Weight (lbs) (Approximate)	2,100	3,500	5,425	8,520	7,530	7,400	16,600	12,169	30,325	20,007	48,324	35,434	57,725	44,455	64,500	45,817
• Filled Weight (lbs)																
—Liquid Oxygen	5,034	8,252	13,999	23,198	22,208	22,081	45,181	40,750	87,467	77,169	134,067	121,177	164,602	149,252	188,779	167,791
—Liquid Nitrogen	4,178	6,841	11,495	18,910	17,920	17,797	36,841	32,410	70,807	60,489	109,047	96,157	134,000	118,672	153,161	132,199
—Liquid Argon	5,682	9,283	15,891	28,438	25,448	25,332	51,490	47,059	100,105	89,787	152,994	140,104	187,735	172,385	215,703	194,716
Gross Capacity (gal)	331	555	961	1,639	1,629	1,639	3,157	3,157	6,250	6,250	9,375	9,375	11,458	11,458	13,336	13,336
Net Capacity (gal)	308	500	900	1,541	1,531	1,541	3,000	3,000	6,000	6,000	9,000	9,000	11,000	11,000	12,803	12,803
Equivalent Capacity of Gas																
• Oxygen (SCF at NTP)	35,451	57,550	103,590	177,369	177,369	177,369	345,300	345,300	690,600	690,600	1,035,900	1,035,900	1,266,100	1,266,100	1,473,625	1,473,625
• Nitrogen (SCF at NTP)	28,878	48,555	83,799	143,483	143,483	143,483	279,330	279,300	558,660	558,660	837,990	837,990	1,024,210	1,024,210	1,192,087	1,192,087
• Argon (SCF at NTP)	34,650	56,250	101,250	173,363	173,363	173,363	337,500	337,500	675,000	675,000	1,012,500	1,012,500	1,237,500	1,237,500	1,440,338	1,440,338
M.A.W.P. (PSI)	250	250	250	250	250	50	250	50	250	75	250	75	250	75	250	75
Line Relief Valves	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350
Inner Vessel Rupture Disc Setting (PSI)	375	375	375	375	375	75	375	75	375	112.5	375	112.5	375	112.5	375	112.5
Normal Evaporation Rate %/Day LOX (Approximate)	.90	.55	.40	.40	.40	.35	.18	.17	.15	.15	.10	.10	.10	.10	.10	.10
Standard Vaporizer (SCFH)	615	1,500+	2,000	2,000	2,000	*	*	*	*	*	*	*	*	*	*	*

NOTE: Refer to pad layout.

NOTE: Values rounded off to nearest whole number.

*Free Standing Vaporizer Available

Design Code: ASME Section VIII, Div. 1

Table 1-2A. VCS/VLS Container Specification (Metric Units)—Super Insulated

DESCRIPTION	MODEL															
	VCS 315-SS	VCS 525-SS	VCS 900-SS	VCS 1500-SS	VCS 1500-NS	VLS 1500-SS	VCS 3000-SS	VLS 3000-SS	VCS 6000-SS	VLS 6000-SS	VCS 9000-SS	VLS 9000-SS	VCS 11000-SS	VLS 11000-SS	VCS 13000-SS	VLS 13000-SS
	DESIGN															
	250-MVE-0	250-MVE-0	250-MVE-0	250-MVE-0	250-MVE-0	50-MVE-0	250-MVE-0	50-MVE-0	250-MVE-0	75-MVE-0	250-MVE-0	75-MVE-0	250-MVE-0	75-MVE-0	250-MVE-0	75-MVE-0
Physical Characteristics																
• Diameter (cm)	122	122	152	168	173	168	244	244	244	244	290	290	290	290	305	305
• Height (cm)	246	343	381	457	462	457	488	488	831	831	937	937	1,092	1,092	1,107	1,107
• Tare Weight (Kg) (Approximate)	953	1,588	2,461	3,865	3,422	3,357	7,530	5,520	13,755	9,075	21,920	16,073	27,128	20,165	30,302	20,783
• Filled Weight (Kg)																
—Liquid Oxygen	2,284	3,734	6,350	10,524	11,104	10,016	20,494	18,484	39,684	35,004	60,813	54,966	74,663	67,701	85,630	76,110
—Liquid Nitrogen	1,895	3,103	5,215	8,581	8,145	8,073	16,711	14,701	32,118	27,438	49,464	43,617	60,792	53,830	69,485	59,965
—Liquid Argon	2,577	4,211	7,209	11,994	11,567	11,486	23,356	21,348	45,408	40,727	69,398	63,551	85,157	78,194	97,843	89,323
Gross Capacity (l)	1,253	2,101	3,660	6,204	6,204	6,204	11,949	11,949	23,656	23,656	35,484	35,484	43,369	43,369	50,477	50,477
Net Capacity (l)	1,166	1,893	3,407	5,833	5,833	5,833	11,355	11,355	22,710	22,710	34,065	34,065	41,635	41,635	48,459	48,459
Equivalent Capacity of Gas																
• Oxygen (NM3)	932	1,513	2,723	4,662	4,662	4,662	9,075	9,075	18,150	18,150	27,225	27,225	33,275	33,275	38,729	38,729
• Nitrogen (NM3)	754	1,224	2,202	3,771	3,771	3,771	7,341	7,341	14,682	14,682	22,023	22,023	26,917	26,917	31,329	31,329
• Argon (NM3)	911	1,479	2,861	4,557	4,557	4,557	8,871	8,871	17,742	17,742	26,613	26,613	32,527	32,527	37,858	37,858
M.A.W.P. (KPa)	1,724	1,724	1,724	1,724	1,724	345	1,724	345	1,724	517	1,724	517	1,724	517	1,724	517
Line Relief Valves (KPa)	2,414	2,414	2,414	2,414	2,414	2,414	2,414	2,414	2,414	2,414	2,414	2,414	2,414	2,414	2,414	2,414
Inner Vessel Rupture Disc Setting (KPa)	2,586	2,586	2,586	2,586	2,586	517	2,586	517	2,586	776	2,586	776	2,586	776	2,586	776
Normal Evaporation Rate %/Day LOX (Approximate)	.90	.55	.40	.40	.40	.35	.18	.17	.15	.15	.10	.10	.10	.10	.10	.10
Standard Vaporizer (NM3/H)	16	39	53	53	53	0	0	0	0	0	0	0	0	0	0	0

NOTE: Refer to pad layout.

*Free Standing Vaporizer Available

Design Code: ASME Section VIII, Div. 1

Table 1-3. VCS/VLS Container Specification—Powder Insulated

DESCRIPTION	MODEL														
	VCS 3000-SP	VCS 3000-NP	VLS 3000-SP	VCS 6000-SP	VCS 6000-NP	VLS 6000-SP	VCS 9000-SP	VCS 9000-NP	VLS 9000-SP	VCS 11000-SP	VCS 11000-NP	VLS 11000-SP	VCS 13000-SP	VCS 13000-NP	VLS 13000-SP
	DESIGN														
	250-MVE-0	250-MVE-0	50-MVE-0	250-MVE-0	250-MVE-0	75-MVE-0	250-MVE-0	250-MVE-0	75-MVE-0	250-MVE-0	250-MVE-0	75-MVE-0	250-MVE-0	250-MVE-0	75-MVE-0
Physical Characteristics															
• Diameter (Ins)	96	96	96	96	96	96	114	114	114	114	114	114	120	120	120
• Height (Ins)	194	194	184	330	330	308	372	372	372	433	433	433	439	439	439
• Tare Weight (lbs) (Approximate)	18,400	15,550	14,179	32,725	28,800	22,983	52,610	48,700	40,664	64,855	57,681	50,475	72,004	63,569	51,517
• Filled Weight (lbs)															
—Liquid Oxygen	46,981	44,131	42,760	89,887	85,962	80,145	138,353	132,443	126,407	169,652	162,476	155,272	193,979	185,544	173,482
—Liquid Nitrogen	38,635	35,785	34,420	73,195	69,282	63,465	113,315	107,423	101,387	139,050	131,876	124,692	158,361	149,926	137,892
—Liquid Argon	53,290	50,440	49,069	102,505	98,580	92,763	157,280	151,370	145,334	192,785	185,611	178,405	220,903	212,468	200,404
Gross Capacity (gal)	3,157	3,157	3,157	6,250	6,250	6,250	9,375	9,375	9,375	11,485	11,485	11,485	13,336	13,336	13,336
Net Capacity (gal)	3,000	3,000	3,000	6,000	6,000	6,000	9,000	9,000	9,000	11,000	11,000	11,000	12,802	12,802	12,802
Equivalent Capacity of Gas															
• Oxygen (SCF at NTP)	345,300	345,300	345,300	690,600	690,600	690,600	1,035,900	1,035,900	1,035,900	1,266,100	1,266,100	1,266,100	1,473,510	1,473,510	1,473,510
• Nitrogen (SCF at NTP)	279,330	279,330	279,330	558,660	558,660	558,660	837,990	837,990	837,990	1,024,210	1,024,210	1,024,210	1,191,994	1,191,994	1,191,994
• Argon (SCF at NTP)	337,500	337,500	337,500	675,000	675,000	675,000	1,012,500	1,012,500	1,012,500	1,237,500	1,237,500	1,237,500	1,440,225	1,440,225	1,440,225
M.A.W.P. (PSI)	250	250	50	250	250	75	250	250	75	250	250	75	250	250	75
Line Relief Valves	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350
Inner Vessel Rupture Disc Setting (PSI)	375	375	75	375	375	112.5	375	375	112.5	375	375	112.5	375	375	112.5
Normal Evaporation Rate %/Day LOX (Approximate)	.50	.50	.50	.30	.30	.30	.26	.26	.26	.25	.25	.25	.25	.25	.25

NOTE: Refer to pad layout on page 4-2.

*Free Standing Vaporizer Available

Design Code: ASME Section VIII, Div. 1

Table 1-3A. VCS/VLS Container Specification (Metric Units)—Powder Insulated

DESCRIPTION	MODEL														
	VCS 3000-SP	VCS 3000-NP	VLS 3000-SP	VCS 6000-SP	VCS 6000-NP	VLS 6000-SP	VCS 9000-SP	VCS 9000-NP	VLS 9000-SP	VCS 11000-SP	VCS 11000-NP	VLS 11000-SP	VCS 13000-SP	VCS 13000-NP	VLS 13000-SP
	DESIGN														
	250-MVE-0	250-MVE-0	50-MVE-0	250-MVE-0	250-MVE-0	75-MVE-0	250-MVE-0	250-MVE-0	75-MVE-0	250-MVE-0	250-MVE-0	75-MVE-0	250-MVE-0	250-MVE-0	75-MVE-0
Physical Characteristics															
• Diameter (cm)	244	244	244	244	244	244	290	290	290	290	290	290	305	305	305
• Height (cm)	488	493	486	831	831	831	927	927	1,080	937	1,092	1,092	1,107	1,107	1,107
• Tare Weight (Kg) (Approximate)	8,346	7,052	6,432	14,844	13,064	10,425	23,864	21,183	18,445	29,432	26,164	22,895	32,661	28,835	23,368
• Filled Weight (Kg)															
—Liquid Oxygen	21,311	20,014	19,396	40,773	38,992	36,354	62,757	60,076	57,338	76,968	73,700	70,431	87,984	84,156	78,691
—Liquid Nitrogen	17,528	16,229	15,613	33,207	31,426	28,788	51,408	48,727	45,989	63,097	59,829	56,560	71,841	68,015	62,548
—Liquid Argon	24,172	22,875	22,258	46,496	44,716	42,077	71,342	68,661	65,924	87,461	84,193	80,925	100,196	96,370	90,903
Gross Capacity (l)	11,949	11,949	11,949	23,656	23,656	23,656	35,484	35,484	35,484	43,471	43,471	43,471	50,477	50,477	50,477
Net Capacity (l)	11,355	11,355	11,355	22,710	22,710	22,710	34,065	34,065	34,065	41,635	41,635	41,635	48,456	48,456	48,456
Equivalent Capacity of Gas															
• Oxygen (NM3)	9,075	9,075	9,075	18,150	18,150	18,150	27,225	27,225	27,225	33,275	33,275	33,275	38,726	38,728	38,726
• Nitrogen (NM3)	7,341	7,341	7,341	14,682	14,682	14,682	22,023	22,023	22,023	26,917	26,917	26,917	31,326	31,328	31,326
• Argon (NM3)	8,871	8,871	8,871	17,742	17,742	17,742	26,613	26,613	26,613	32,527	32,527	32,527	37,856	37,856	37,856
M.A.W.P. (KPa)	1,724	1,724	345	1,724	1,724	517	1,724	1,724	517	1,724	1,724	517	1,724	1,724	517
Line Relief Valves (KPa)	2,414	2,414	2,414	2,414	2,414	2,414	2,414	2,414	2,414	2,414	2,414	2,414	2,414	2,414	2,414
Inner Vessel Rupture Disc Setting (KPa)	2,586	2,586	517	2,586	2,586	776	2,586	2,586	776	2,586	2,586	776	2,586	2,586	776
Normal Evaporation Rate %/Day LOX (Approximate)	.50	.50	.50	.30	.30	.30	.26	.26	.26	.25	.25	.25	.26	.25	.26

NOTE: Refer to pad layout on page 4-2.

NOTE: Values rounded off to nearest whole number.

*Free Standing Vaporizer Available

Design Code: ASME Section VIII, Div. 1

2-1. GENERAL

VCS and VLS cryogenic container operating procedures specify that the operator shall be familiar with all controls and indicators. Pressure gauge G-1 and liquid level gauge LL-1 and V-10, equalization valve are mounted at eye level on the container. All other controls and indicators are mounted under the customer station. VCS and VLS controls and indicators, with appropriate reference designators, are shown in alphabetical order.

Table 2-1. Controls and Indicators

REFERENCE DESIGNATION	CONTROL/INDICATOR	PURPOSE
BD-1	Tank Burst Disc	The rupture disc that will rupture completely to relieve inner tank pressure in the event the tank relief valve (RV-2) malfunctions and pressure reaches 1.5 times the maximum allowable working pressure.
BD-2	Annulus Burst Disc	The rupture disc that will rupture completely in the event pressure in the container vacuum jacket reaches a predetermined setting.
C-1	Fill Connection	The connection point used for filling liquid gas into the customer station.
C-2	Customer Gas Use Connection	Connection used for customer gas line connection to the vessel.
C-3	Full Trycock Connection	The full trycock connection point that may be used during filling operation.
C-4	Vent Connection	The connection point for the vent valve (V-4) output line.
C-5	Liquid Withdrawal Connection (Capped)	The connection point that can be used for liquid supply. This connection is normally capped.
C-6	Vent Connection (Capped)	A connection point that may be used for gas sampling. It may also be used as a pump vapor return. This connection point is normally capped.
C-7	Drain Connection	The hose drain connection point may be used in conjunction with the drain valve.
C-8	Liquid Withdrawal Connection (Capped)	The connection point that is used primarily for liquid pump inlet in 900 gallon and larger stations. This connection point is normally capped.
C-9	Pump Vapor Return Connection (Capped)	The connection point used primarily for pump return. This connection is normally capped and is standard on 900 gallon and larger stations.
C-10	Connection, Gas	Auxiliary gas connection point. (VCS-3000 and larger)
C-11	Liquid Connection (V.I.P.)	Optional liquid-only withdrawal through vacuum insulate pipe.
C-12	Optional Hospital Reserve Connection	The connection point used to connect the final line assembly to the hospital reserve kit.
CV-1	Fill Check Valve	The check valve used to prevent reverse flow through the fill fitting during a liquid fill operation.

Table 2-1. **Controls and Indicators** (continued)

REFERENCE DESIGNATION	CONTROL/INDICATOR	PURPOSE
CV-2	Economizer Isolation Check Valve	Prevents reverse flow of gas, and allows economizer to be serviced.
CV-3	Final Line Check Valve	The check valve used to prevent any downstream gas from back flowing into the bottom of the station.
G-1	Pressure Gauge	The indicator used to show inner vessel vapor pressure.
G-2	Final Line Pressure Gauge	The indicator used to show customer line pressure.
LL-1	Liquid Level Gauge	An indicator used to show the quantity of liquid in the station in inches of water. The contents chart for each tank size converts the readings to gallons of oxygen, nitrogen, or argon at 0 PSI pressure.
PB-1	Pressure Building Coil	The coil used to vaporize liquid and build vapor pressure in the tank.
R-1	Pressure Building Regulator	The regulator used to automatically control the minimum set pressure in the vessel.
R-2	Economizer Regulator	The regulator that automatically allows vapor space gas to be introduced preferentially into the gas use circuit when the customer station pressure exceeds the regulator setting.
R-3	Final Line Regulator	The regulator used to control pressure in the customer's house line.
RV-1	Line Relief Valve	The relief valve that automatically relieves pressure in line whenever pressure exceeds the 350 PSI setting.
RV-2	Tank Relief Valve	The safety relief valve used to automatically relieve inner tank pressure when the pressure exceeds the maximum allowable working pressure.
RV-4	Final Line Relief Valve	The relief valve used to relieve pressure in the vaporizer and connecting piping whenever the pressure setting is exceeded.
S-1	Strainer	The filtering device used to protect the pressure build-up system from damage by contaminants.
V-1	Top Fill Valve	The valve which is normally used for transferring liquid into the top of the customer station. This valve is normally closed except during top filling.
V-2	Bottom Fill Valve	The valve which may be used to transfer liquid into the bottom of the customer station. Generally not used.

Table 2-1. Controls and Indicators (continued)

REFERENCE DESIGNATION	CONTROL/INDICATOR	PURPOSE
V-3	Full Trycock Valve	The valve used to determine when the vessel is full (used during a filling operation). Liquid will spit from the trycock when full. Except during filling operations, this valve is normally closed.
V-4	Manual Vent Valve	The valve used to vent pressure from the inner tank vapor space. This valve is normally closed.
V-5	Pressure Building Valve	The valve used to control flow into the pressure building system of the vessel. This valve is normally open.
V-6	Pressure Building Isolation Shutoff Valve	The valve used to isolate the inner tank vapor space from the pressure build-up and economizer circuits. This valve is open except during maintenance.
V-7	Gas Use Valve (Liquid to Vaporizer)	The valve used to allow liquid to flow into the external vaporizer where it is converted into gas. This valve is normally open.
V-8, V-9	Liquid Phase (High) and Gas Phase (Low) Valves	These instrument valves are used to isolate the liquid level gauge and pressure gauge from the inner tank. These valves are normally open.
V-10	Equalization Valve	The valve used for equalizing the high phase and low phase sides of the liquid level gauge (LL-1). This valve is normally closed, except during servicing or calibration.
V-11	Drain Valve	The valve used to drain any trapped liquid in the transfer hose at completion of fill, and to cool down the hose before liquid transfer. This valve is normally closed.
V-12	Evacuation Valve	The valve used to evacuate the container vacuum space. This valve is always closed. **DO NOT** touch or attempt to manipulate this valve.
V-13	Economizer Isolation Valve	The shutoff valve used to isolate the economizer line from the inner tank. This valve is normally open. (This valve has been replaced by CV-3 on some models.)
V-14	Final Line Regulator Isolation Valves (2)	These valves are used to isolate the final line regulator. The valves are normally open, except during servicing.
V-15	Final Line Regulator By-Pass Valve	The by-pass valve used to allow product flow around the final line regulator. This valve is normally closed.
VP-1	Vaporizer	The device used to vaporize the liquid product.

3-1. GENERAL

This chapter provides the initial fill, gas use, liquid delivery, and refilling procedures for VCS and VLS containers. Before performing any of the procedures contained in this chapter, become familiar with the location and function of VCS controls and indicators.

NOTE

If a procedure in this section specifies the use of a valve that is not on your container, disregard that portion of the procedure.

3-2. INITIAL FILL

The initial fill is usually performed on a warm VLS or VCS, one that has not been in use for an extended period of time. The warm container must be purged to ensure product purity.

When preparing the tank for filling or when changing service, the following items should be considered:

1. The vessel should be inspected for possible damage or unsuitability for the intended use. If damage is detected (e.g. serious dents, loose fittings, etc.) remove the unit from service and perform repairs as soon as possible.

2. The VCS or VLS may be filled by pumping or pressure transfer. If internal VCS pressure is at least 50 PSI less than the maximum allowable pressure of the supply unit, liquid may be transferred by 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.

3. To remove moisture or foreign matter from the tank or tank lines, the vessel must be purged. Use a small amount of the new product for purging when changing service, and a small amount of the same product if the purge is to ensure purity or remove contaminants.

4. When changing service, the approved CGA fitting will have to be installed for connection C-1.

Detailed purging procedures are provided in Table 3-1. Table 3-2 provides the top filling procedure.

Table 3-1. VCS Purging Procedure

STEP NUMBER	PROCEDURE
	CAUTION 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 operation. To prevent drawing atmospheric contaminants back into the tank, a positive pressure of at least 5 PSIG must always be maintained in the tank
1	Attach the source of liquid purge product to the fill connection (C-1)
2	Close all valves except the pressure build-up valves (V-5 and V-6) and liquid level gauge vapor phase and liquid phase shutoff valves (V-8 and V-9).
	NOTE The pressure building regulator is normally set to build pressure to 120 PSIG. When this pressure is used as the purge pressure, DO NOT adjust the regulator adjusting screw. When a solenoid valve is used to control the pressure building circuit, it must be energized.
3	Open hose drain valve (V-11) and allow source to vent through hose. Vent until slight frosting appears on hose. Close V-11.
4	Open the bottom fill valve (V-2) enough to allow liquid to flow slowly into the tank through the bottom fill line. The gradual flow enables the liquid to vaporize in the line and pressure buildup coil (PB-1), and to slowly build up pressure in the inner tank.

Table 3-1. VCS Purging Procedure (continued)

STEP NUMBER	PROCEDURE
5	Shut off the liquid supply source when the pressure in the tank reaches the maximum purge pressure as indicated on tank pressure gauge (G-1).
6	Open the fill line drain valve (V-11) slowly to avoid splashing of 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.
7	Close drain valve (V-11) and bottom fill valve (V-2).
8	When all liquid is drained, close the liquid level gauge vapor phase and liquid phase shut-off valves (V-8 and V-9). Open the liquid level gauge by-pass valve (V-10) to prevent damage to the gauge before closing valves V8 and V9.
9	Loosen 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 checked for signs of moisture. Provided no moisture is observed after blowing the lines for approximately two minutes, both valves should be closed. If moisture is observed in the gas stream, the gas should be discharged until it is clear of all moisture. **NOTE** A careful check for moisture in the phase lines will ensure trouble-free operation of the liquid level gauge. Due to their small diameter, gauge lines are easily plugged by ice.
10	Open the vapor vent valve (V-4) and full trycock valve (V-3) The top fill valve (V-1) will have to be vented by opening hose drain valve (V-11)
11	Repeat purge procedures 2 through 6 and 10 at least three times to ensure product purity.
12	Reconnect the liquid level gauge (LL-1), open the liquid level control valves (V-8 and V-9), then close the by-pass valve (V-10).
13	After purging the tank, but before filling, verify that the following valves are open or closed as indicated: Valve — Position Bottom fill valve (V-2) — Closed Top fill valve (V-1) — Closed Vapor vent valve (V-4) — Closed Full trycock valve (V-3) — Closed Liquid level gauge equalizing valve (V-10) — Closed Gas use valve (V-7) — Closed Pressure building shut-off isolation valve (V-6) — Closed Economizer isolation valve (V-13) — Closed Liquid level gauge liquid phase valve (V-8) — Open Liquid level gauge vapor phase valve (V-9) — Open

Table 3-2. Initial (Warm Tank) Filling Procedure

STEP NUMBER	PROCEDURE
1	Purge tank to assure product purity (see Table 3-1).
2	Verify that the contents of the supply unit is the proper product to be transferred.
3	Verify that all valves except liquid phase-high (V-8) and gas phase-low (V-9) are closed.
4	Connect the supply unit transfer hose to tank fill connection (C-1).
	NOTE Cool down the transfer hose prior to filling by opening hose drain valve (V-11) and the supply unit discharge valve for approximately three minutes. Close drain valve (V-11).
5	Open top fill valve (V-1) slowly.
6	If a pressure transfer is to be made, allow pressure to build up in the liquid supply unit until it is at least 50 PSI higher than station pressure. Open the discharge valve on the supply unit to begin flow. (or) If a pump transfer is to be made, make the required connections to the pump. Open the supply unit transport discharge valve slowly. Maintain pump discharge pressure from 50 to 100 PSI higher than tank pressure.
7	Monitor pressure tank (P-1) during filling. If pressure rises above supply pressure, or near relief valve pressure (RV-2), the tank may have to be vented through V-4, should pressure continue to rise, the fill may have to be interrupted to allow pressure to drop.
8	Monitor liquid level contents gauge (LL-1). When the gauge indicates approximately three-quarters full, open full trycock valve (V-3).
9	When liquid spurts from trycock valve (V-3), stop fill at the supply source and close trycock valve (V-3).
10	Close tank fill valve (V-1).
11	Drain residual liquid in the fill hose via drain valve (V-11).
12	Relieve fill hose pressure by loosening the hose at fill connection (C-1), then disconnect the hose. It is recommended that the fill hose be allowed to defrost.
13	Open valves V-5, V-6, V-7, and V-13 as required to place the unit into service.

3-3. REFILLING

A vessel that is in service must be refilled using top and bottom fill valves (V-2). Bottom filling causes an increase in tank pressure since the warm vapor above the liquid will be compressed. Table 3-3 details the refill operation.

Proper filling procedures will ensure that there is no interruption of service or supply. Generally it is not necessary to vent the vessel down prior to filling.

Table 3-3. Vessel Refilling Procedure

STEP NUMBER	PROCEDURE
	NOTE Filling a cryogenic vessel through the bottom tends to raise pressure in the vessel, as gases in vapor space are compressed. Filling through the top tends to lower pressure, as gases in head space are cooled down and re-liquified.
1	Verify that the contents of the supply unit is the proper product to be transferred.
2	Verify that top and bottom fill valves (V-1 and V-2) are closed
3	Verify minimum required operating pressure in vessel.
4	Verify that all other valves are in normal operating positions (V-5, V-6, V-7, V-8, V-9, V-13 open). (Note: If tank is not in operation, V-5, V-6, and V-7 are closed.)
5	Connect the supply unit transfer hose to tank fill connection (C-1).
	NOTE Cool and purge down the transfer hose prior to filling by opening hose drain valve (V-11) and the supply unit discharge valve for approximately three minutes or until hose begins to frost. Close drain valve (V-11).
6	Open top fill valve (V-1) completely.
7	If a PRESSURE TRANSFER is to be made, allow pressure to build up in the liquid supply unit until it is at least 50 PSI higher than station pressure. Open the discharge valve on the supply unit to begin flow. (or) If a PUMP TRANSFER is to be made, make the required connections to the pump. Open the supply unit transport discharge valve slowly. Close pump circulating valve slowly, so as not to lose pump prime. Maintain pump discharge pressure from 50 to 100 PSI higher than tank pressure.
8	Monitor pressure in vessel as indicated by (G-1). If pressure begins to drop to near the minimum operating pressure, begin to open bottom fill valve (V-2), and throttle top fill valve (V-1), until pressure stabilizes.
9	Monitor liquid level contents gauge (LL-1). When the gauge indicates approximately three-quarters full, open full trycock valve (V-3).
10	When liquid spurts from trycock valve (V-3), stop fill at the supply source and close trycock valve (V-3).
11	Close tank fill valve (V-1 and V-2)
12	Drain residual liquid in the fill hose via drain valve (V-11)
13	Relieve fill hose pressure by loosening the hose at fill connection (C-1), then disconnect the hose.

Table 3-4. Gas Withdrawal Procedure

STEP NUMBER	PROCEDURE
1	Connect customer line to VCS gas use connection (C-2), or to the optional final line connection (C-10) if used.
2	Verify that all valves except gauge liquid phase (V-8) and gauge gas phase (V-9) are closed.
3	Open gas use valve (V-7), pressure building valve (V-5), vapor shutoff valve (V-6), and economizer shut-off valve (V-13) to start gas flow. At this time, final line pressure gauge (G-2) will be indicating pressure in the customer line and the system will automatically deliver gas until stopped, or vessel is empty. **NOTE** In the event tank pressure exceeds the setting of the economizer regulator (R-2) after a long shutdown, the regulator will automatically begin to divert vapor from the vapor space into the vaporizer until set pressure of R-2 is reached.
4	Once the required amount of product has been delivered (or to close the tank down for an extended period of time), stop gas flow by closing gas use valve (V-7). The operation of an MVE unit is completely automatic, valves need to be opened and closed only during filling and during major maintenance.
5	Normal operating valve position for a VCS unit are as follows: Bottom Fill (V-2) Closed Top Fill (V-1) Closed Vapor Vent (V-4) Closed Full Trycock (V-3) Closed Liquid Level Equalizer (V-10) Closed Hose Drain (V-11) Closed Gas Use (V-2) Open Pressure Building (V-5) Open Isolation Valve (V-6) Open Economizer Valve (V-13) Open Liquid Phase Level (V-8) Open Vapor Phase Level (V-9) Open

3-4. LIQUID DELIVERY

Liquid product may be drawn at low pressure from the VCS and VLS via liquid withdrawal connection (C-5), (C-8) or optional vacuum jacketed outlet (C-11). The detailed liquid withdrawal procedures are provided in Table 3-5.

NOTE

When using a large vessel (VCS-3000 or larger) for gaseous service, a free standing vaporizer will have to be installed between connection C-2 and the final line pressure regulating system.

NOTE

If a VCS does not have a liquid draw valve near the C-8 connection, consult the factory for valve installation instructions.

Table 3-5. Liquid Withdrawal Procedure

STEP NUMBER	PROCEDURE
1	Connect customer line liquid withdrawal connection (C-5, C-8, or C-11).
2	Verify that all valves except gauge liquid phase valve (V-8) and gauge gas phase valve (V-9) are closed.
3	Observe pressure building regulator (PB-1) setting as indicated on the station pressure gauge (G-1). If station pressure is too high, open vent valve (V-4) to relieve excessive gas. It is possible that regulator springs will require changing for lower operational pressure.
4	Open liquid draw valve slowly to begin liquid flow.
5	Once the desired amount of liquid has been delivered, close the liquid draw valve.

3-5. VCS REGULATOR ADJUSTMENTS

NOTE

To field set or to adjust regulators quickly, the vessel must contain a liquid product, preferably a full tank.

Under normal circumstances the system does not require frequent adjustment. However, it may be necessary to change regulator settings to obtain either higher or lower pressure settings within the range of the factory installed springs, at the time of starting up the vessel. It is good practice to verify set points during an initial fill.

The adjustments which follow are required to "final set" the regulators following spring replacement, or after completing valve repairs which required disassembly and reassembly.

As a general rule, economizer regulator (R-2) should be set 20 PSI higher than pressure building regulator (R-1), and 40 PSI higher than optional final line regulator (R-3). The pressure building regulator (R-1) should be set approximately 20 PSI higher than the desired delivery pressure. Detailed regulator adjustment procedures are provided in Tables 3-6 and 3-7.

Table 3-6. Pressure Building Regulator Adjustment

STEP NUMBER	PROCEDURE—FULL VESSEL
1	This procedure is best performed with a completely full tank, as all changes in adjustment of R-1 will be reflected rapidly. Observe reading on pressure gauge (G-1). If pressure is lower than desired set point of pressure building regulator R-1, proceed to Step 2; if higher, proceed to Step 3.
2	If tank pressure is below the desired setting, loosen the pressure screw lock nut on the regulator. With valves V-5 and V-6 open, gradually open regulator by turning the pressure screw (clockwise) to build tank pressure to the desired setting. Note that the pressure screw should be adjusted in small increments, thus allowing sufficient time for tank pressure to stabilize each time the screw is turned. The tank can be considered stabilized when no frost is found on the pressure building circuit (V-5, S-1, R-1, and PB-1). This reduces the possibility of over-shooting the desired pressure which would, in turn, require partial tank blowdown via the vent valve (V-4). Tighten lock nut on regulator, and return vessel to normal service.
3	If the tank pressure is above the desired setting, open vent valve (V-4) to vent excess gas. Should pressure continue to rise above the desired level, proceed as stated below.
4	Again vent excess gas by opening vent valve (V-4). Reduce pressure until tank pressure gauge indicates a reading of 10 PSI below the desired setting. Loosen set screw on R-1, and proceed to Step 2.
	PROCEDURE—PARTIALLY FULL VESSEL
1	This procedure is best followed when unit is only partially full, or time available is limited. This method is equivalent to a bench set of the pressure building regulator (R-1). Raise pressure 20 PSIG above desired set pressure of R-1 by tightening R-1 set screw.
2	Isolate pressure building circuit by closing valves P.B. inlet valve (V-5), and P.B. outlet valve, (V-6).
3	Loosen line relief valve, RV-1, slowly to depressurized isolated P.B. system. Once all flow has stopped, completely remove RV-1.
4	Install pressure gauge downstream from R-1. If no gauges are available, close liquid level gauge valves V-8 and V-9, and remove tank pressure gauge G-1.
5	Loosen lock nut on pressure building regulator, and back set screw out until loose.
6	Open pressure building inlet valve, V-5. Verify reading on pressure gauge. Slowly tighten set screw of pressure building regulator until the desired pressure is reached on gauge. Tighten lock nut, and monitor pressure gauge for a few minutes to verify that pressure building regulator operates satisfactorily and closes correctly.
7	Reassemble system.

Table 3-7. Economizer Regulator Adjustment

STEP NUMBER	PROCEDURE—FIELD SET OF ECONOMIZER REGULATOR
1	Check tank pressure gauge (G-1). If economizer regulator (R-2) pressure is below the economize set pressure, proceed to Step 2; if above, proceed to Step 3.
2	If tank pressure is below the desired setting, build pressure by opening fill valves V-1 and V-2. Note that fill connection (C-1) must be securely blanked off. As tank pressure increases to approximately 20 PSI above setting of pressure building regulator (R-1), close valve V-2, allowing the remaining liquid to vaporize. Close valve V-1 once pipe has defrosted.
3	Close isolation valves (V-13). Loosen connection after (R-2) and before (CV-3 or V-13) and adjust set screw of regulator until it vents slightly at tank pressure.
4	Tighten lock nut. Tighten connection between R-2 and CV-3 or V-13.
5	Open V-13 fully, bubble test and return tank to normal operation.
	PROCEDURE—BENCH SET OF ECONOMIZER REGULATOR
1	Close economizer isolation valve, V-13.
2	Loosen connections on both sides of economizer slowly, so as to depressurize system.
3	After all gas flow from the loose connections has stopped, remove economizer regulator, R-2. Note the orientation, so as to be able to reinstall it in the same direction.
4	After removal, connect a dry nitrogen gas source and pressure gauge to the inlet port of the regulator.
5	Turn economizer regulator (R-2) adjusting screw in (clockwise) until the unit opens at approximately 20 PSI higher than the desired container pressure. Retighten set screw.
6	Reinstall the regulator on the tank using a liquid sealant or Teflon tape compatible with oxygen to prevent leaking.

3-6. LIQUID LEVEL GAUGE ADJUSTMENT

The liquid level gauge (LL-1) is a differential pressure gauge used to indicate the amount of liquid in the vessel. This gauge may occasionally require adjustment. To check and/or adjust the zero setting of this gauge, open V-10 and close V-8 and V-9. The gauge pointer should indicate zero. If the gauge pointer indicates other than zero, adjust the unit until the zero setting is reached.

Verify method to adjust zero point on that gauge. Some gauges have a set screw for adjustment, other gauges require movement of the pointer. Check adjustment several times by closing and opening V-10. Normally the glass face must be removed for adjustment, use an oxygen compatible grease or sealant to wet the protective o-ring prior to reassembly. Entry of water into the gauge by improper sealing of the glass face will rapidly deteriorate the gauge. After adjustment, open V-8 and V-9, and close V-10, in that order.

4-1. GENERAL

This chapter describes and illustrates proper VCS and VLS handling and site considerations. Covered under site considerations are instructions relating to site selection, foundation, pads, and equipment protection. The handling procedures include instructions for container rigging.

4-2. SITE CONSIDERATIONS

Site Selection (Per NFPA Bulletins and the CGA)

Prime considerations in choosing a site for the VLS/VCS are soil stability of the location, accessibility for servicing, and proximity to the gas consumption point. Firm soil conditions are desirable to protect against settling of the facility and possible station damage. The foundation site must also be located such that drainage away from the foundation is ensured. Since the vessel will normally be serviced by a truck, it must be readily accessible. Generally, a location adjacent to a parking lot is most suitable. Since liquid delivery hoses will be at most 14 feet long, the tank should be situated no more than 10 feet from the closest possible access.

Normally, the VCS/VLS will be located out-of-doors The site selected should be such that the container and associated equipment (if any) will not be beneath or exposed by the failure of electric power lines, flammable or combustible liquid lines, or flammable gas lines. Should the unit be located indoors, the building must be of noncombustible construction, be adequately vented, and be used exclusively for gas storage.

Site Preparation

Site preparation considerations include selecting the proper foundation. However, before the foundation is laid the site must be cleared of all organic material and topsoil. In addition, the site soil bearing must be capable of 2000 P.S.F. (pounds per square foot) minimum. If this cannot be substantiated, a local professional engineer should be consulted. The construction of a firm base or foundation for the station is of prime importance. Most often this will be of concrete; however, steel frames may also be used. In either case, a firm bed consisting of gravel or crushed stone is required for the foundation to rest on.

Concrete pads are the most common foundations on which stations are installed. They provide a highly stable, permanent location for the unit, as well as any on-site support equipment required (reserve cylinders, additional vaporizers, etc.). Pad thickness depends on the VCS/VLS model used. Generally, pad thickness should be as follows:

Size	Thickness
Less than 900 Gal.	12 inches minimum
1500 Gal. to 3000 Gal.	15 inches minimum
6000 Gal. to 9000 Gal.	18 inches minimum
11,000 Gal.	21 inches minimum
13,000 Gal.	24 inches minimum

For Models VCS-315 and VCS-525, a number 6 gauge 4-inch by 4-inch steel wire mesh is generally sufficient for reinforcing. In the case of larger stations, and also where soil stability is questionable, steel rods are required for enforcement. One-half inch O.D. steel rods on 12-inch centers, both ways, are recommended. Reinforcements should be embedded at least two inches in the concrete.

The concrete pad must be capable of developing a minimum compression strength of 3,000 PSI (pounds per square inch) at 28 days. All concrete work shall be in accordance with ACI 318-71 and the reinforcing steel shall conform to ASME Spec. A305. Anchor bolts, nuts, and washers shall be ASTM A307. All exposed parts must be coated with an aluminum paint or equivalent. Skirted pads should only be used if required by local codes. If used, install as required, but below the local frost line.

Lateral dimensions of the concrete pad are arbitrary. Experience indicates that at least two inches of clearance on each side of the tank is desirable. More space should be allowed if high pressure cylinders, additional vaporizers, or other equipment are also to be installed or stored at the site Minimum recommended pad dimensions, based on a two inch clearance, are:

Model	Pad Dimensions
VCS-300	6' x 6'
VCS-500	6' x 6'
VCS-900	7' x 7'
VLS/VCS-1500	8' x 8'
VLS/VCS-3000	10' x 10'
VLS/VCS-6000	13' x 13'
VLS/VCS-9000	15' x 15'
VLS/VCS-11000	16' x 16'
VLS/VCS-13000	16' x 16'

A firm bed for the concrete is required. This is necessary to protect the pad and equipment from damage due to shifting of the ground beneath it. If good soil conditions exist, the ground need only be well compacted prior to pouring the concrete. If the setting is less favorable, a four inch layer of crushed limestone beneath a two inch layer of sand will provide a satisfactory bed for the pad. This bed should be formed in a trench recessed into the ground and of the same dimensions as the pad.

The illustration on page 4-4 shows site preparation details and provides complete pad dimensional data by VCS/VLS model.

NOTE

The information and design herein contained is intended only as a general outline of minimal requirements. Soil and climatic conditions, as well as seismic load requirements, will require modifications to meet local conditions. Consultation with a local qualified engineer is suggested. MVE disclaims any warranty with respect to the fitness and/or the adequacy of the design and information contained herein.

Site Protection

In many situations, the customer station is vulnerable to damage. This may be due to tampering by unauthorized personnel, other equipment moving in the area, or a combination of these. Depending on the exposure, protection should be provided by either a fence or pylons.

Other Site Considerations

- Installation of a VCS/VLS should be supervised by personnel familiar with their construction and intended use.
- Following installation, all field erected piping and tank connect points should be tested at the maximum operating pressure to check for leaks.
- When oxygen is the product, the VCS/VLS location site must be permanently placarded to indicate the following, or an equivalent type warning:

  OXYGEN
  NO SMOKING
  NO OPEN FLAMES

- Each VCS/VLS system installed on consumer premises should be inspected annually. Weeds and long dry grass must be cut back within 15 feet of any bulk oxygen storage container.
- If during site preparation any questions arise concerning foundation, location, etc., it is advised that your local MVE distributor or the factory be consulted.

4-3. HANDLING CONSIDERATIONS

General Handling Instructions

Installation of a VCS/VLS at the storage site requires the use of a lift crane. For VCS Models 315 through 1500, a crane with one hoist may be used. For Models 3000 and larger, the crane must be configured with two hoists.

NOTE

If the pad is not completed when the tank arrives, arrangements should be made to have the unit taken from the truck and stored in a protected area.

Rigging Details

The illustrations which follow show the proper methods for handling and erecting VCS/VLS containers. Figure 4-1B illustrates procedures for VCS/VLS units.

NOTE

Since the 3,000 through 15,000 gallon units have the bottom lifting lug on the bottom head, when lifting (as in last sketch above), vessel will roll slightly until the legs make contact with ground.

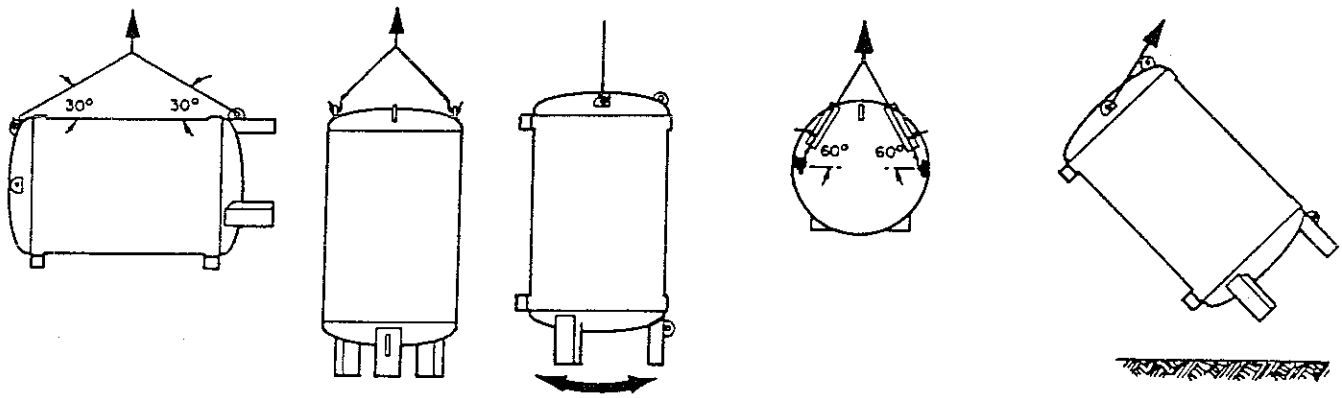


Figure 4-1. VCS/VLS Rigging (One Crane).

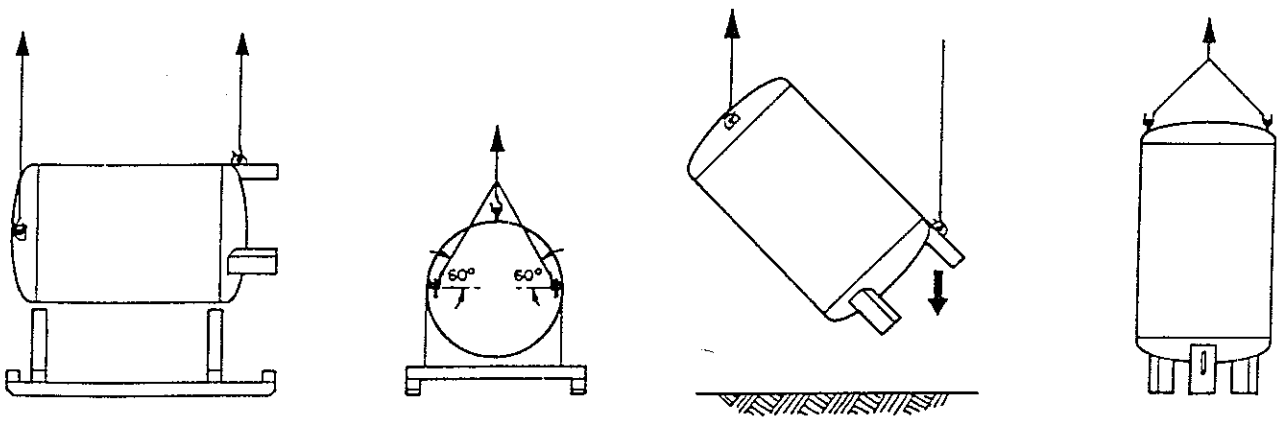
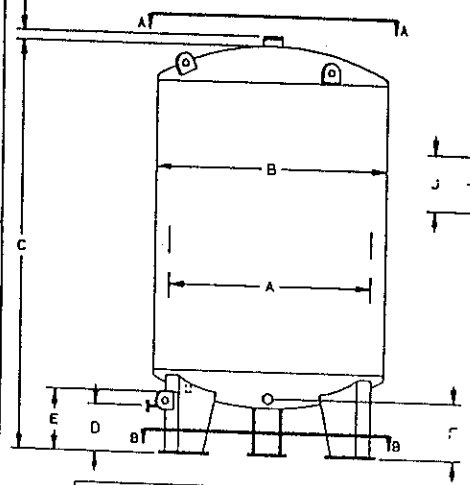
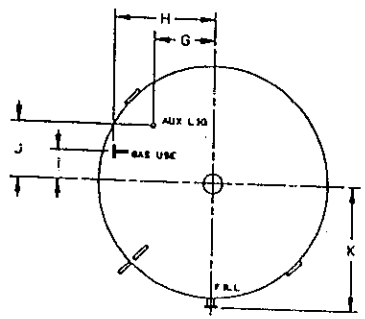


Figure 4-1B. VCS/VLS Rigging, Models 3000 through 13000 (Two Crane Method)

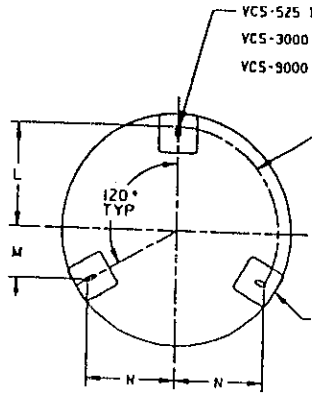
2 APPROX VCS-525 THRU VCS-3000
3 APPROX VCS-6000 & VCS-9000
3 1/2 APPROX VCS-11,000 & VCS-13,000

DRAWING NO. C- 26383

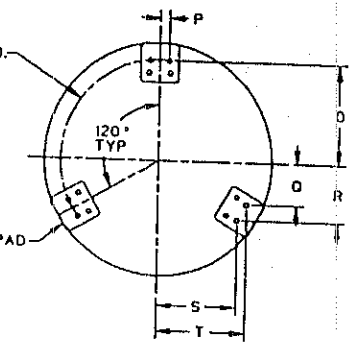




VIEW A-A



VIEW B-B
VCS-525 THRU VCS-6000



VIEW B-B
VCS-9000 THRU VCS-13000

MODEL	DIMENSIONS IN INCHES																					
	A	B	C *	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	B.C.D.	FOOT PAD
VCS-525	42	48	135	**	N/A	19.25	N/A	**	**	N/A	29.5	21.5	10.875	18.75	N/A	N/A	N/A	N/A	N/A	N/A	40	.375•5•9.25
VCS-900	54	60	147	**	21.5	19.25	21.0	**	**	12.0	37.5	27.5	13.875	23.938	N/A	N/A	N/A	N/A	N/A	N/A	55	.625•6•11.25
VCS-1500	60	66	180	**	21.5	19.5	23.5	**	**	13.5	41.0	30.125	15	26.0	N/A	N/A	N/A	N/A	N/A	N/A	60	1•7.125•13.5
VCS-3000	84	96	192	15.563	19.375	22.75	32.25	40.25	12.5	20.188	60.75	43.5	21.75	37.688	N/A	N/A	N/A	N/A	N/A	N/A	87	1•12•12
VCS-6000	84	96	327	15.563	19.375	22.75	32.25	40.25	12.5	20.188	60.75	43.5	21.75	37.688	N/A	N/A	N/A	N/A	N/A	N/A	87	1•12•12
VCS-9000	96.375	114	369	18.0	19.375	24.75	32.25	40.25	12.5	20.188	60.75	N/A	N/A	N/A	47.0	8.0	16.563	30.438	36.625	44.625	95.375	1.375•22•22
VCS-11000	96.375	114	430	18.0	19.375	24.75	32.25	40.25	12.5	20.188	60.75	N/A	N/A	N/A	47.0	8.0	16.563	30.438	36.625	44.625	95.375	1.375•22•22
VCS-13000	104	120	436	18.0	19.0	24.75	40.438	40.625	20.875	28.063	60.75	N/A	N/A	N/A	47.0	8.0	16.563	30.438	36.625	44.625	95.375	1.375•22•22

** GAS USE PIPED TO SIDE MOUNTED VAPORIZER
* C DIMENSIONS ARE ROUNDED TO THE NEAREST WHOLE NUMBER

SPECIFACATIONS

1) INNER VESSEL:
- CODE COMPLIANCE: ASME SECTION VIII DIVISION 1
- M.A.W.P.: 250 P.S.I.
- DESIGN PRESSURE: M.A.W.P. PLUS 14.7 P.S.I. PLUS STATIC HEAD OF ARGON
- DESIGN TEMPERATURE: -320 F TO +100 F
- MATERIALS OF CONSTRUCTION:
  - -SA240 T304 STAINLESS STEEL AVAILABLE ON ALL UNITS
  - -SA553 9% NICKEL STEEL AVAILABLE ON 3000 GAL & LARGER

2) OUTER VESSEL
- DESIGN: FULL VACUUM PER CGA-341
- DESIGN TEMPERATURE: -20 F TO 300 F
- MATERIALS OF CONSTRUCTION:
  - -A36 CARBON STEEL

3) INSULATION TYPE:
- -VACUUM AND SUPER INSULATION AVAILABLE ON ALL UNITS
- -VACUUM AND PERLITE AVAILABLE ON 3000 GAL & LARGER
- EVACUATION CONNECTION: 1 1/2 PS GRINNELL VACUUM VALVE
- VACUUM GAUGE CONNECTION: HASTINGS DV6R

REV	ZONE	REVISION DESCRIPTION	BY	DATE
F		G6BZ CHG WTS ON 3000GAL	MMK	11-9-92
E		6209 CHG SHIP DIMS VCS-1500	JJC	1-13-92
D		003736 CHG SHIP DIMS	CMK	7-25-91
C		ADD WEIGHTS FOR VCS-3000 NP	BC	12-11-90
B		WEIGHT CHART FOR 400 P.S.I.	MJB	1-18-89
A		003625 STADARDIZE SR & SS TANKS	JWS	9-29-88

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MAT'L

	APPROVED	DATE
DRAWN BY	DJJ	7-3-86
CHECKED BY	DC	7-3-86
APPR. BY	JR	7-3-86
MFG. ENG.		
MFG. DEPT.		

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES: FRACTIONS ± ANGLES ± 2 PLACE DECIMAL ± 3 PLACE DECIMAL ±

NEXT ASSY | USED ON | NEXT ASSY | FINAL ASSY

APPLICATION | QUANTITY REQ'D

MVE MINNESOTA VALLEY ENGINEERING
CRYOGENICS NEW PRAGUE, MINNESOTA 56071

TITLE VCS OUTLINE, DIMENSION, AND SPECIFICATION SHEET

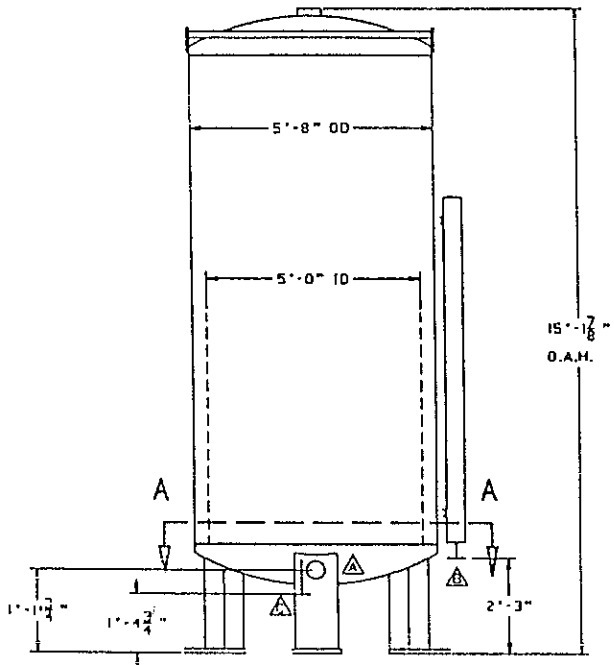
DRAWING NO. C- 26383 REV F

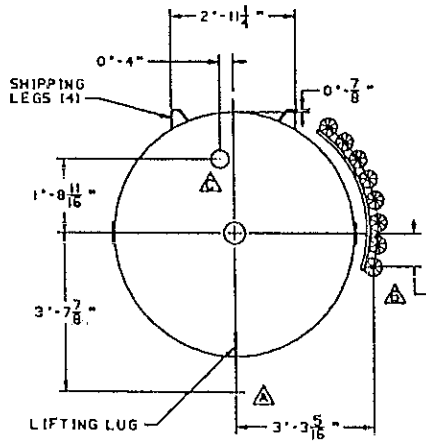
SCALE DO NOT SCALE DRAWING SHEET 1 OF 2

DRAWING NO. B- 32847

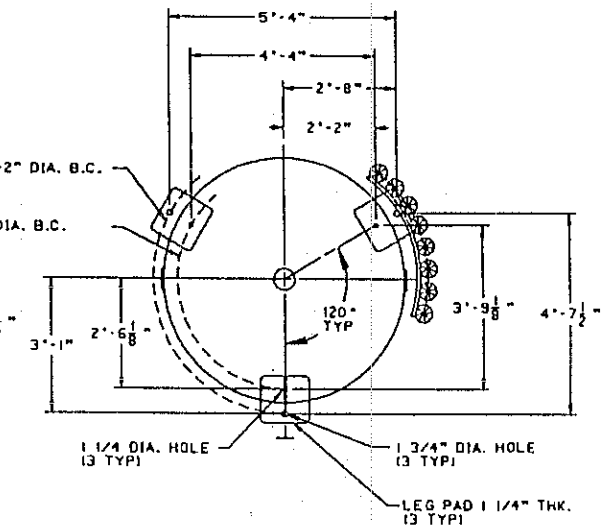
CONNECTIONS

△1 FILL CONNECTION
△2 GAS USE (VAPORIZER OUTLET)
△3 AUX. LIQUID WITHDRAWAL





PIPING INTERFACES
TOP VIEW



TANK SUPPORT DETAIL
VIEW A-A

SPECIFICATIONS

CAPACITY:	
GROSS LIQUID	1,639 GAL
NET LIQUID	1,510 GAL
GASEOUS EQUIVALENT AT 0 PSIG AND 70°F:	
OXYGEN	173,801 SCF
NITROGEN	140,596 SCF
ARGON	173,362 SCF
MAWP:	250 PSIG
WEIGHT: EMPTY	7,407 LBS
FULL OXYGEN	22,088 LBS
NITROGEN	17,801 LBS
ARGON	25,329 LBS
MATERIAL:	
INNER VESSEL	9% NICKLE, SA553
OUTER VESSEL	CARBON STEEL, A-36
INSULATION	SUPER INSULATION
SHIPPING ENVELOPE: 15'-1 7/8"L • 6'-8 13/16"H • 6'-8 3/4"W	

REV	ZONE	REVISION DESCRIPTION	BY	DATE

MAT'L APPLIES FOR:
FINISH P/N 9919939
INR/OTR 9615669

APPROVED	DATE	
DRAWN BY TJS	5-30-89	
CHECKED BY GP	6-9-89	
MFG. SERV. BM	6-20-89	
PROJ. ENGR. JR	6-8-89	
MFG. ENG. BL	6-20-89	
QUAL. CONT. GHE	6-8-89	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.
TOLERANCES:
FRACTIONS ±
ANGLES ±
2 PLACE DECIMAL ±
3 PLACE DECIMAL ±

NEXT ASS'Y	USED ON	NEXT ASS'Y	FINAL ASS'Y
APPLICATION		QUANTITY REQ'D	

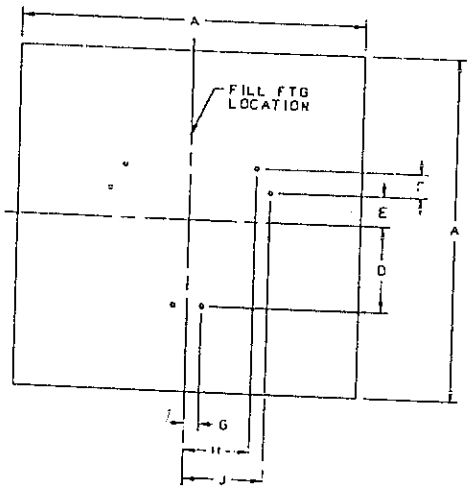
M V E MINNESOTA VALLEY ENGINEERING
CRYOGENICS NEW PRAGUE, MINNESOTA 56071

TITLE OUTLINE AND DIMENSION
VCS-1500NS-250-MVE-0

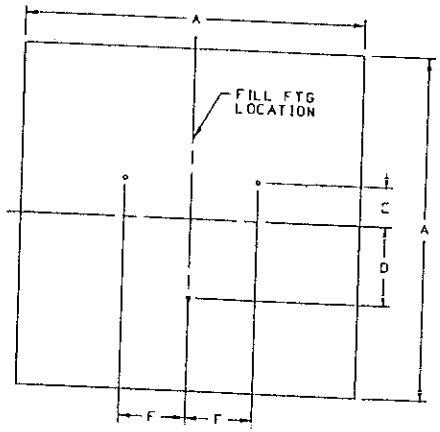
DRAWING NO. B- 32847 REV

SCALE N/A | DO NOT SCALE DRAWING | SHEET 1 OF 1

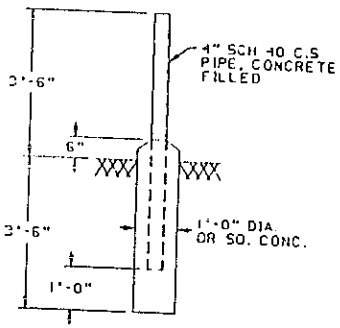
MODEL	O.D. OF VESSEL	PLAN VIEW	A	B	C	D	E	F	G	H	J	ANCHOR BOLT DIA	ANCHOR BOLT DET'L	K	L	ANCHOR PL. SIZE	REBAR TOP	REBAR BOTTOM
VCS-100	40"	B	5'-6"	1'-0"	2"MAX.	1'-9 1/2"	0'-10 7/8"	1'-6 3/4"	N/A	N/A	N/A	1"	C	6"	10"MIN.	NOT REQ'D	#4 AT 12"E.W.	#5 AT 12"E.W.
VCS-500	48"	B	6'-6"	1'-0"	2"MAX.	1'-9 1/2"	0'-10 7/8"	1'-6 3/4"	N/A	N/A	N/A	1"	C	6"	10"MIN.	NOT REQ'D	#4 AT 12"E.W.	#5 AT 12"E.W.
VCS-900	60"	B	7'-6"	1'-3"	2"MAX.	2'-3 1/2"	1'-1 7/8"	1'-11 15/16"	N/A	N/A	N/A	1"	C	6"	10"MIN.	NOT REQ'D	#4 AT 12"E.W.	#5 AT 12"E.W.
VCS-1500	66"	B	9'-0"	1'-3"	3"MAX.	2'-6 1/8"	1'-3"	2'-2"	N/A	N/A	N/A	1"	C	6"	11"MIN.	NOT REQ'D	#4 AT 12"E.W.	#5 AT 12"E.W.
VCS-3000	96"	B	11'-6"	1'-6"	3"MAX.	3'-7 1/2"	1'-9 3/4"	3'-1 11/16"	N/A	N/A	N/A	1 1/4"	C	6"	1'-2"	NOT REQ'D	#4 AT 12"E.W.	#6 AT 9"E.W.
VCS-6000	96"	B	16'-0"	1'-6"	6"MAX.	3'-7 1/2"	1'-9 3/4"	3'-1 11/16"	N/A	N/A	N/A	1 3/8"	C	6"	1'-2"	3 1/2" X 8" X 8"	#4 AT 12"E.W.	#8 AT 9"E.W.
VCS-9000	114"	A	17'-6"	1'-9"	6"MAX.	3'-11"	1'-4 9/16"	1'-1 7/8"	0'-8"	3'-0 5/8"	3'-8 5/8"	1 3/4"	D	6"	1'-2"	1 1/2" X 8" X 22"	#4 AT 9"E.W.	#8 AT 9"E.W.
VCS-11000	114"	A	19'-0"	2'-0"	9"MAX.	3'-11"	1'-4 9/16"	1'-1 7/8"	0'-8"	3'-0 5/8"	3'-8 5/8"	1 3/4"	D	6"	1'-4"	1 3/4" X 10" X 24"	#5 AT 12"E.W.	#9 AT 12"E.W.
VCS-13000	120"	A	20'-0"	2'-0"	12"MAX.	3'-11"	1'-4 9/16"	1'-1 7/8"	0'-8"	3'-0 5/8"	3'-8 5/8"	1 3/4"	D	6"	1'-6"	1 3/4" X 10" X 24"	#5 AT 12"E.W.	#10 AT 12"E.W.



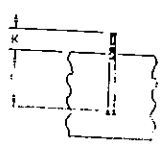
PLAN VIEW A



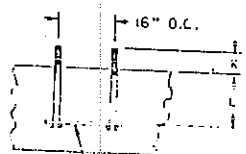
PLAN VIEW B



BUMPER GUARD DETAIL



ANCHOR BOLT DETAIL C



ANCHOR BOLT DETAIL D

DRAWING NO. B- 26290

NOTES:

1.) TANK FOUNDATION SITE SHALL BE LOCATED SUCH THAT DRAINAGE AWAY FROM THE FOUNDATION IS ASSURED.

2.) THE SITE SHALL BE CLEARED OF ALL ORGANIC MATERIAL AND TOPSOIL.

3.) SOIL BEARING MUST BE 2000 P.S.F. MINIMUM. IF THIS CANNOT BE SUSTAINED, CONSULT A PROFESSIONAL ENGINEER.

4.) ALL CONCRETE MUST BE IN ACCORDANCE W/ACI 318.

5.) THE CONCRETE SHALL DEVELOP A MIN. ULTIMATE COMPRESSIVE STRENGTH OF 3000 PSI AT 28 DAYS.

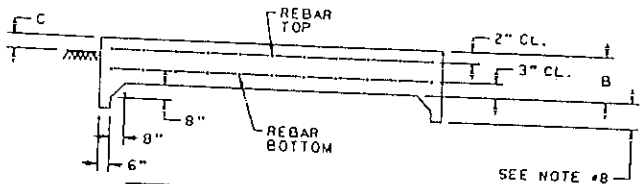
6.) REINFORCING STEEL SHALL BE DEFORMED AND CONFORM TO ASTM SPEC. A-615, GR 60.

7.) ANCHOR BOLTS, NUTS AND WASHERS SHALL BE ASTM A-307. COAT EXPOSED PARTS WITH ALUMINUM PAINT OR EQUAL EXCEPT THE VCS-6000 WHICH REQUIRES A-490, AND VCS-9000, 11000, AND 13000 REQUIRE A-325 A.B.

8.) USE SKIRTED PAD ONLY IF REQUIRED BY LOCAL CODES. DEPTH AS REQUIRED, BUT BELOW LOCAL FROST LINE.

NOTICE

THE INFORMATION AND DESIGN HEREIN CONTAINED IS INTENDED ONLY AS A GENERAL OUTLINE OF MINIMAL REQUIREMENTS. THIS FOUNDATION DESIGN MEETS THE APPLICABLE PROVISIONS OF TITLE 24, CALIFORNIA ADMINISTRATIVE CODE FOR SEISMIC ZONE 4, ESSENTIAL FACILITIES LOCATION. M.V.E. DISCLAIMS ANY WARRANTY WITH RESPECT TO THE FITNESS AND/OR THE ADEQUACY OF THE DESIGN AND INFORMATION CONTAINED HEREIN



SECTION VIEW

REV	ZONE	REVISION DESCRIPTION	BY	DATE
B		4527 UPDATE PER 1988 UBC REQMNTS	JK	7-27-89
A		3898 CHG SPECS FOR VCS-6000	MKD	8-10-88

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MAT'L

	APPROVED	DATE
DRAWN BY	OJJ	6-4-86
CHECKED BY	GP	6-19-86
MFG. SERV.	BM	6-19-86
PROJ. ENGR.	JR	6-20-86
MFG. ENG.	BL	6-20-86
QUAL. CONT.	GHE	6-19-86

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES: FRACTIONS ± ANGLES ± 2 PLACE DECIMAL ± 3 PLACE DECIMAL ±

NEXT ASS'Y	USED ON	NEXT ASS'Y	FINAL ASS'Y
APPLICATION		QUANTITY REQ'D	

M V E MINNESOTA VALLEY ENGINEERING
CRYOGENICS NEW PRAGUE, MINNESOTA 56071

TITLE FOUNDATION L/O, VCS-300 THRU 13000

DRAWING NO. B- 26290 REV B

SCALE N/A | DO NOT SCALE DRAWING | SHEET 1-1

1) NOTE: For VCS-1500 NS Bolt hole pattern, please see previous page.

2) NOTE: The above foundation layout drawing is not certified for all seismic locations and conditions. It is intended only as a guide. For further information on foundation construction, please contact the factory or a licensed professional engineer.

5-1. GENERAL

This chapter contains vessel maintenance information, including troubleshooting and repair procedures. Service and/or repairs are not difficult because parts are easily accessible and replaceable. Before performing any of the procedures in this chapter be sure you are familiar with the location and function of controls and indicators shown and described in Chapter 2. Parts location views are provided in Chapter 6.

5-2. MAINTENANCE

Compatibility and Cleaning

It is essential to always keep the vessel clean and free of grease and oil. This is particularly important for units used in nitrogen and argon service since the temperature of liquid nitrogen or argon is below the liquefacation temperature of air; thus making it possible to condense liquid oxygen from air on the piping and vaporizer surfaces.

When replacing components, use only parts which are considered compatible with liquid oxygen and 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. Only oxygen compatible sealants or virgin Teflon tape should be used on threaded fittings. All new joints should be leak tested with an oxygen compatible leak test solution. When degreasing parts, trichloroethylene, 1-1-1 trichloroethane (methyl chloroform), or other suitable solvent should be used.

Periodic Inspection

In order to maintain a cryogenic vessel in good operating condition, certain system components should be inspected on a periodic basis. Those components requiring periodic inspection are listed in Table 5-1. In vessels being operated in areas having either extreme hot or cold climates, inspection intervals should be shortened.

Soldering

Before performing any soldering work, always exhaust oxygen from oxygen lines and purge with nitrogen gas. Verify that lines are inert.

Vacuum Integrity

The vessel may or may not be equipped with vacuum thermocouple gauge tubes. Deterioration or loss of vacuum will be apparent by cold spots, frost, or condensation on the jacket, or evidenced by abnormally rapid pressure buildup. Unless one of these conditions is evidenced, the vacuum level should not be suspect. In the event one of the above conditions exists, contact the factory for advice on vessel vacuum testing.

Table 5-1. Periodic Inspection Intervals

ITEM	INTERVAL
Valves and fittings for leaks and other malfunctions	Quarterly
Strainer for clogged condition	Semi-Annually
Regulators for malfunction	Annually
Indicating gauges for malfunction	Annually
Relief valves to verify proper settings	2 years
Tank burst disc (BD-1)	2 years*

*Requires replacement. See the information on tank burst disc replacement in this chapter.

5-3. TROUBLESHOOTING

Table 5-6 provides some troubleshooting procedures. The table is arranged in a Trouble/Probable Cause/Remedy format. Note that probable causes for a specific problem are listed in descending order of significance. That is, check out the first cause listed before proceeding to the next. Repair procedures required, as listed in the remedy column, may be found in the Repair portion of this chapter. Perform procedures in the order listed and exactly as stated (Refer to Chapter 6 as required to locate system components identified in the troubleshooting guide.)

5-4. REPAIR

CAUTION

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

When repair of damaged components is required (in those instances when a spare part is not readily available), follow the instructions below.

When disassembly of an assembly is required, removed parts should be coded to facilitate reassembly. Reassembly of parts should always be performed in the reverse manner in which they are disassembled. 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. All rubber

components should be washed in a soap and warm water solution. Air dry all cleaned parts using an oil-free, clean, low- pressure air source. Before reassembly, make sure that all parts are thoroughly cleaned and have been degreased. Cleaning will prevent valves and regulators from freezing while in service and also prevent contamination of the liquid product.

When removing assemblies from a vessel 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.

Valve Repair

NOTE

Always have an adequate number of spare parts in your inventory. Refer to Chapter 6 for recommended components to maintain in your inventory.

When a defective valve is suspect, remove and repair the assembly as described in Table 5-3. If a valve is leaking through the packing, tighten the packing nut first to see if the leakage will stop before removing the valve. Packings are best tightened when the valve is warm. If a safety relief valve (RV-1, RV-2, or RV-4) fails, the defective assembly should be discarded and a new valve installed.

NOTE

Globe valves used on containers vary in tube size from ⅜" to 1½". While internal valve components may vary from valve to valve, the functional operation and repair procedures for these valves are the same.

Table 5-2. Valve Repair

STEP NUMBER	PROCEDURE
	NOTE Unless valve component parts are available in inventory, a defective valve should be replaced with a new assembly.
1	Release pressure in the VCS by opening vent valve (V-4).
2	Remove the valve seat assembly.
3	Disassemble the valve and inspect all piece parts.
4	Clean all metal parts in a good industrial cleaner, and all rubber parts in a warm water and soap solution.
5	Air dry all components using a clean, low pressure air source.
6	Replace all worn, deformed or damaged parts.
7	Repack the valve. Either preformed or twisted Teflon filament packing can be used. When using twisted Teflon filament packing, untwist Teflon and use only a single strand. Pack Teflon tightly; otherwise, moisture can get into the valve and freeze when the valve is cold.
8	Reassemble the valve. Make sure that mating surfaces are clean and properly seated. If the repaired valve is not to be reinstalled immediately, seal it in a polyethylene bag for storage. Apply a label to the bag such as "CLEAN VALVE. DO NOT OPEN BAG UNLESS UNIT IS TO BE INSTALLED."

Regulator Repair

When a defective pressure building regulator (R-1), economizer regulator (R-2) or final line regulator (R-3) is identified, remove and repair the unit as detailed in Table 5-4.

NOTE

Replacement regulators should be obtained from MVE to ensure compatibility. (See Chapter 6 for applicable part numbers.)

Table 5-3. Regulator Repair

STEP NUMBER	PROCEDURE
	NOTE Unless regulator component parts are available in inventory, a defective regulator should be replaced with a new assembly.
1	Release pressure in the vessel by opening vent valve (V-4).
2	Depressurize the regulator. a. For the pressure building regulator (R-1), this is accomplished by closing the pressure building valve (V-5) and the pressure building isolation valve (V-6), and by loosening line relief valves (RV-1). This relieves pressure on both the upstream and downstream sides of the regulator. b. For the economizer regulator (R-2), this is accomplished by closing the economizer isolation valve (V-13). c. For the final line regulator (R-3), this is accomplished by closing the two final line regulator isolation valves (V-14).
3	Remove the defective regulator from the container.
4	Disassemble the regulator, making sure to identify all piece parts removed.
5	Inspect all parts for wear, deformation or damage. Replace all gaskets and O-rings removed with new ones.
6	Clean all metal parts with a good industrial cleaning solvent. Air dry with a clean, low-pressure air source.
7	Reassemble the regulator in the reverse order of disassembly.
8	Bench test the rebuilt unit to make sure that it opens properly at the set pressure.
9	If the regulator is to be reinstalled on a vessel, do so as soon as possible following repair. If it is to be returned to inventory, seal the unit in a polyethylene bag for storage. Apply a label to the bag such as "CLEAN REGULATOR, DO NOT OPEN BAG UNLESS UNIT IS TO BE INSTALLED."
10	Silver solder all joints except for the pipe threads. Teflon tape all thread joints.
11	Pressurize the regulator by opening the applicable pressure building and isolation valves. Allow pressure to build up in the system and verify the reliability of the rebuilt unit.

Pressure and Liquid Level Gauge Repairs

Since an instrument specialist is normally required for making gauge repairs, it is advised that a defective gauge be replaced with a new unit and the defective one returned to your local MVE distributor or to the factory for repairs. However, before replacing a gauge there are a number of checks that can be performed.

CAUTION

Before removing (or adjusting) either tank pressure gauge (G-1) or liquid level gauge (LL-1), make sure valves V-8, V-9 and V-10 are closed.

The major cause of gauge malfunction is a leakage in the gauge line. Therefore, as a first check, make certain that gauge lines are leaktight. Other gauge checks include:

1. Check gauge lines for obstructions.
2. Check leaky equalizer valve.
3. Ensure that connection lines are properly mated.
4. Verify that the gauge is properly zeroed.
5. Ensure that the pointer doesn't stick.

If the above checks fail to correct the problem, remove and replace the gauge. When returning the gauge to MVE for repair, indicate the nature of the difficulty experienced with the gauge in your letter of transmittal.

Strainer Repair

If an excessive decrease in vessel operating pressure is noted, strainer (S-1) may be clogged. Remove, clean and reinstall the strainer according to the procedure in Table 5-4.

Tank Burst Disc (BD-1) Repair

The tank burst disc is a safety relief device that will rupture completely to relieve inner tank pressure in the event tank relief valve (RV-2) fails. The disc should be replaced at least every two (2) years. Instructions for the replacement of this disc are provided in Table 5-5.

5-5. TESTING AFTER REPAIR

After making repairs requiring disassembly or part replacement, leak test all valves and piping joints that were taken apart and reconnected. Do not return the vessel to service until all leaks have been corrected and retested.

Table 5-4. Strainer Service

STEP NUMBER	PROCEDURE
1	Close pressure building valve (V-5) and pressure building isolation valve (V-6).
2	Relieve line pressure by loosening in-line relief valve (RV-1) and by slowly loosening the strainer plug.
3	Remove the strainer plug and clean or replace the screen as required. (Clean the strainer using a warm water and soap solution.)
4	Air dry the cleaned assembly thoroughly using a low pressure air source.
5	Just before reinstalling the strainer, momentarily open pressure building valve (V-5) to blow out piping
6	Reinstall the strainer, tighten relief valve (RV-1), and open valves V-5 and V-6.

Table 5-5. Tank Burst Disc (BD-1) Replacement

STEP NUMBER	PROCEDURE
1	Close pressure building valve. Open vent valve (V-4) to vent pressure from the inner tank vapor space. If dual relief system is installed, switch selector valve to other side, rather than venting vessel.
2	Remove burst disc (BD-1) from the vessel.
3	Install new burst disc, making sure that mating surfaces are clean and properly seated. Use an oxygen compatible liquid thread sealant to prevent leaking.
4	Tighten burst disc down and close vent valve (V-4). Open pressure building valve.

Table 5-6. Troubleshooting

PROBLEM	POSSIBLE CAUSE	DIAGNOSIS	SOLUTION
Excessive Tank Pressure Vessel • Vessel vents through relief valve frequently. • Pressure remains above economizer set point.	1. Inadequate vacuum	1. Take vacuum reading	1. Consult Factory
	2. Leaking pressure building regulator (R-1)	1. Line to R-1 frosted from tank to V-5, S-1, R-1 and beyond	1 Check adjustment 2 Repair or replace (table 5.3)
	3. Economizer not operating (tank above economizer set pressure)	1. No frost evident on pipe to V-13, R-2 or CV-2	1. Check if V-13 open 2 Check set point of economizer (R-2) (sec 3.7)
	4. Tank gauge (G-1) in error	1. Compare with gauge of known accuracy	1. Replace
	5. Low withdrawal rate	1 Frosting on economizer piping No frosting on V-7 or C-2	1. Consult factory
	6. Excessive shutdown time	1. User pattern	1. Replace vessel with more efficient model
Failure to maintain set delivery pressure • House pressure is low.	1. Pressure builder not operational	1 PB Valve Closed 2. Isolation valve closed	1. Open valve V-5 2. Open valve V-6
	2 Regulator set too low	1. No frosting on pipe to V-5, S-1, R-1 or PB-1 2 Set pressure at or below final line pressure	1. Readjust (sec 3 6)
	3. Economizer (R-2) set too low	1 Frost evident on V-13, R-2, CV-2, and on V-5, S-1 and R-1	1. Reset economizer (sec 3 7)
	4 Cannot maintain pressure	1. V-5, S-1 R-1 always frosted	1 Check S-1 for clogging
		2 Withdrawal too high	2. Install higher capacity PB system—consult factory
	5 Tank burst disk (BD-1) ruptured	1. Flow can be felt at outlet of BD-1	1 Replace
	6. Piping leak	1. Leak is audible	1. Repair
Erratic contents gauge reading	1. Needle is stuck	1 Tap gauge	1. Inspect pointer and bend if need be
	2. Needle binds	1. Tap gauge repeatedly	1. Replace gauge
	3 Needle does not adjust to "0"	1 Does not "0" when V-10 (equalizing valve) opened	1 Adjust (sec 3 7)
	4. Leaky gauge lines	1. Soap test	1. Tighten lines and fittings
	5 Incorrect span	1 Reading does not correspond to use	1. Check calibration of gauge with calibrated standard
	6 Valves not opened	1. Needle stays at "0"	1. Equalization valve open (V-10) 2. Isolation valves (V-8 and V-9) closed
	7. Reversed lines	1. Needle pegs below "0"	1. Check stampings in gauge and vessel bottom "HP" corresponds to liquid phase
	8. Plugged line	1. Needle pegs, or moves very slowly	1. Consult factory
Leaking relief valve	1 Ice under/in seat	1 Valve reseats when warming up	1. Warm and dry valve to prevent moisture accumulation
	2. Damaged seat	1. Valve does not re-seat	1. Replace valve
Ruptured tank burst disk (BD-1)	1. Excessive pressure	1. Relief valve damaged	1. Replace disk and valve
	2. Fatigue or corrosion	1. Environment?	1. Replace disk (5.6)
Inability to hold vacuum	1 Improper vacuum gauge change (voids warranty)	1 Measure vacuum rise in gauge assembly	1. Consult factory
	2 Internal/external leak	1. Vacuum rises in tank over short time	1. Consult factory
	3. Corroded safety disk (BD-2)	1. Visual on helium leak test	1 Replace and repump
	4 Outgassing	1 Slow vacuum rise over long time	1. Repump

6-1. GENERAL

This chapter contains recommended spare and repair parts data for MVE VCS cryogenic containers. Spare parts can be obtained from your local MVE distributor or the factory. When ordering parts, always specify the container model number (VCS-525, VCS-3000, etc.) and the complete part number with nomenclature identified in the parts list.

The illustrations and parts list 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 illustration.

If any questions arise cn spare/repair parts contact MVE at:

Minnesota Valley Engineering, Inc.
Technical Service 800-253-1769
Customer Service 800-247-4446
FAX 612-853-9661

Figure 6-1. Parts Identification View
VCS 315-SS-250-MVE-0

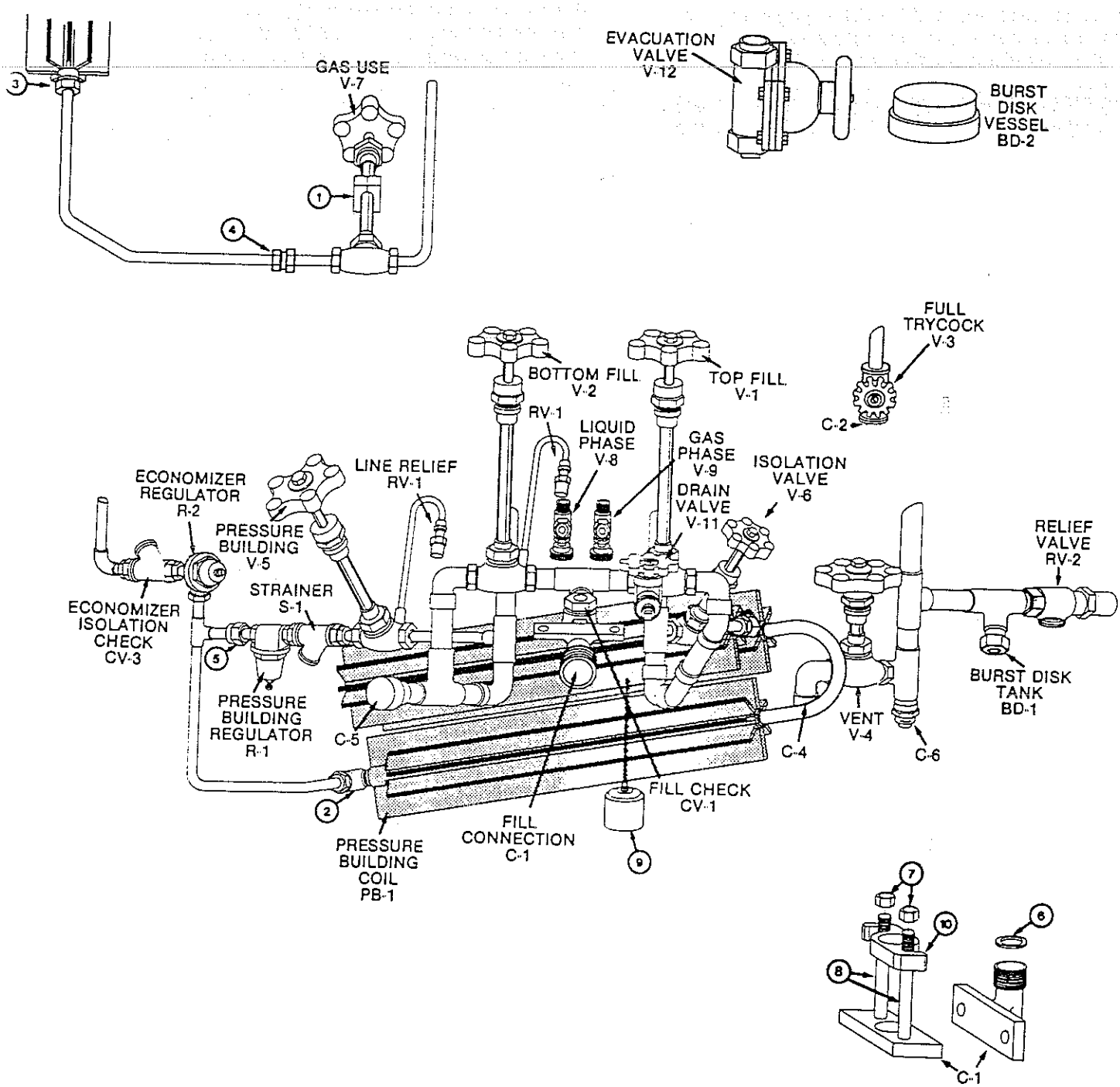


Table 6-1. Parts Identification List
VCS 315-SS-250-MVE-0

TAG	NOMENCLATURE	COMP. PART NO.	DESCRIPTION
	TOP FILL	90-5087-2	GLOBE VALVE, 1" NOM
V-2	BOTTOM FILL	90-7846-2	GLOBE VALVE, 1" NOM
V-3	FULL TRYCOCK	17-1320-2	SHUT OFF VALVE, 3/8" NPT
V-4	VENT	17-1387-2	GLOBE VALVE, 1" NOM
V-5	P.B. FEED	90-5152-2	1/2" NOM* 1/2 NPT
V-6	P.B. ISOLATION	17-1110-2	GATE VALVE, 1/2" NOM
V-7	GAS USE	17-1390-2	GLOBE VALVE, 1/2" C* 1/2" NPT
V-8	LIQUID PHASE HIGH	17-1186-2	ANGLE VALVE, 1/4" ODT* 1/4" MPT
V-9	GAS PHASE LOW	17-1186-2	ANGLE VALVE, 1/4" ODT* 1/4" MPT
V-10	EQUALIZATION	17-1046-2	NEEDLE VALVE, 1/4" NPT
V-11	FILL DRAIN	17-1670-2	SHUTOFF VALVE, 3/8" NPT
V-12	EVACUATION	17-1322-4	DIAPHRAGM VALVE, 1-1/2 '
V-16	TC ISOLATION	17-1267-2	BELLOWS SEALED, 1/8"
CV-1	FILL CHECK	17-1371-2	3/4" NPT
CV-2	ECONOMIZER CHECK	17-1099-2	3/8" NPT
S-1	STRAINER	49-1023-2	3/8" NPT
RV-1	LINE TRAP SAFETY	18-1046-2	350 PSIG, 1/4" NPT
RV-2	INNER VESSEL SAFETY	18-1040-2	250 PSIG, 1/2" MPT* 3/4" FPT
BD-1	INNER BURST DISC	19-1034-2	350 PSIG, 1/2" MPT
BD-2	ANNULUS BURST DISC	19-1064-1	25 PSIG, 2-1/2" MPT
R-1	P.B. REGULATOR	21-1003-2	TYPE A-32, 1/4" NPT, 125 PSIG
R-2	ECONOMIZER REGULATOR	21-1002-2	TYPE FRM, 1/4" NPT, 140 PSIG
C-1	FILL CONNECTION	65-1047-2	CGA-OXYGEN
		65-1057-2	CGA-NITROGEN
		65-1067-2	CGA-ARGON
		65-1036-2	FLANGE-OXYGEN
		65-1036-2	FLANGE-ARGON
		65-1036-2	FLANGE-NITROGEN
C-2	GAS USE CONNECTION	10-1158-2	CONN 0.625 ODT, 0.5 MPT
C-3	FULL TRYCOCK	39-1015-6	3/8" NPT
	VENT	15-1056-3	ELBOW 1.000" FTG.
	AUXILIARY LIQUID	12-1100-2	1" FPT
		17-1327-2	VALVE (OPTIONAL)
		12-1052-2	STREET ELBOW (OPTIONAL)
C-6	AUXILIARY VENT	12-1087-2	PLUG 0.750 MPT
C-7	HOSE DRAIN	39-1015-6	3/8" NPT
1	STAUFF CLAMP	34-1021-6	0.625" O.D.
2	P B. CONNECTION	10-1157-2	MALE ELBOW .625 ODT* .500 MPT
3	VAPORIZER CONNECTION	10-1156-2	MALE CONN. 0.625 ODT* 0.750 M
4	VAPORIZER CONNECTION	10-1156-2	MALE CONN 0.625 OD* 0.750 MPT
5	PRESSURE BUILDING CONN.	10-1155-2	M. ELBOW 0.5 ODT* 0.5 MPT
6	FILL GASKET	65-1006-2	GASKET, FILL FITTING
7	NUT	65-1035-2	NUT
8	STUD—SS	65-1034-1	STUD
9	CAP—CGA	65-1058-5	NITROGEN SERVICE
		65-1069-5	ARGON
		65-1070-5	OXYGEN
10	CAP/FLANGE	65-1033-1	COMB. FLANGE CAP
11	RUPTURE DISC CAP	39-1065-6	CAP, VINYL
		38-1493-5	WARRANTY SEAL
12	LIQUID LEVEL GAUGE	20-1032-9	0-100" H20
		20-1229-9	0-100" H20 W/ALARM
13	PRESSURE GAUGE	20-1027-2	0-400 P.S.I.

Table 6-2. Liquid Contents Chart
VCS 315-SS-250-MVE-0

GAUGE (IN.)	ARGON (GAL.)	OXYGEN (GAL.)	NITROGEN (GAL.)
0	0	0	0
2	1	1	3
4	4	5	11
6	9	12	23
8	15	20	38
10	22	30	52
12	30	40	67
14	39	50	82
16	47	60	97
18	56	71	111
20	65	81	126
22	73	91	141
24	82	101	156
26	90	112	170
28	99	122	185
30	108	132	200
32	116	142	215
34	125	153	229
36	133	163	244
38	142	173	259
40	151	183	274
42	159	193	288
44	168	204	303
46	176	214	316
48	185	224	326
50	194	234	331
52	202	245	
54	211	255	
56	219	265	
58	228	275	
60	236	286	
62	245	296	
64	254	306	
66	262	315	
68	271	322	
70	279	328	
72	288	331	
74	297		
76	305		
78	313		
80	319		
82	325		
84	329		
86	331		

NOTE: Contents based on liquid saturated at 0 PSIG.

Figure 6-2. Parts Identification View
VCS 525-SS-250-MVE-0

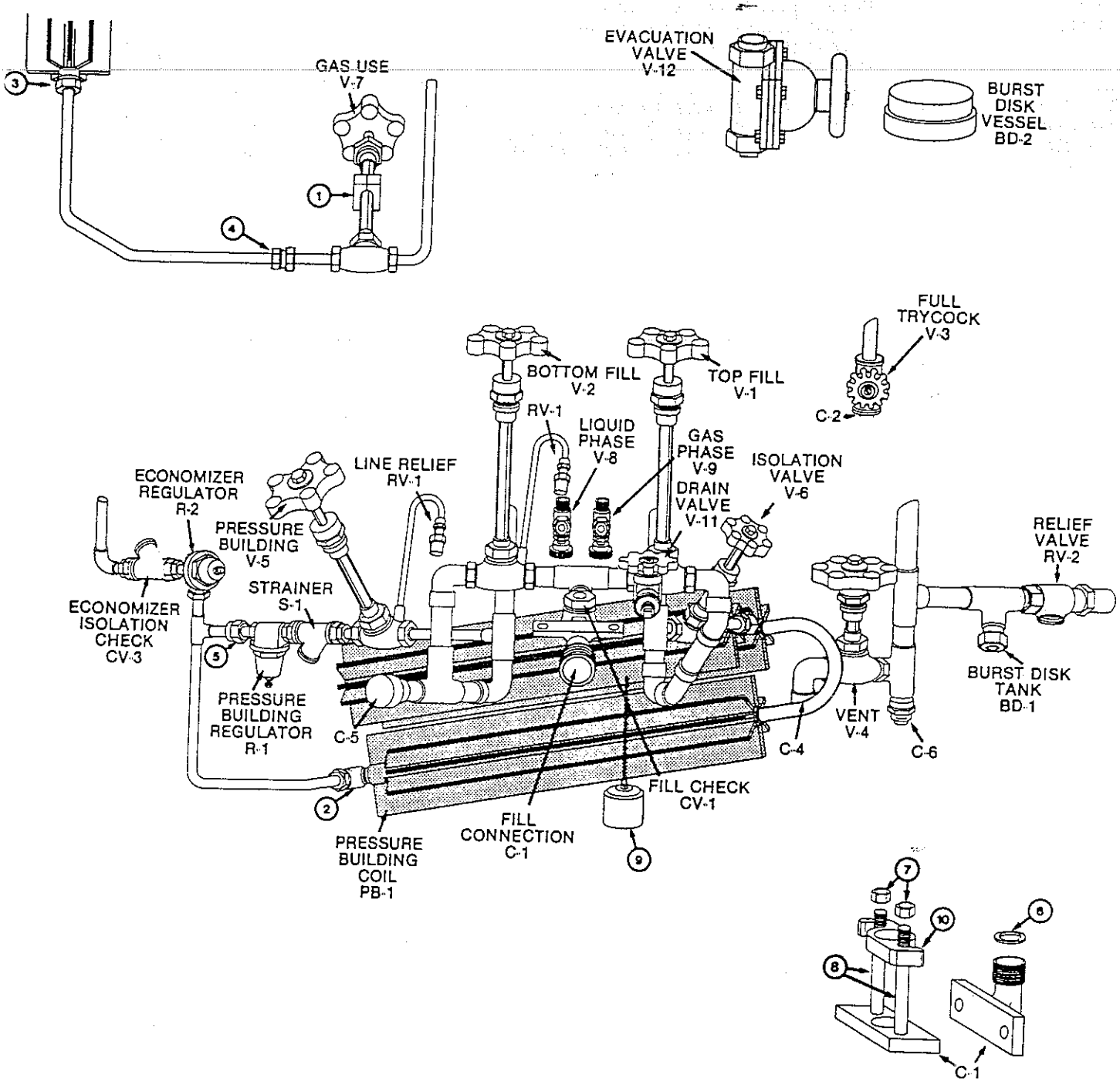


Table 6-3. Parts Identification List
VCS 525-SS-250-MVE-0

TAG	NOMENCLATURE	COMP. PART NO.	DESCRIPTION
V-1	TOP FILL	90-5087-2	GLOBE VALVE, 1" NOM
V-2	BOTTOM FILL	90-7846-2	GLOBE VALVE, 1" NOM
V-3	FULL TRYCOCK	17-1320-2	SHUTOFF VALVE, 3/8" NPT
V-4	VENT	17-1387-2	GLOBE VALVE, 1" NOM
V-5	P.B. FEED	90-5152-2	1/2" NOM* 1/2" NPT
V-6	P.B. ISOLATION	17-1110-2	GATE VALVE, 1/2" NOM
V-7	GAS USE	17-1390-2	GLOBE VALVE, 1/2" C* 1/2" NPT
V-8	LIQUID PHASE HIGH	17-1186-2	ANGLE VALVE, 1/4" ODT* 1/4" MPT
V-9	GAS PHASE LOW	17-1186-2	ANGLE VALVE, 1/4" ODT* 1/4 ' MPT
V-10	EQUALIZATION	17-1046-2	NEEDLE VALVE, 1/4" NPT
V-11	FILL DRAIN	17-1670-2	SHUTOFF VALVE, 3/8" NPT
V-12	EVACUATION	17-1322-4	DIAPHRAGM VALVE, 1-1/2"
V-16	TC ISOLATION	17-1267-2	BELLOWS SEALED, 1/8"
CV-1	FILL CHECK	17-1371-2	3/4" NPT
CV-2	ECONOMIZER CHECK	17-1099-2	3/8" NPT
S-1	STRAINER	49-1023-2	3/8" NPT
RV-1	LINE TRAP SAFETY	18-1046-2	350 PSIG, 1/4" NPT
RV-2	INNER VESSEL SAFETY	18-1040-2	250 PSIG, 1/2" MPT* 3/4" FPT
BD-1	INNER BURST DISC	19-1034-2	350 PSIG, 1/2" MPT
BD-2	ANNULUS BURST DISC	19-1064-1	25 PSIG, 2-1/2" MPT
R-1	P.B. REGULATOR	21-1003-2	TYPE A-32, 1/4" NPT, 125 PSIG
R-2	ECONOMIZER REGULATOR	21-1002-2	TYPE FRM, 1/4" NPT, 140 PSIG
		97-1557-2	REBUILD KIT
C-1	FILL CONNECTION	65-1047-2	CGA-OXYGEN
		65-1057-2	CGA-NITROGEN
		65-1067-2	CGA-ARGON
		65-1036-2	FLANGE-OXYGEN
		65-1036-2	FLANGE-ARGON
		65-1036-2	FLANGE-NITROGEN
C-2	GAS USE CONNECTION	10-1158-2	CONN 0.625 ODT, 0.5 MPT
C-3	FULL TRYCOCK	39-1015-6	3/8" NPT
C-4	VENT	15-1058-3	ELBOW 1.000" FTG.
C-5	AUXILIARY LIQUID	12-1100-2	1" FPT
		17-1327-2	VALVE (OPTIONAL)
		12-1052-2	STREET ELBOW (OPTIONAL)
C-6	AUXILIARY VENT	12-1087-2	PLUG 0.750 MPT
C-7	HOSE DRAIN	39-1015-6	3/8" NPT
1	STAUFF CLAMP	34-1021-6	0.625" O.D.
2	P.B. CONNECTION	10-1157-2	MALE ELBOW .625 ODT* .500 MPT
3	VAPORIZER CONNECTION	10-1156-2	MALE CONN 0.625 ODT* 0.750 M
4	VAPORIZER CONNECTION	10-1156-2	MALE CONN 0.625 OD* 0.750 MPT
5	PRESSURE BUILDING CONN	10-1155-2	M. ELBOW 0.5 ODT* 0.5 MPT
6	FILL GASKET	65-1006-2	GASKET, FILL FITTING
7	NUT	65-1035-2	NUT
8	STUD—SS	65-1034-1	STUD
9	CAP—CGA	65-1058-5	NITROGEN SERVICE
		65-1069-5	ARGON
		65-1070-5	OXYGEN
10	CAP/FLANGE	65-1033-1	COMB. FLANGE CAP
11	RUPTURE DISC CAP	39-1065-6	CAP, VINYL
		38-1493-5	WARRANTY SEAL
12	LIQUID LEVEL GAUGE	20-1032-9	0-100" H20
		20-1229-9	0-100" H20 W/ALARM
13	PRESSURE GAUGE	20-1027-2	0-400 P.S.I

Table 6-4. Liquid Contents Chart
VCS 525-SS-250-MVE-0

GAUGE (IN.)	ARGON (GAL.)	OXYGEN (GAL.)	NITROGEN (GAL.)
0	0	0	0
4	4	6	12
8	15	21	38
12	31	40	68
16	48	61	97
20	65	81	127
24	82	102	157
28	99	122	186
32	177	143	215
36	134	163	245
40	151	184	274
44	168	204	304
48	185	225	333
52	203	245	363
56	220	266	392
60	237	286	422
64	254	307	451
68	271	327	481
72	288	347	510
76	306	368	537
80	323	388	549
84	340	409	
88	357	429	
92	374	450	
96	392	470	
100	409	491	
104	426	511	
108	443	530	
112	460	545	
116	478		
120	495		
124	512		
128	529		
132	543		
136	551		
138	553		

NOTE: Contents based on liquid saturated at 0 PSIG.

Figure 6-3. Parts Identification View
VCS 900-SS-250-MVE-0

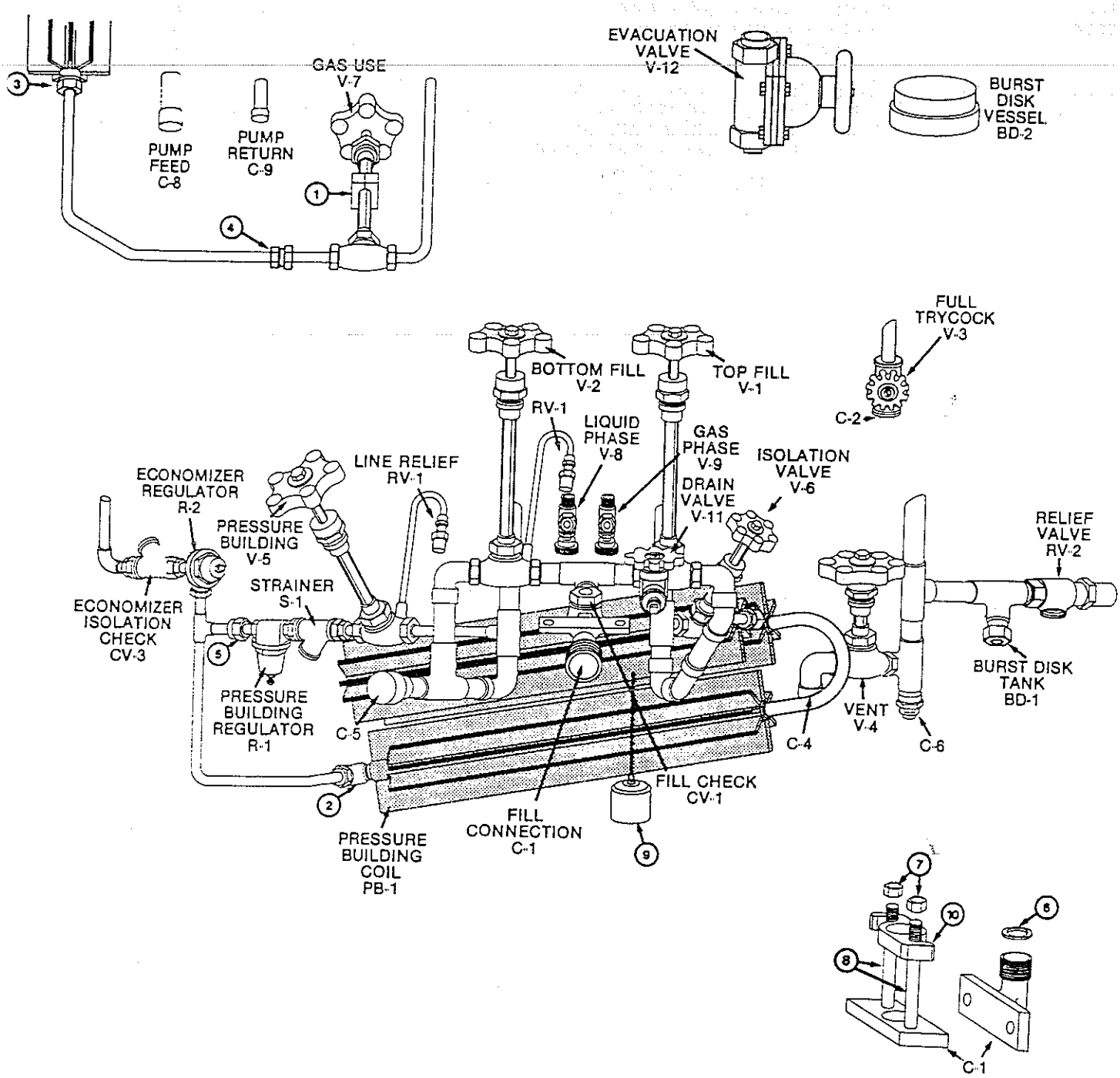


Table 6-5. Parts Identification List
VCS 900-SS-250-MVE-0

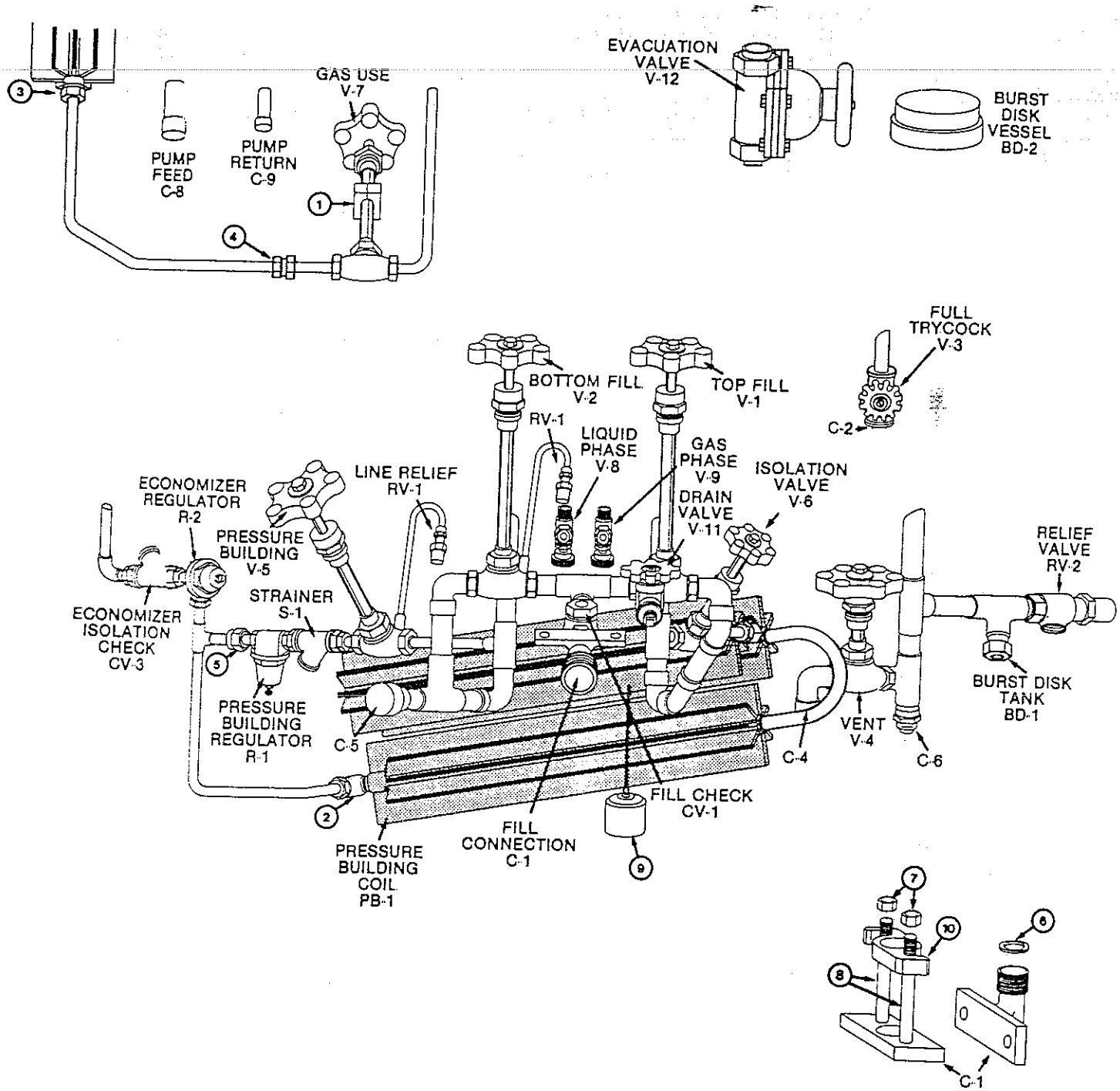
	NOMENCLATURE	COMP. PART NO.	DESCRIPTION
V-1	TOP FILL	90-5087-2	GLOBE VALVE, 1" NOM
V-2	BOTTOM FILL	90-7846-2	GLOBE VALVE, 1" NOM
V-3	FULL TRYCOCK	17-1320-2	SHUTOFF VALVE, 3/8" NPT
V-4	VENT	17-1387-2	GLOBE VALVE, 1" NOM
V-5	P.B. FEED	90-5152-2	1/2" NOM* 1/2" NPT
V-6	P.B. ISOLATION	17-1110-2	GATE VALVE, 1/2" NOM
V-7	GAS USE	17-1390-2	GLOBE VALVE, 1/2" C* 1/2" NPT
V-8	LIQUID PHASE HIGH	17-1186-2	ANGLE VALVE, 1/4" ODT* 1/4" MPT
V-9	GAS PHASE LOW	17-1186-2	ANGLE VALVE, 1/4" ODT* 1/4" MPT
V-10	EQUALIZATION	17-1046-2	NEEDLE VALVE, 1/4" NPT
V-11	FILL DRAIN	17-1670-2	SHUTOFF VALVE, 3/8" NPT
V-12	EVACUATION	17-1322-4	DIAPHRAGM VALVE, 1-1/2"
V-16	TC ISOLATION	17-1267-2	BELLOWS SEALED, 1/8"
CV-1	FILL CHECK	17-1371-2	3/4" NPT
CV-2	ECONOMIZER CHECK	17-1099-2	3/8" NPT
S-1	STRAINER	49-1023-2	3/8" NPT
RV-1	LINE TRAP SAFETY	18-1046-2	350 PSIG, 1/4" NPT
RV-2	INNER VESSEL SAFETY	18-1040-2	250 PSIG, 1/2" MPT* 3/4" FPT
BD-1	INNER BURST DISC	19-1034-2	350 PSIG, 1/2" MPT
BD-2	ANNULUS BURST DISC	19-1064-1	25 PSIG, 2-1/2" MPT
R-1	P.B. REGULATOR	21-1003-2	TYPE A-32, 1/4" NPT, 125 PSIG
R-2	ECONOMIZER REGULATOR	21-1002-2	TYPE FRM, 1/4" NPT, 140 PSIG
		97-1557-2	REBUILD KIT
C-1	FILL CONNECTION	65-1047-2	CGA-OXYGEN
		65-1057-2	CGA-NITROGEN
		65-1067-2	CGA-ARGON
		65-1036-2	FLANGE-OXYGEN
		65-1036-2	FLANGE-ARGON
		65-1036-2	FLANGE-NITROGEN
	GAS USE CONNECTION	10-1158-2	CONN 0.625 ODT, 0.5 MPT
	FULL TRYCOCK	39-1015-6	3/8" NPT
C-4	VENT	15-1056-3	ELBOW 1.000" FTG.
C-5	AUXILIARY LIQUID	12-1100-2	1" FPT
		17-1327-2	VALVE (OPTIONAL)
		12-1052-2	STREET ELBOW (OPTIONAL)
C-6	AUXILIARY VENT	12-1087-2	PLUG 0.750 MPT
C-7	HOSE DRAIN	39-1015-6	3/8" NPT
C-8	PUMP FEED	12-1100-2	CAP 1.000 FPT
C-9	PUMP RETURN	12-1097-2	CAP 0.500 FPT
1	STAUFF CLAMP	34-1021-6	0.625" O.D.
2	P.B. CONNECTION	10-1157-2	MALE ELBOW .625 ODT* .500 MPT
3	VAPORIZER CONNECTION	10-1156-2	MALE CONN. 0.625 ODT* 0.750 M
4	VAPORIZER CONNECTION	10-1156-2	MALE CONN 0.625 OD* 0.750 MPT
5	PRESSURE BUILDING CONN.	10-1155-2	M. ELBOW 0.5 ODT* 0.5 MPT
6	FILL GASKET	65-1006-2	GASKET, FILL FITTING
7	NUT	65-1035-2	NUT
8	STUD—SS	65-1034-1	STUD
9	CAP—CGA	65-1058-5	NITROGEN SERVICE
		65-1069-5	ARGON
		65-1070-5	OXYGEN
10	CAP/FLANGE	65-1033-1	COMB. FLANGE CAP
11	RUPTURE DISC CAP	39-1065-6	CAP, VINYL
		38-1493-5	WARRANTY SEAL
12	LIQUID LEVEL GAUGE	20-1219-9	0-150" H20
		20-1153-9	0-150" H20 W/ALARM
13	PRESSURE GAUGE	20-1027-2	0-400 P.S.I.

Table 6-6. Liquid Contents Chart
VCS 900-SS-250-MVE-0

GAUGE (IN.)	ARGON (GAL.)	OXYGEN (GAL.)	NITROGEN (GAL.)
0	0	0	0
4	6	8	16
8	21	28	54
12	43	58	102
16	69	91	150
20	98	125	199
24	126	158	248
28	154	192	297
32	183	226	346
36	211	260	394
40	240	294	443
44	268	328	492
48	197	361	541
52	325	395	589
56	353	429	638
60	382	463	687
64	410	497	736
68	439	531	784
72	467	564	833
76	496	598	882
80	524	632	925
84	552	666	949
88	581	700	
92	609	734	
96	638	767	
100	666	801	
104	695	835	
108	723	869	
112	751	902	
116	780	031	
120	808	952	
124	837		
128	865		
132	893		
136	919		
140	941		
144	955		

NOTE: Contents based on liquid saturated at 0 PSIG.

Figure 6-4. Parts Identification View
VCS 1500-SS-250-MVE-0
VLS 1500-SS-50-MVE-0



NOTE: VLS models will not have an economizer or gas use circuit.

Table 6-7. Parts Identification List
VCS 1500-SS-250-MVE-0
VLS 1500-SS-50-MVE-0

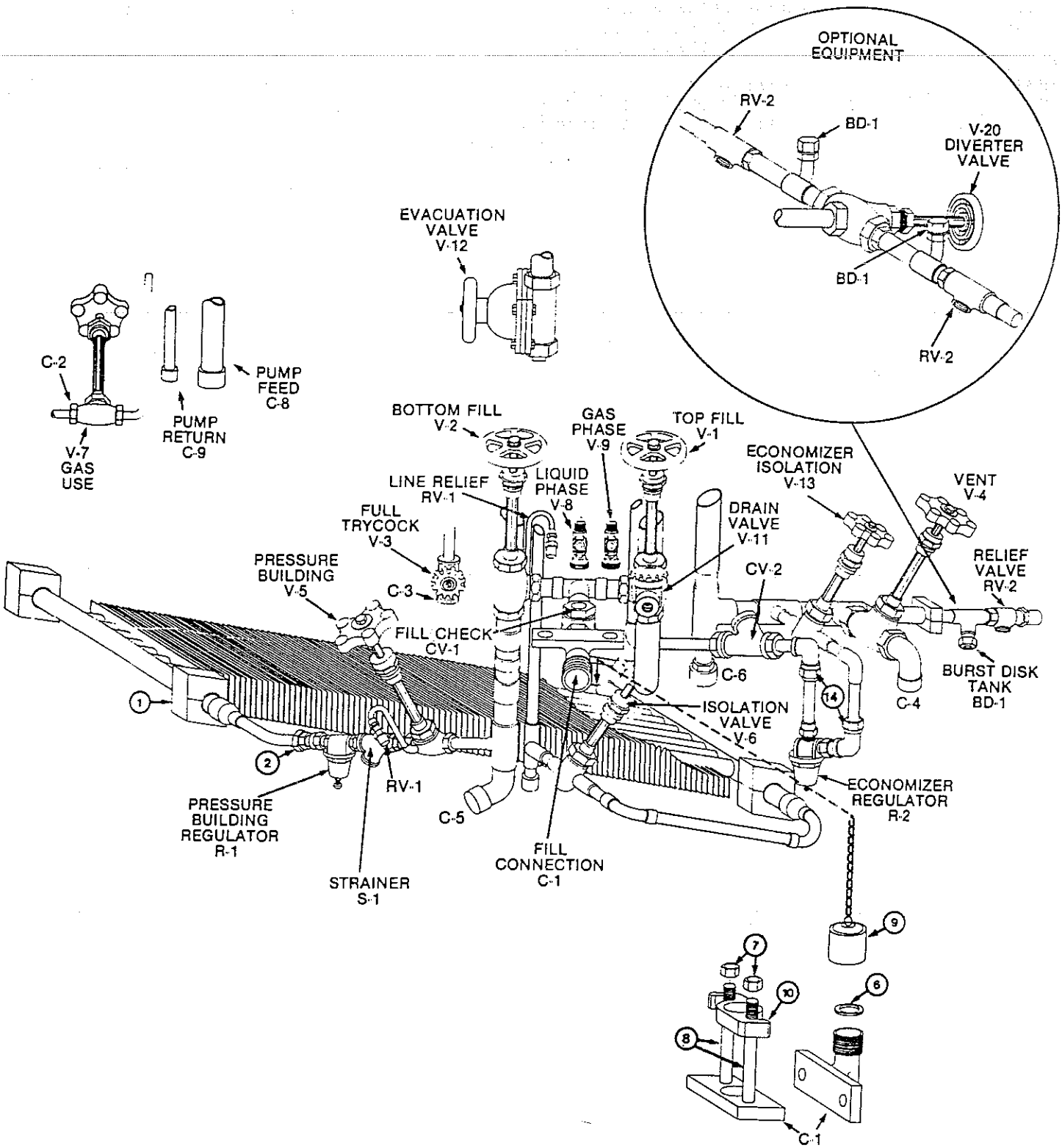
	NOMENCLATURE	COMP. PART NO.	DESCRIPTION
V-1	TOP FILL	90-5087-2	GLOBE VALVE, 1" NOM
V-2	BOTTOM FILL	90-7846-2	GLOBE VALVE, 1" NOM
V-3	FULL TRYCOCK	17-1320-2	SHUTOFF VALVE, 3/8" NPT
V-4	VENT	17-1387-2	GLOBE VALVE, 1" NOM
V-5	P.B. FEED	90-5152-2	1/2" NOM* 1/2" NPT
V-6	P.B. ISOLATION	17-1110-2	GATE VALVE, 1/2" NOM
V-7	GAS USE	17-1390-2	GLOBE VALVE, 1/2" C* 1/2" NPT
V-8	LIQUID PHASE HIGH	17-1186-2	ANGLE VALVE, 1/4" ODT* 1/4" MPT
V-9	GAS PHASE LOW	17-1186-2	ANGLE VALVE, 1/4" ODT* 1/4 ' MPT
V-10	EQUALIZATION	17-1046-2	NEEDLE VALVE, 1/4" NPT
V-11	FILL DRAIN	17-1670-2	SHUTOFF VALVE, 3/8" NPT
V-12	EVACUATION	17-1322-4	DIAPHRAGM VALVE, 1-1/2"
V-16	TC ISOLATION	17-1267-2	BELLOWS SEALED, 1/8"
CV-1	FILL CHECK	17-1371-2	3/4" NPT
CV-2	ECONOMIZER CHECK	17-1099-2	3/8" NPT
S-1	STRAINER	49-1023-2	3/8" NPT
RV-1	LINE TRAP SAFETY	18-1046-2	350 PSIG, 1/4" NPT
RV-2	INNER VESSEL SAFETY	18-1040-2	250 PSIG, 1/2" MPT* 3/4" FPT
BD-1	INNER BURST DISC	19-1034-2	350 PSIG, 1/2" MPT
BD-2	ANNULUS BURST DISC	19-1064-1	25 PSIG, 2-1/2" MPT
R-1	P.B. REGULATOR	21-1003-2	TYPE A-32, 1/4" NPT, 125 PSIG
R-2	ECONOMIZER REGULATOR	21-1002-2	TYPE FRM, 1/4" NPT, 140 PSIG
		97-1557-2	REBUILD KIT
C-1	FILL CONNECTION	65-1047-2	CGA-OXYGEN
		65-1057-2	CGA-NITROGEN
		65-1067-2	CGA-ARGON
		65-1036-2	FLANGE-OXYGEN
		65-1036-2	FLANGE-ARGON
		65-1038-2	FLANGE-NITROGEN
	GAS USE CONNECTION	10-1158-2	CONN 0.625 ODT, 0.5 MPT
	FULL TRYCOCK	39-1015-6	3/8" NPT
C-4	VENT	15-1056-3	ELBOW 1.000" FTG.
C-5	AUXILIARY LIQUID	12-1100-2	1" FPT
		17-1327-2	VALVE (OPTIONAL)
		12-1052-2	STREET ELBOW (OPTIONAL)
C-6	AUXILIARY VENT	12-1087-2	PLUG 0.750 MPT
C-7	HOSE DRAIN	39-1015-6	3/8" NPT
C-8	PUMP FEED	12-1100-2	CAP 1.000 FPT
C-9	PUMP RETURN	12-1097-2	CAP 0.500 FPT
1	STAUFF CLAMP	34-1021-6	0.625" O.D.
2	P.B. CONNECTION	10-1157-2	MALE ELBOW .625 ODT* .500 MPT
3	VAPORIZER CONNECTION	10-1156-2	MALE CONN. 0.625 ODT* 0.750 M
4	VAPORIZER CONNECTION	10-1156-2	MALE CONN 0.625 OD* 0.750 MPT
5	PRESSURE BUILDING CONN.	10-1155-2	M. ELBOW 0.5 ODT* 0.5 MPT
6	FILL GASKET	65-1006-2	GASKET, FILL FITTING
7	NUT	65-1035-2	NUT
8	STUD—SS	65-1034-1	STUD
9	CAP—CGA	65-1058-5	NITROGEN SERVICE
		65-1069-5	ARGON
		65-1070-5	OXYGEN
10	CAP/FLANGE	65-1033-1	COMB. FLANGE CAP
11	RUPTURE DISC CAP	39-1065-6	CAP, VINYL
		38-1493-5	WARRANTY SEAL
12	LIQUID LEVEL GAUGE	20-1167-9	0-200" H20
		20-1149-9	0-200" H20 W/ALARM
13	PRESSURE GAUGE	20-1027-2	0-400 P.S.I.

Table 6-8. Liquid Contents Chart
VCS 1500-SS-250-MVE-0
VLS 1500-SS-50-MVE-0

GAUGE (IN.)	ARGON (GAL.)	OXYGEN (GAL.)	NITROGEN (GAL.)
0	0	0	0
4	10	13	23
8	29	41	70
12	56	78	130
16	88	120	191
20	124	163	252
24	159	206	312
28	194	249	373
32	229	292	433
36	284	334	494
40	299	377	554
44	334	420	614
48	369	462	675
52	404	505	735
56	439	548	795
60	474	590	856
64	509	633	916
68	543	676	976
72	578	718	1036
76	613	761	1097
80	648	804	1157
84	683	846	1217
88	718	889	1277
92	753	931	1338
96	787	974	1398
100	822	1017	1458
104	857	1059	
108	892	1102	
112	927	1144	
116	962	1197	
120	997	1230	
124	1031	1272	
128	1066	1315	
132	1101	1357	
136	1136	1400	
140	1171	1443	
144	1206	1485	
148	1240		
152	1275		
156	1310		
160	1345		
164	1380		
168	1415		
172	1449		
176	1484		

NOTE: Contents based on liquid saturated at 0 PSIG

Figure 6-5. Parts Identification View
VCS 3000-SS-250-MVE-0
VLS 3000-SS-50-MVE-0
VCS 3000-SP-250-MVE-0
VLS 3000-SP-50-MVE-0



NOTE: VLS models will not have an economizer or gas use circuit.

Table 6-9. Parts Identification List
3000 Gallon Units

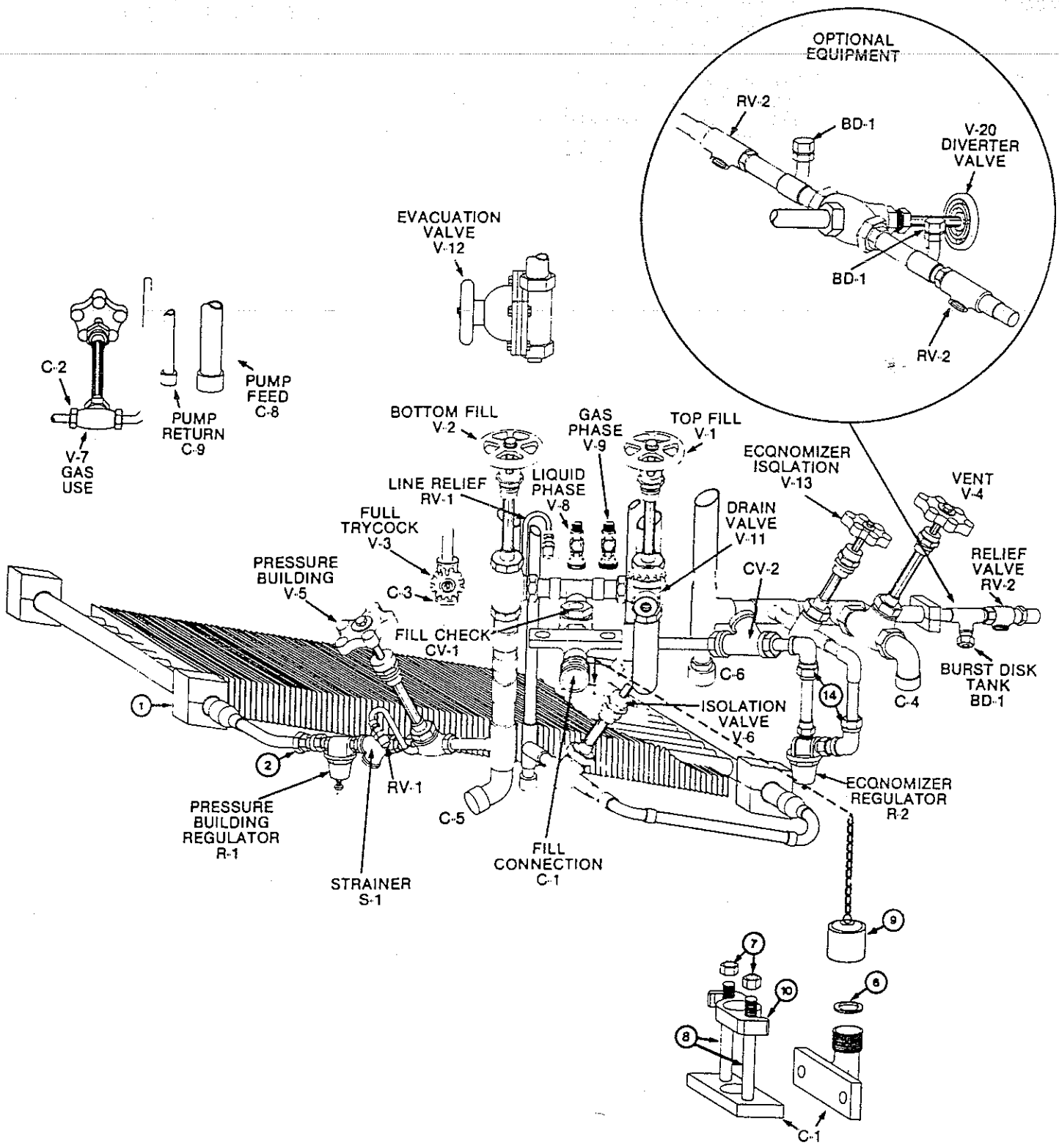
TAG	NOMENCLATURE	COMP. PART NO.	DESCRIPTION
	TOP FILL	90-5932-2	ANGLE VALVE, 1-1/2" NOM
V-2	BOTTOM FILL	90-7845-2	ANGLE VALVE, 1-1/2" NOM
V-3	FULL TRYCOCK	17-1320-2	SHUTOFF VALVE, 3/8" NPT
V-4	VENT	17-1387-2	GLOBE VALVE, 1" NOM
V-5	P.B. FEED	90-5152-2	1/2" NOM * 1/2" NPT
V-6	P B. ISOLATION	17-1110-2	GATE VALVE, 1/2" NOM
V-7	GAS USE	17-1176-2	GLOBE VALVE, 1/2" NPT
V-8	LIQUID PHASE HIGH	17-1186-2	ANGLE VALVE, 1/4" ODT * 1/4" MPT
V-9	GAS PHASE LOW	17-1186-2	ANGLE VALVE, 1/4 ' ODT * 1/4" MPT
V-10	EQUALIZATION	17-1046-2	NEEDLE VALVE, 1/4" NPT
V-11	FILL DRAIN	17-1670-2	SHUTOFF VALVE, 3/8" NPT
V-12	EVACUATION	17-1322-4	DIAPHRAGM VALVE, 1-1/2 '
V-13	ECONOMIZER ISOLATION	17-1110-2	GATE VALVE, 1/2" NOM
V-16	TC ISOLATION	17-1267-2	BELLOWS SEALED, 1/8"
CV-1	FILL CHECK	17-1358-2	1-1/2' NPT
CV-3	ECONOMIZER CHECK	17-1099-2	3/8" NPT
S-1	STRAINER	49-1023-2	3/8" NPT
RV-1	LINE TRAP SAFETY	18-1046-2	350 PSIG, 1/4" NPT
RV-2	INNER VESSEL SAFETY	18-1040-2	250 PSIG, 1/2 ' MPT * 3/4" FPT
BD-1	INNER BURST DISC	19-1112-5	375 PSIG, 3/4" MPT
BD-2	ANNULUS BURST DISC	19-1064-1	6" LIFT PLATE
R-1	P.B. REGULATOR	21-1003-2	TYPE A-32, 1/4" NPT, 125 PSIG
R-2	ECONOMIZER REGULATOR	21-1002-2	TYPE FRM, 1/4" NPT, 140 PSIG
	REBUILD KIT	97-1557-2	REGULATOR RENEWAL KIT
	SPRING KIT		
C-1	FILL CONNECTION	65-1047-2	CGA-OXYGEN
		65-1057-2	CGA-NITROGEN
		65-1067-2	CGA-ARGON
		65-1036-2	FLANGE-OXYGEN
		65-1036-2	FLANGE-ARGON
	CUSTOMER GAS USE	65-1036-2	FLANGE-NITROGEN 1" NPT
	FULL TRYCOCK	39-1015-6	PLUG 3/8" MPT PLASTIC
C-4	VENT	15-1056-3	ELBOW 1" FTG
C-5	AUXILIARY LIQUID	12-1108-2	CAP 1-1/4" FPT BRASS
		17-1327-2	VALVE (OPTIONAL)
		12-1052-2	STREET ELBOW (OPTIONAL)
C-6	AUXILIARY VENT	12-1100-2	CAP 1" FPT BRASS
C-7	DRAIN CONNECTION	39-1015-6	PLUG 3/8" MPT PLASTIC
C-8	PUMP FEED	12-1108-2	CAP 1-1/4" FPT BRASS
C-9	PUMP RETURN	12-1097-2	CAP .5" FPT BRASS
1	STAUFF CLAMP	34-1080-6	1-1/4" O D. CLAMP
		34-1059-4	.25 SM NUT
2	P.B. CONNECTION	10-1158-2	M CONNECTOR .625 O.D.T. x .500 MPT
6	FILL GASKET	65-1006-2	GASKET, FILL FITTING
7	NUT	65-1035-2	NUT
8	STUD-SS	65-1034-1	STUD
9	CAP-CGA	65-1058-5	NITROGEN SERVICE
		65-1070-5	OXYGEN SERVICE
		65-1069-5	ARGON SERVICE
10	CAP-FLANGE	65-1033-1	COMB. FLANGE CAP
12	LIQUID LEVEL GAUGE	20-1167-9	0-200" H_2O
		20-1149-9	0-200" H_2O W/ALARM
13	PRESSURE GAUGE	20-1027-2	0-400 PSI
14	ECONOMIZER FITTINGS	10-1162-2	M. ELBOW 90D .625 O.D.T. x .375 MPT

Table 6-10. Liquid Contents Chart
VCS 3000-SS-250-MVE-0
VLS 3000-SS-50-MVE-0
VCS 3000-SP-250-MVE-0
VLS 3000-SP-50-MVE-0

GAUGE (IN.)	ARGON (GAL.)	OXYGEN (GAL.)	NITROGEN (GAL.)
0	0	0	0
5	13	19	39
10	52	71	139
15	109	149	274
20	181	242	422
25	262	343	569
30	347	446	717
35	433	548	864
40	519	650	1012
45	605	753	1159
50	691	855	1307
55	777	957	1454
60	863	1060	1602
65	949	1162	1749
70	1035	1264	1897
75	1121	1367	2044
80	1207	1469	2192
85	1293	1571	2339
90	1379	1674	2487
95	1465	1776	2634
100	1551	1878	2782
105	1637	1981	2921
110	1723	2083	3027
115	1809	2185	
120	1895	2288	
125	1981	2390	
130	2067	2493	
135	2153	2595	
140	2239	2697	
145	2325	2799	
150	2411	2896	
155	2497	2980	
160	2583		
165	2669		
170	2755		
175	2840		
180	2919		
185	2987		

NOTE: Contents based on liquid saturated at 0 PSIG.

Figure 6-6. Parts Identification View
VCS 6000-SS-250-MVE-0
VLS 6000-SS-75-MVE-0
VCS 6000-SP-250-MVE-0
VCS 6000-NP-250-MVE-0
VLS 6000-SP-75-MVE-0



NOTE: VLS models will not have an economizer or gas use circuit

Table 6-11. Parts Identification List
6000 Gallon Units

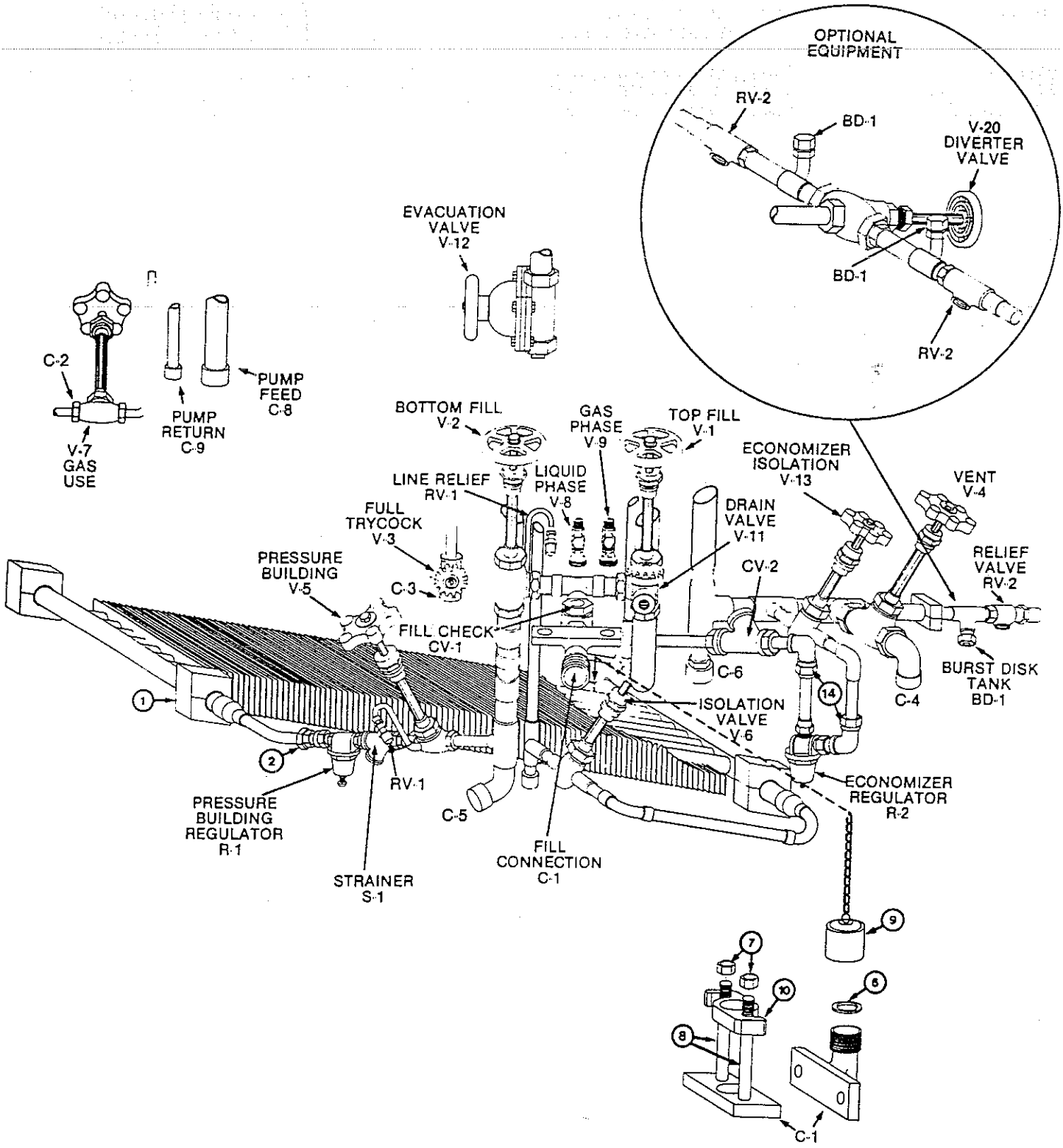
T[illegible]	NOMENCLATURE	COMP. PART NO.	DESCRIPTION
	TOP FILL	90-5932-2	ANGLE VALVE, 1-1/2" NOM
V-2	BOTTOM FILL	90-7845-2	ANGLE VALVE, 1-1/2" NOM
V-3	FULL TRYCOCK	17-1320-2	SHUTOFF VALVE 3/8" NPT
V-4	VENT	17-1387-2	GLOBE VALVE, 1" NOM
V-5	P.B FEED	90-5152-2	1/2" NOM* 1/2" NPT
V-6	P.B. ISOLATION	17-1324-2	GLOBE VALVE, 1" NOM
V-7	GAS USE	17-1176-2	GLOBE VALVE, 1/2" NPT
V-8	LIQUID PHASE HIGH	17-1186-2	ANGLE VALVE, 1/4" ODT* 1/4" MPT
V-9	GAS PHASE LOW	17-1186-2	ANGLE VALVE, 1/4" ODT* 1/4" MPT
V-10	EQUALIZATION	17-1046-2	NEEDLE VALVE, 1/4" NPT
V-11	FILL DRAIN	17-1670-2	SHUTOFF VALVE, 3/8" NPT
V-12	EVACUATION	17-1322-4	DIAPHRAGM VALVE, 1-1/2"
V-13	ECONOMIZER ISOLATION	17-1110-2	GATE VALVE 1/2" NOM
V-16	TC ISOLATION	17-1267-2	BELLOWS SEALED, 1/8"
CV-1	FILL CHECK	17-1358-2	1-1/2" NPT
CV-3	ECONOMIZER CHECK	17-1099-2	3/8" NPT
S-1	STRAINER	49-1023-2	3/8" NPT
RV-1	LINE TRAP SAFETY	18-1046-2	350 PSIG, 1/4" NPT
RV-2	INNER VESSEL SAFETY	18-1040-2	250 PSIG, 1/2" MPT* 3/4" FPT
BD-1	INNER BURST DISC	19-1112-5	375 PSIG, 3/4" MPT
BD-2	ANNULUS BURST DISC	19-1064-1	6" LIFT PLATE
R-1	P.B. REGULATOR	21-1007-2	TYPE B, 1/2" NPT, 120 PSIG
R-2	ECONOMIZER REGULATOR	21-1002-2	TYPE FRM, 1/4" NPT, 140 PSIG
	REBUILD KIT	97-1557-2	REGULATOR RENEWAL KIT
	SPRING KIT		
C-1	FILL CONNECTION	65-1047-2	CGA-OXYGEN
		65-1057-2	CGA-NITROGEN
		65-1067-2	CGA-ARGON
		65-1036-2	FLANGE-OXYGEN
		65-1036-2	FLANGE-ARGON
		65-1036-2	FLANGE-NITROGEN
C-2	CUSTOMER GAS USE		1" NPT
C-3	FULL TRYCOCK	39-1015-6	PLUG 3/8" MPT PLASTIC
C-4	VENT	15-1056-3	ELBOW 1" FTG
C-5	AUXILIARY LIQUID	12-1108-2	CAP 1-1/4" FPT BRASS
		17-1327-2	VALVE (OPTIONAL)
		12-1052-2	STREET ELBOW (OPTIONAL)
C-6	AUXILIARY VENT	12-1100-2	CAP 1" FPT BRASS
C-7	DRAIN CONNECTION	39-1015-6	PLUG 3/8" MPT PLASTIC
C-8	PUMP FEED	12-1108-2	CAP 1-1/4" FPT BRASS
C-9	PUMP RETURN	12-1097-2	CAP .5" FPT BRASS
1	STAUFF CLAMP	34-1080-6	1-1/4" O.D. CLAMP
		34-1059-4	.25 SM NUT
2	P.B. CONNECTION	10-1158-2	M. CONNECTOR .625 O.D.T. x .500 MPT
6	FILL GASKET	65-1006-2	GASKET, FILL FITTING
7	NUT	65-1035-2	NUT
8	STUD-SS	65-1034-1	STUD
9	CAP-CGA	65-1058-5	NITROGEN SERVICE
		65-1070-5	OXYGEN SERVICE
		65-1069-5	ARGON SERVICE
10	CAP-FLANGE	65-1033-1	COMB. FLANGE CAP
12	LIQUID LEVEL GAUGE	20-1151-9	0-400" H_2O
		20-1210-9	0-400" H_2O W/ALARM
13	PRESSURE GAUGE	20-1027-2	0-400 PSI
14	ECONOMIZER FITTINGS	10-1162-2	M. ELBOW 90D .625 O.D.T. x .375 MPT

Table 6-12. Liquid Contents Chart
VCS 6000-SS-250-MVE-0
VLS 6000-SS-75-MVE-0
VCS 6000-SP-250-MVE-0
VCS 6000-NP-250-MVE-0
VLS 6000-SP-75-MVE-0

GAUGE (IN.)	ARGON (GAL.)	OXYGEN (GAL.)	NITROGEN (GAL.)
0	0	0	0
10	52	71	139
20	181	242	422
30	347	446	717
40	519	650	1012
50	691	855	1307
60	863	1060	1602
70	1035	1264	1897
80	1207	1469	2192
90	1379	1674	2487
100	1551	1878	2782
110	1723	2083	3077
120	1895	2288	3372
130	2067	2493	3667
140	2239	2697	3962
150	2411	2902	4257
160	2583	3107	4552
170	2755	3311	4847
180	2927	3516	5142
190	3099	3721	5437
200	3271	3925	5732
210	3443	4130	6001
220	3615	4335	
230	3787	4539	
240	3959	4744	
250	4131	4949	
260	4303	5153	
270	4475	5358	
280	4647	5563	
290	4818	5767	
300	4990	5959	
310	5162		
320	5334		
330	5506		
340	5678		
350	5849		
360	5998		

NOTE: Contents based on liquid saturated at 0 PSIG.

Figure 6-7. Parts Identification View
VCS 9000-SS-250-MVE-0
VLS 9000-SS-75-MVE-0
VCS 9000-SP-250-MVE-0
VCS 9000-NP-250-MVE-0
VLS 9000-SP-75-MVE-0



NOTE: VLS models will not have an economizer or gas use circuit.

Table 6-13. Parts Identification List
9000 Gallon Units

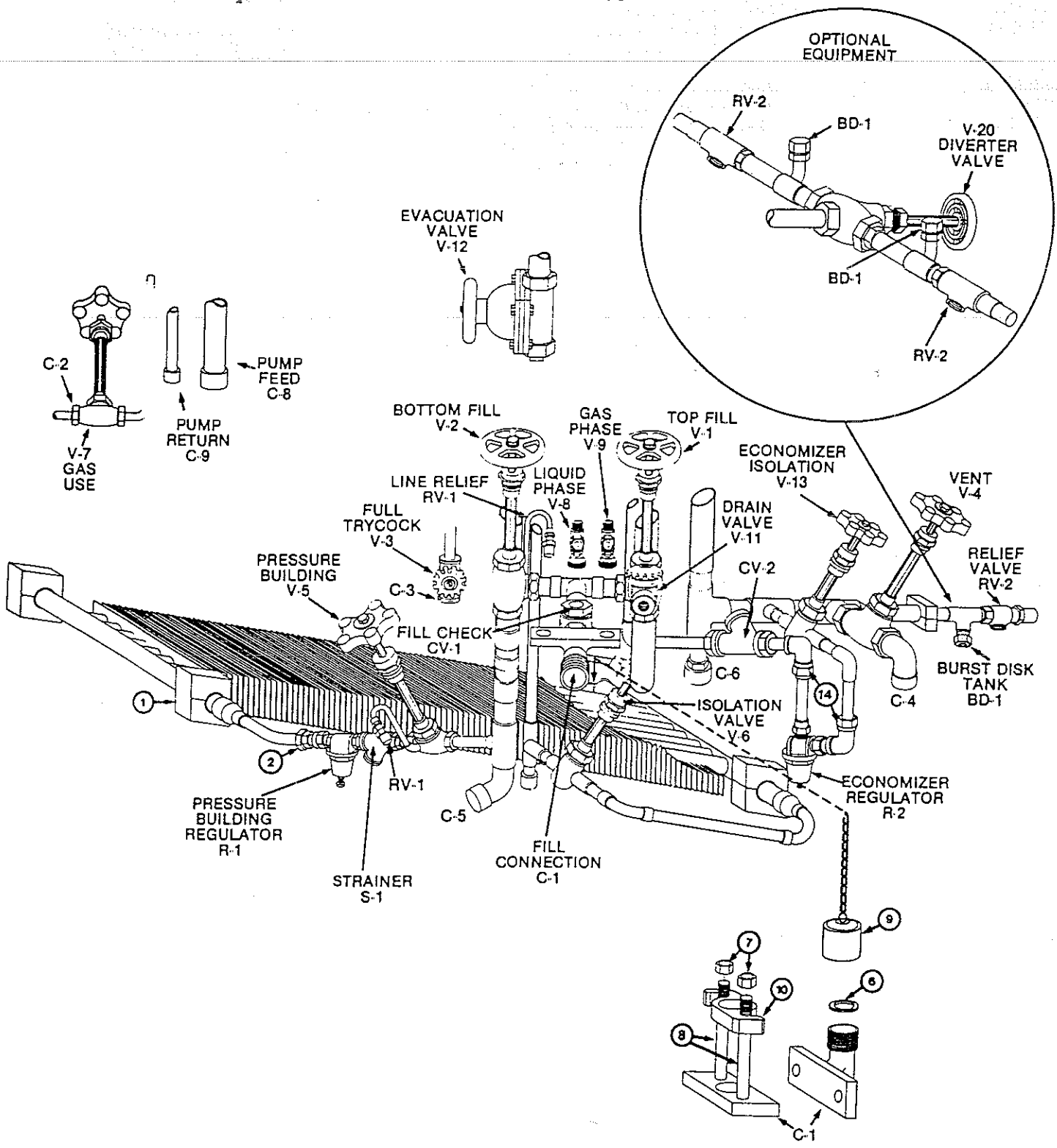
?	NOMENCLATURE	COMP. PART NO.	DESCRIPTION
'	TOP FILL	90-5932-2	ANGLE VALVE, 1-1/2" NOM
V-2	BOTTOM FILL	90-7845-2	ANGLE VALVE, 1-1/2" NOM
V-3	FULL TRYCOCK	17-1320-2	SHUTOFF VALVE, 3/8 ' NPT
V-4	VENT	17-1387-2	GLOBE VALVE, 1" NOM
V-5	P.B. FEED	90-5152-2	1/2" NOM* 1/2" NPT
V-6	P.B. ISOLATION	17-1324-2	GLOBE VALVE, 1" NOM
V-7	GAS USE	17-1327-2	GLOBE VALVE, 1" NPT
V-8	LIQUID PHASE HIGH	17-1186-2	ANGLE VALVE, 1/4" ODT* 1/4" MPT
V-9	GAS PHASE LOW	17-1186-2	ANGLE VALVE, 1/4" ODT* 1/4" MPT
V-10	EQUALIZATION	17-1046-2	NEEDLE VALVE, 1/4" NPT
V-11	FILL DRAIN	17-1670-2	SHUTOFF VALVE, 3/8" NPT
V-12	EVACUATION	17-1322-4	DIAPHRAGM VALVE, 1-1/2"
V-13	ECONOMIZER ISOLATION	17-1110-2	GATE VALVE, 1/2" NOM
V-16	TC ISOLATION	17-1267-2	BELLOWS SEALED, 1/8 '
CV-1	FILL CHECK	17-1358-2	1-1/2" NPT
CV-3	ECONOMIZER CHECK	17-1357-2	1/2" NPT
S-1	STRAINER	49-1023-2	3/8" NPT
RV-1	LINE TRAP SAFETY	18-1046-2	350 PSIG, 1/4" NPT
RV-2	INNER VESSEL SAFETY	18-1040-2	250 PSIG, 1/2" MPT* 3/4 ' FPT
BD-1	INNER BURST DISC	19-1112-5	375 PSIG, 3/4" MPT
BD-2	ANNULUS BURST DISC	19-1064-1	6" LIFT PLATE
R-1	P.B. REGULATOR	21-1007-2	TYPE B, 1/2" NPT, 120 PSIG
R-2	ECONOMIZER REGULATOR	21-1008-2	TYPE FRM, 1/2" NPT, 140 PSIG
	REBUILD KIT	97-1557-2	REGULATOR RENEWAL KIT
	SPRING KIT		
C-1	FILL CONNECTION	65-1047-2	CGA-OXYGEN
		65-1057-2	CGA-NITROGEN
		65-1067-2	CGA-ARGON
		65-1036-2	FLANGE-OXYGEN
		65-1036-2	FLANGE-ARGON
		65-1036-2	FLANGE-NITROGEN
C-2	CUSTOMER GAS USE		1" NPT
C-3	FULL TRYCOCK	39-1015-6	PLUG 3/8" MPT PLASTIC
C-4	VENT	15-1056-3	ELBOW 1" FTG
C-5	AUXILIARY LIQUID	12-1108-2	CAP 1-1/4" FPT BRASS
		17-1327-2	VALVE (OPTIONAL)
		12-1052-2	STREET ELBOW (OPTIONAL)
C-6	AUXILIARY VENT	12-1100-2	CAP 1" FPT BRASS
C-7	DRAIN CONNECTION	39-1015-6	PLUG 3/8" MPT PLASTIC
C-8	PUMP FEED	12-1108-2	CAP 1-1/4" FPT BRASS
C-9	PUMP RETURN	12-1097-2	CAP .5" FPT BRASS
1	STAUFF CLAMP	34-1080-6	1-1/4" O.D. CLAMP
		34-1059-4	.25 SM NUT
2	P.B CONNECTION	10-1158-2	M. CONNECTOR .625 O.D.T. x .500 MPT
6	FILL GASKET	65-1006-2	GASKET, FILL FITTING
7	NUT	65-1035-2	NUT
8	STUD-SS	85-1034-1	STUD
9	CAP-CGA	65-1058-5	NITROGEN SERVICE
		85-1070-5	OXYGEN SERVICE
		85-1069-5	ARGON SERVICE
10	CAP-FLANGE	65-1033-1	COMB. FLANGE CAP
12	LIQUID LEVEL GAUGE	20-1152-9	0-600" H_2O
		20-1209-2	0-600" H_2O W/ALARM
13	PRESSURE GAUGE	20-1027-2	0-400 PSI
14	ECONOMIZER FITTINGS	10-1162-2	M. ELBOW 90D .625 O.D.T. x .375 MPT

Table 6-14. Liquid Contents Chart
VCS 9000-SS-250-MVE-0
VLS 9000-SS-75-MVE-0
VCS 9000-SP-250-MVE-0
VCS 9000-NP-250-MVE-0
VLS 9000-SP-75-MVE-0

GAUGE (IN.)	ARGON (GAL.)	OXYGEN (GAL.)	NITROGEN (GAL.)
0	0	0	0
10	60	84	164
20	215	291	523
30	425	554	911
40	651	824	1299
50	878	1093	1688
60	1104	1363	2076
70	1330	1632	2464
80	1557	1901	2853
90	1783	2171	3241
100	2010	2440	3629
110	2236	2710	4018
120	2462	2979	4406
130	2689	3249	4794
140	2915	3518	5183
150	3141	3787	5571
160	3368	4057	5959
170	3594	4326	6348
180	3820	4596	6736
190	4047	4865	7124
200	4273	5135	7513
210	4499	5404	7901
220	4726	5673	8289
230	4952	5943	8678
240	5179	6212	9061
250	5405	6482	9333
260	5631	6751	
270	5858	7021	
280	6084	7290	
290	6310	7560	
300	6537	7829	
310	6763	8098	
320	6989	8368	
330	7216	8637	
340	7442	8907	
350	7669	9156	
360	7895		
370	8121		
380	8348		
390	8574		
400	8800		
410	9023		
420	9215		
430			
435			

NOTE: Contents based on liquid saturated at 0 PSIG.

Figure 6-8. Parts Identification View
VCS 11000-SS-250-MVE-0
VLS 11000-SS-75-MVE-0
VCS 11000-SP-250-MVE-0
VCS 11000-NP-250-MVE-0
VLS 11000-SP-75-MVE-0



NOTE: VLS models will not have an economizer or gas use circuit.

Table 6-15. Parts Identification List
11000 Gallon Units

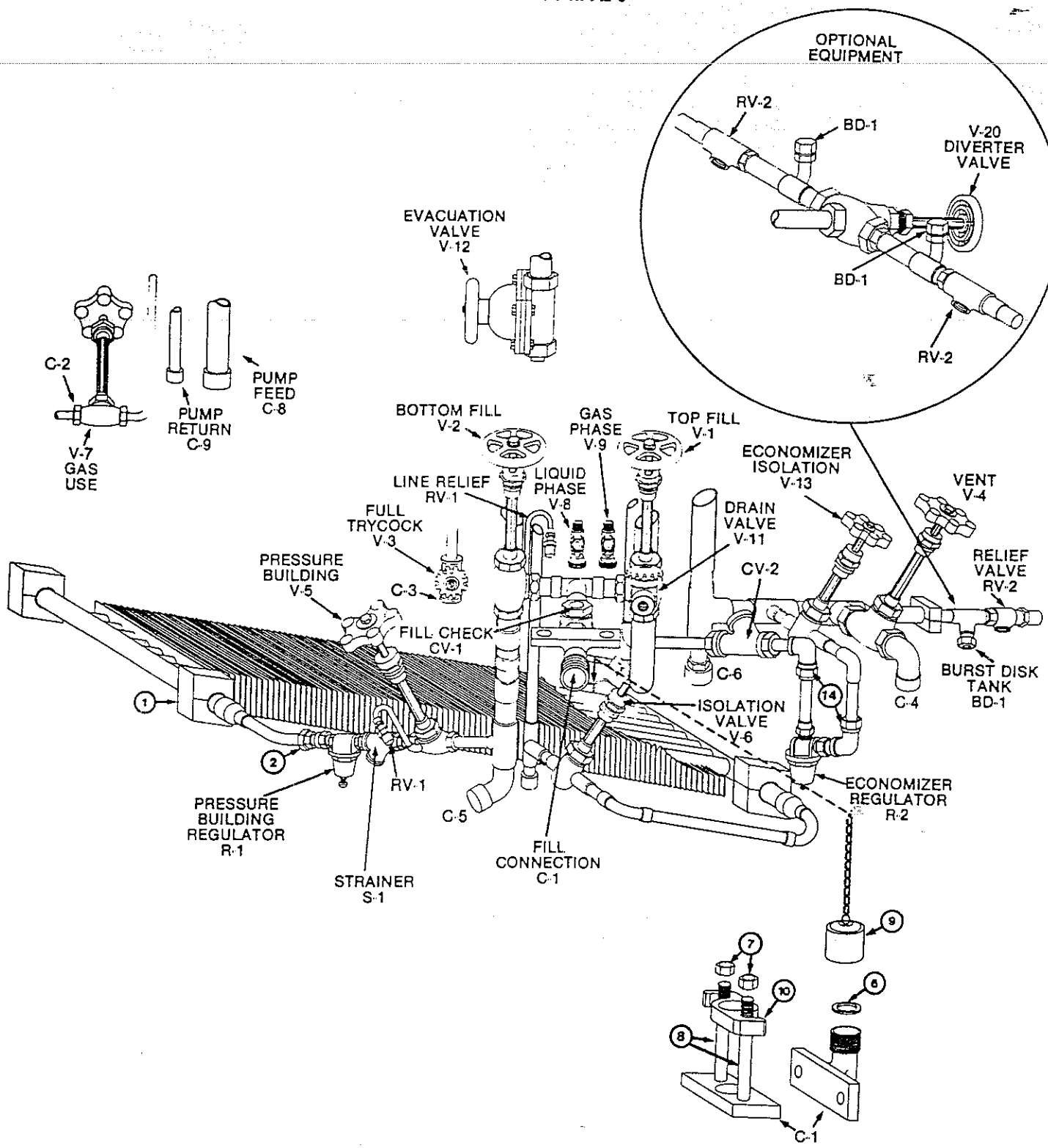
TAG	NOMENCLATURE	COMP. PART NO.	DESCRIPTION
	TOP FILL	90-5932-2	ANGLE VALVE, 1-1/2" NOM
V-2	BOTTOM FILL	90-7845-2	ANGLE VALVE, 1-1/2" NOM
V-3	FULL TRYCOCK	17-1320-2	SHUTOFF VALVE, 3/8" NPT
V-4	VENT	17-1387-2	GLOBE VALVE, 1" NOM
V-5	P.B. FEED	90-5152-2	1/2" NOM* 1/2" NPT
V-6	P.B. ISOLATION	17-1324-2	GLOBE VALVE, 1" NOM
V-7	GAS USE	17-1327-2	GLOBE VALVE, 1" NPT
V-8	LIQUID PHASE HIGH	17-1186-2	ANGLE VALVE, 1/4" ODT* 1/4" MPT
V-9	GAS PHASE LOW	17-1186-2	ANGLE VALVE, 1/4" ODT* 1/4" MPT
V-10	EQUALIZATION	17-1046-2	NEEDLE VALVE, 1/4" NPT
V-11	FILL DRAIN	17-1670-2	SHUTOFF VALVE, 3/8" NPT
V-12	EVACUATION	17-1322-4	DIAPHRAGM VALVE, 1-1/2"
V-13	ECONOMIZER ISOLATION	17-1110-2	GATE VALVE, 1/2" NOM
V-16	TC ISOLATION	17-1267-2	BELLOWS SEALED, 1/8"
CV-1	FILL CHECK	17-1358-2	1-1/2" NPT
CV-3	ECONOMIZER CHECK	17-1357-2	1/2" NPT
S-1	STRAINER	49-1023-2	3/8" NPT
RV-1	LINE TRAP SAFETY	18-1046-2	350 PSIG, 1/4" NPT
RV-2	INNER VESSEL SAFETY	18-1040-2	250 PSIG, 1/2" MPT* 3/4" FPT
BD-1	INNER BURST DISC	19-1112-5	375 PSIG, 3/4" MPT
BD-2	ANNULUS BURST DISC	19-1064-1	6" LIFT PLATE
R-1	P.B. REGULATOR	21-1007-2	TYPE B, 1/2" NPT, 120 PSIG
R-2	ECONOMIZER REGULATOR	21-1008-2	TYPE FRM, 1/2" NPT, 140 PSIG
	REBUILD KIT	97-1557-2	REGULATOR RENEWAL KIT
	SPRING KIT		
C-1	FILL CONNECTION	65-1047-2	CGA-OXYGEN
		65-1057-2	CGA-NITROGEN
		65-1067-2	CGA-ARGON
		65-1036-2	FLANGE-OXYGEN
		65-1036-2	FLANGE-ARGON
		65-1036-2	FLANGE-NITROGEN
	CUSTOMER GAS USE		1" NPT
C-3	FULL TRYCOCK	39-1015-6	3/8" NPT
C-4	VENT	15-1056-3	ELBOW 1" FTG
C-5	AUXILIARY LIQUID	12-1108-2	CAP 1-1/4" FPT BRASS
		17-1327-2	VALVE (OPTIONAL)
		12-1052-2	STREET ELBOW (OPTIONAL)
C-6	AUXILIARY VENT	12-1100-2	CAP 1" FPT BRASS
C-7	DRAIN CONNECTION	39-1015-6	3/8" NPT
C-8	PUMP FEED	12-1108-2	CAP 1-1/4" FPT BRASS
C-9	PUMP RETURN	12-1097-2	CAP .5" FPT BRASS
1	STAUFF CLAMP	34-1080-6	1-1/4" O.D. CLAMP
		34-1059-4	.25 SM NUT
2	P.B. CONNECTION	10-1158-2	M. CONNECTOR .625 O.D.T. x .500 MPT
6	FILL GASKET	65-1006-2	GASKET, FILL FITTING
7	NUT	65-1035-2	NUT
8	STUD-SS	65-1034-1	STUD
9	CAP-CGA	65-1058-5	NITROGEN SERVICE
		65-1070-5	OXYGEN SERVICE
		65-1069-5	ARGON SERVICE
10	CAP-FLANGE	65-1033-1	COMB. FLANGE CAP
12	LIQUID LEVEL GAUGE	20-1152-9	0-600" H_2O
		20-1209-2	0-600" H_2O W/ALARM
13	PRESSURE GAUGE	20-1027-2	0-400 PSI
14	ECONOMIZER FITTINGS	10-1162-2	M. ELBOW 90D .625 O.D.T. x .375 MPT

Table 6-16. Liquid Contents Chart
VCS 11000-SS-250-MVE-0
VLS 11000-SS-75-MVE-0
VCS 11000-SP-250-MVE-0
VCS 11000-NP-250-MVE-0
VLS 11000-SP-75-MVE-0

GAUGE (IN.)	ARGON (GAL.)	OXYGEN (GAL.)	NITROGEN (GAL.)
0	0	0	0
10	60	84	164
20	215	291	523
30	425	554	911
40	651	824	1299
50	878	1093	1688
60	1104	1363	2076
70	1330	1632	2464
80	1557	1901	2853
90	1783	2171	3241
100	2010	2440	3629
110	2236	2710	4018
120	2462	2979	4406
130	2689	3249	4794
140	2915	3518	5183
150	3141	3787	5571
160	3368	4057	5959
170	3594	4326	6348
180	3820	4596	6736
190	4047	4865	7124
200	4273	5135	7513
210	4499	5404	7901
220	4726	5673	8289
230	4952	5943	8678
240	5179	6212	9066
250	5405	6482	9454
260	5631	6751	9843
270	5858	7021	10231
280	6084	7290	10620
290	6310	7560	11003
300	6537	7829	11279
310	6763	8098	
320	6989	8368	
330	7216	8637	
340	7442	8907	
350	7669	9176	
360	7895	9446	
370	8121	9715	
380	8348	9984	
390	8574	10254	
400	8800	10523	
410	9027	10793	
420	9253		
430	9479		
440	9706		
450	9932		
460	10158		
470	10385		
480	10611		
490	10838		
500	11054		

NOTE: Contents based on liquid saturated at 0 PSIG.

Figure 6-9. Parts Identification View
VCS 13000-SS-250-MVE-0
VLS 13000-SS-75-MVE-0
VCS 13000-SP-250-MVE-0
VCS 13000-NP-250-MVE-0
VLS 13000-SP-75-MVE-0



NOTE: VLS models will not have an economizer or gas use circuit.

Table 6-17. Parts Identification List
13000 Gallon Units

	NOMENCLATURE	COMP. PART NO.	DESCRIPTION
V-1	TOP FILL	90-5932-2	ANGLE VALVE, 1-1/2" NOM
V-2	BOTTOM FILL	90-7845-2	ANGLE VALVE, 1-1/2" NOM
V-3	FULL TRYCOCK	17-1320-2	SHUTOFF VALVE, 3/8" NPT
V-4	VENT	17-1387-2	GLOBE VALVE, 1" NOM
V-5	P.B. FEED	90-5152-2	1/2" NOM* 1/2" NPT
V-6	P.B. ISOLATION	17-1324-2	GLOBE VALVE, 1" NOM
V-7	GAS USE	17-1327-2	GLOBE VALVE 1" NPT
V-8	LIQUID PHASE HIGH	17-1186-2	ANGLE VALVE, 1/4" ODT* 1/4" MPT
V-9	GAS PHASE LOW	17-1186-2	ANGLE VALVE, 1/4" ODT* 1/4" MPT
V-10	EQUALIZATION	17-1046-2	NEEDLE VALVE, 1/4" NPT
V-11	FILL DRAIN	17-1670-2	SHUTOFF VALVE, 3/8" NPT
V-12	EVACUATION	17-1322-4	DIAPHRAGM VALVE, 1-1/2"
V-13	ECONOMIZER ISOLATION	17-1110-2	GATE VALVE, 1/2" NOM
V-16	TC ISOLATION	17-1267-2	BELLOWS SEALED, 1/8"
CV-1	FILL CHECK	17-1358-2	1-1/2" NPT
CV-3	ECONOMIZER CHECK	17-1357-2	1/2" NPT
S-1	STRAINER	49-1023-2	3/8" NPT
RV-1	LINE TRAP SAFETY	18-1046-2	350 PSIG, 1/4" NPT
RV-2	INNER VESSEL SAFETY	18-1040-2	250 PSIG 1/2" MPT* 3/4" FPT
BD-1	INNER BURST DISC	19-1112-5	375 PSIG, 3/4" MPT
BD-2	ANNULUS BURST DISC	19-1064-1	6" LIFT PLATE
R-1	P.B. REGULATOR	21-1007-2	TYPE B, 1/2" NPT, 120 PSIG
R-2	ECONOMIZER REGULATOR	21-1008-2	TYPE FRM, 1/2" NPT, 140 PSIG
	REBUILD KIT	97-1557-2	REGULATOR RENEWAL KIT
	SPRING KIT		
C-1	FILL CONNECTION	65-1047-2	CGA-OXYGEN
		65-1057-2	CGA-NITROGEN
		65-1067-2	CGA-ARGON
		65-1036-2	FLANGE-OXYGEN
		65-1036-2	FLANGE-ARGON
		65-1036-2	FLANGE-NITROGEN
C-2	CUSTOMER GAS USE		1" NPT
C-3	FULL TRYCOCK	39-1015-6	3/8 " NPT
C-4	VENT	15-1056-3	ELBOW 1" FTG
C-5	AUXILIARY LIQUID	12-1108-2	CAP 1-1/4" FPT BRASS
		17-1327-2	VALVE (OPTIONAL)
		12-1052-2	STREET ELBOW (OPTIONAL)
C-6	AUXILIARY VENT	12-1100-2	CAP 1" FPT BRASS
C-7	DRAIN CONNECTION	39-1015-6	3/8" NPT
C-8	PUMP FEED	12-1108-2	CAP 1-1/4" FPT BRASS
C-9	PUMP RETURN	12-1097-2	CAP .5" FPT BRASS
1	STAUFF CLAMP	34-1080-6	1-1/4" O.D. CLAMP
		34-1059-4	.25 SM NUT
2	P.B. CONNECTION	10-1158-2	M. CONNECTOR .625 O.D.T x .500 MPT
6	FILL GASKET	65-1006-2	GASKET, FILL FITTING
7	NUT	65-1035-2	NUT
8	STUD-SS	65-1034-1	STUD
9	CAP-CGA	65-1058-5	NITROGEN SERVICE
		65-1070-5	OXYGEN SERVICE
		65-1069-5	ARGON SERVICE
10	CAP-FLANGE	65-1033-1	COMB. FLANGE CAP
12	LIQUID LEVEL GAUGE	20-1152-9	0-600" H_2O
		20-1209-2	0-600" H_2O W/ALARM
13	PRESSURE GAUGE	20-1027-2	0-400 PSI
14	ECONOMIZER FITTINGS	10-1162-2	M. ELBOW 90D .625 O.D.T x .375 MPT

Table 6-18. Liquid Contents Chart
VCS 13000-SS-250-MVE-0
VLS 13000-SS-75-MVE-0
VCS 13000-SP-250-MVE-0
VCS 13000-NP-250-MVE-0
VLS 13000-SP-75-MVE-0

GAUGE (IN.)	ARGON (GAL.)	OXYGEN (GAL.)	NITROGEN (GAL.)
0	0	0	0
10	66	91	180
20	237	321	585
30	473	622	1038
40	735	936	1490
50	999	1250	1942
60	1262	1563	2394
70	1526	1877	2846
80	1790	2191	3299
90	2053	2505	3751
100	2317	2818	4203
110	2580	3132	4655
120	2844	3446	5108
130	3108	3760	5560
140	3371	4073	6012
150	3635	4387	6464
160	3898	4701	6916
170	4162	5015	7369
180	4426	5328	7821
190	4689	5642	8273
200	4953	5956	8725
210	5216	6270	9178
220	5480	6583	9630
230	5744	6897	10082
240	6007	7211	10534
250	6271	7525	10986
260	6534	7838	11439
270	6798	8152	11891
280	7062	8466	12343
290	7325	8780	12795
300	7589	9093	13224
310	7852	9407	
320	8116	9721	
330	8379	10035	
340	8643	10349	
350	8907	10662	
360	9170	10976	
370	9434	11290	
380	9697	11604	
390	9961	11917	
400	10225	12231	
410	10488	12545	
420	10752	12859	
430	11015	13160	
440	11279		
450	11543		
460	11806		
470	12070		
480	12333		
490	12597		
500	12861		
510	13116		

NOTE: Contents based on liquid saturated at 0 PSIG.

A-1. GENERAL

This appendix describes optional equipment and accessories available for use with MVE VCS cryogenic containers. These items may be obtained from your local MVE distributor or the factory.

A-2. HOSPITAL RESERVE KIT

The MVE Hospital Reserve Kit, shown in Figure A-1, is a device used to control an emergency supply of high pressure cylinders. It can be used in a backup system to a bulk customer station (MVE VCS), or to portable liquid cylinders on the MVE Model M-45 Manifold. The Hospital Reserve Kit will supply gas when the liquid supply is depleted. Figure A-2 illustrates the use of the Hospital Reserve Kit when used with the MVE VCS.

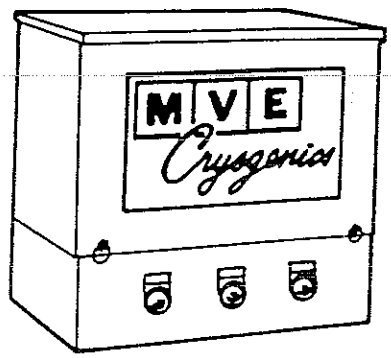
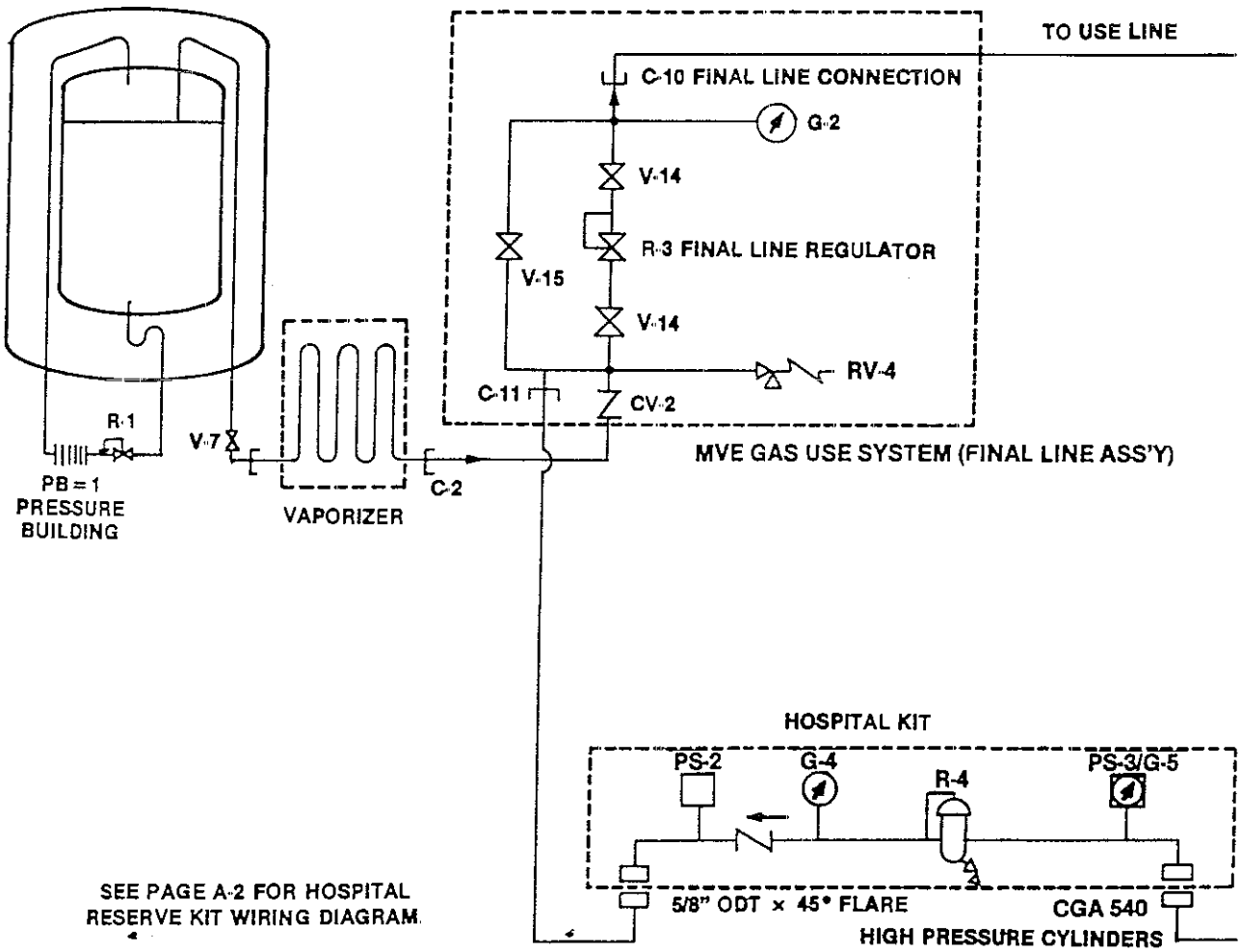


Figure A-1. MVE Hospital Reserve Kit

Figure A-2. Typical Hospital Reserve Kit/VCS Configuration



V-7	VALVE, GAS USE
V-14	FINAL LINE REGULATOR ISOLATION VALVES
V-15	FINAL LINE REGULATOR BYPASS VALVE
G-2	FINAL LINE PRESSURE GAUGE
RV-4	FINAL LINE RELIEF VALVE
R-1	PRESSURE BUILDING REGULATOR—at least 10 PSI above hospital kit regulator
R-3	FINAL LINE REGULATOR—set below hospital kit regulator
R-4	HOSPITAL KIT REGULATOR
PS-2	PRESSURE SWITCH, LOW—actuates when VCS pressure falls below (R-1) setting
PS-3	PRESSURE SWITCH, HIGH-actuates when pressure (reserve oxygen cylinders) falls below 1000 PSI (factory setting)
C-2	VCS GAS USE CONNECTION
CV-2	CHECK VALVE, GAS USE
C-10	FINAL LINE CONNECTION
C-11	HOSPITAL RESERVE CONNECTION—connection point for Hospital Reserve Kit, soldered cap

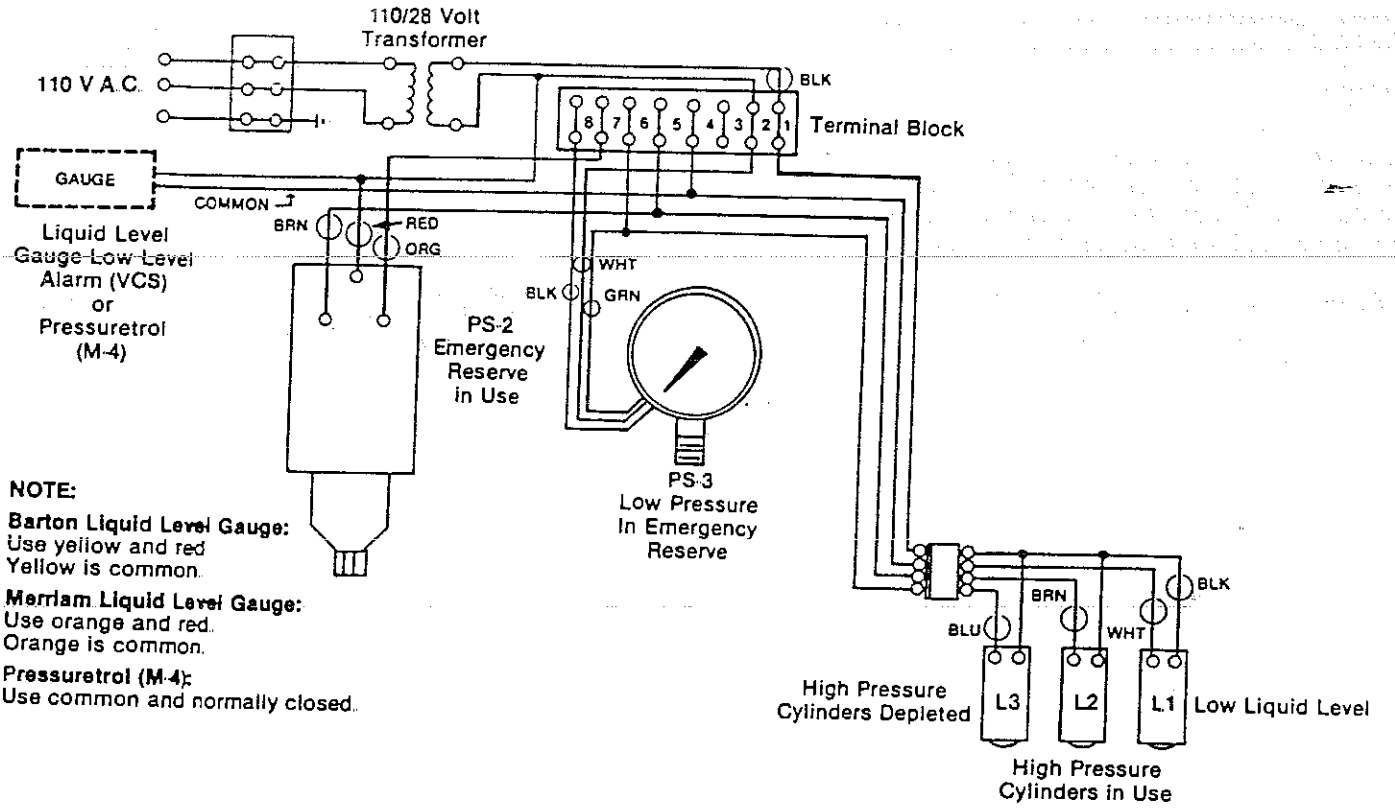


Figure A-3. Hospital Reserve Kit and Alarm Wiring Diagram

Terminal Block Pairs Connections:

1-4 **Main supply—low level or reserve**—(Normally Open)
1-5 High pressure reserve—½ empty (1000 PSI)—(Normally Open)
1-6 Reserve system in use—(Normally Open)
1-7 Reserve bank above 1000 PSI (High Pressure)—(Normally Closed)
1-8 Main system in use—(Normally Closed)

A-3. FINAL LINE ASSEMBLY

The MVE Final Line Assembly, shown in Figure A-3, controls pressure and gas flow from the VCS into the customer's line. It consists of a by-pass valve, pressure gauge, safety valve, regulator, isolation valves, and connection for the Hospital Reserve Kit.

TAG	P/N	DESCRIPTION
V-14	17-1108-2	Final line regulator isolation valves
V-15	17-1109-2	Final line regulator bypass valve
CV-2	17-1111-2	Check valve
RV-4	55-1602-9	Relief valve
R-3	21-1014-5	Final line regulator
G-2	20-1137-9	Line pressure gauge
15	10-1160-2	Connection, final line regulator

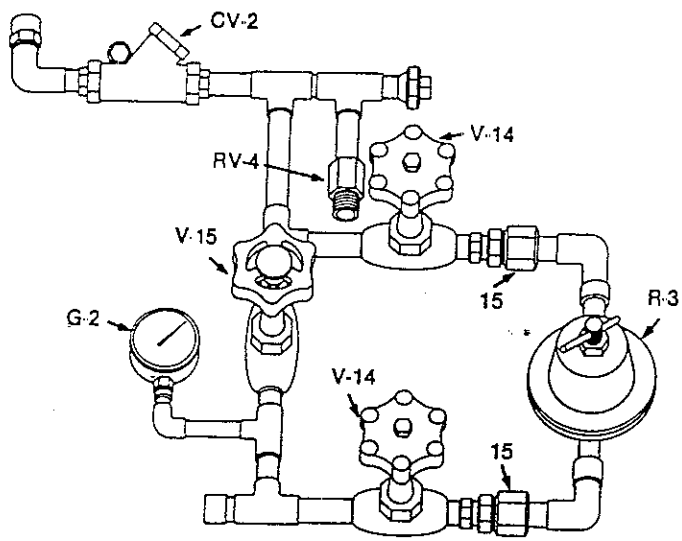


Figure A-4. MVE Final Line Assembly

Liquid Hospital Reserve System

DRAWING NO. C- 27011

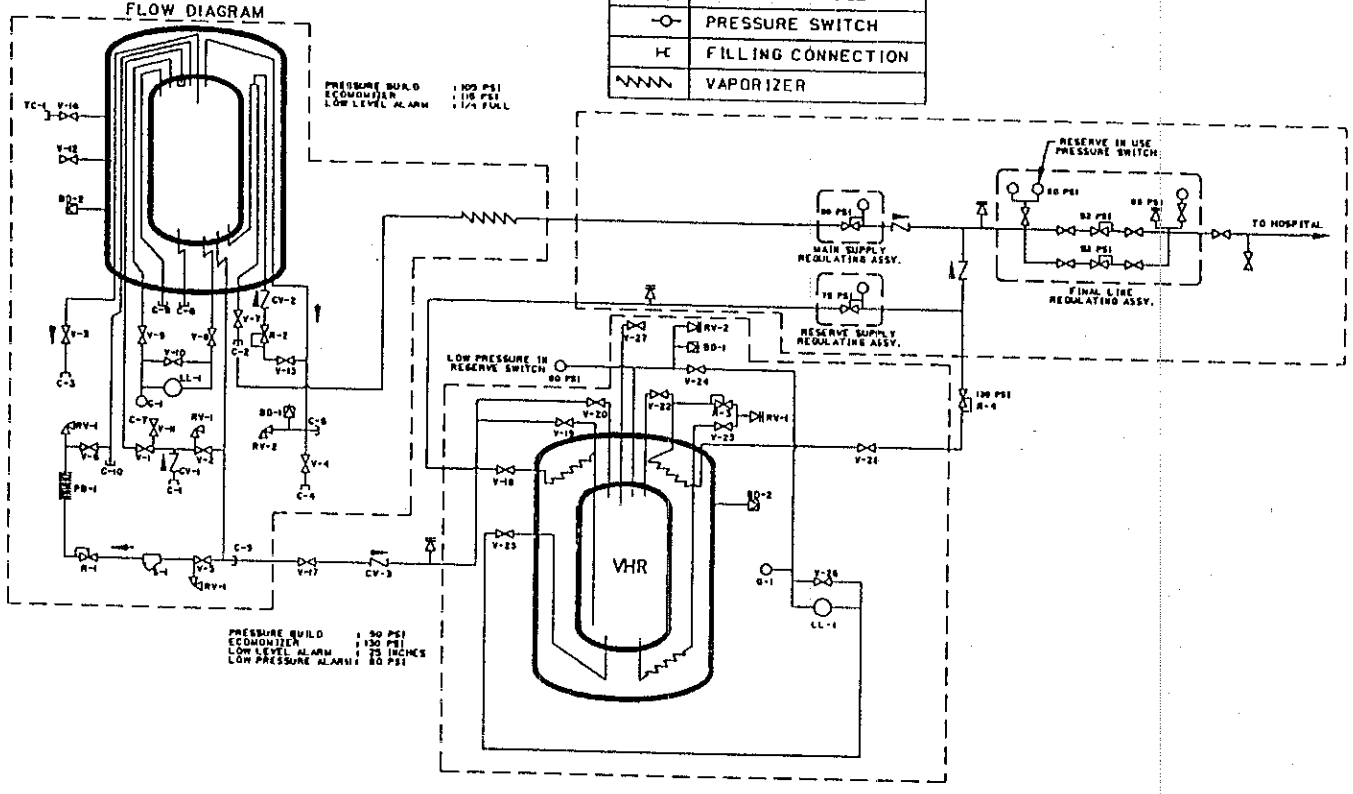
NOMENCLATURE

V-1	VALVE,TOP FILL
V-2	VALVE,BOTTOM FILL
V-3	VALVE,FULL TRYCOCK
V-4	VALVE,VENT
V-5	VALVE,PRESSURE BUILDING INLET
V-6	VALVE,PRESSURE BUILDING OUTLET
V-7	VALVE,GAS USE ISOLATION,VCS
V-8	VALVE,LIQUID PHASE(HIGH)
V-9	VALVE,GAS PHASE(LOW)
V-10	VALVE,EQUALIZATION
V-11	VALVE,DRAIN
V-12	VALVE,EVACUATION
V-13	VALVE,ECONOMIZER ISOLATION
V-16	VALVE,VACUUM PROBE SHUTOFF
V-17	VALVE,LIQUID ISOLATION,VCS
V-18	VALVE,GAS USE,VHR
V-19	VALVE,BOTTOM FILL,VHR
V-20	VALVE,TOP FILL,VHR
V-22	VALVE,PRESS.BLDR./ECOMOMIZER ISO.,VHR
V-23	VALVE,PRESS. BUILDER ISOLATON, VHR
V-24	VALVE,GAS PHASE (LOW)
V-25	VALVE,LIQUID PHASE (HIGH)
V-26	VALVE,EQUALIZATION
V-27	VALVE,FULL TRYCOCK AND VENT
V-28	VALVE,ECONOMIZER OUT,VHR
CV-1	CHECK VALVE,FILL
CV-2	CHECK VALVE,ECONOMIZER
CV-3	CHECK VALVE,LIQUID WITHDRAWAL
R-1	REGULATOR,PRESSURE BUILDING
R-2	REGULATOR,ECONOMIZER
R-3	REGULATOR,PRESSURE BUILDING,VHR
R-4	REGULATOR,ECONOMIZER,VHR
RV-1	RELIEF VALVE,LINE
RV-2	RELIEF VALVE,INNER VESSEL
BD-1	BURST DISC,TANK
BD-2	RELIEF DEVICE,OUTER VESSEL
PB-1	PRESSURE BUILDING COIL
LL-1	GAUGE,LIQUID LEVEL W/LOW LEVEL ALARM
G-1	GAUGE,PRESSURE
S-1	STRAINER
C-1	CONNECTION,FILL
C-2	CONNECTION,GAS USE
C-3	CONNECTION,FULL TRYCOCK
C-4	CONNECTION,VENT
C-5	CONNECTION,LIQUID WITHDRAWAL(CAPPED)
C-6	CONNECTION,VENT(CAPPED)
C-7	CONNECTION,DRAIN
C-8	CONNECTION,PUMP WITHDRAWAL(CAPPED)
C-9	CONNECTION,PUMP RETURN(CAPPED)
C-10	CONNECTION,VAPOR(CAPPED)
TC-1	VACUUM PROBE

LEGEND

	SHUT OFF VALVE
	CHECK VALVE
	PRESSURE REGULATOR
	ECONOMIZER REG.
	SAFTY VALVE
	PRESSURE GAUGE
	PRESSURE SWITCH
	FILLING CONNECTION
	VAPORIZER

FLOW DIAGRAM



REV	ZONE	REVISION DESCRIPTION	BY	DATE
B		003705 REVISE PER SALES	KM	5-11-88
A		DESIGN UPDATE	KM	1-13-87

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APPROVED	DATE
DRAWN BY TJS	11-26-86
CHECKED BY MJ	11-16-87
MFG. REV. BM	12-9-87
PROJ. ENG. SA	11-20-87
SALES ENG. BL	11-11-87
QUAL. ENG. QC	11-12-87

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.
TOLERANCES:
FRACTIONS ±
ANGLES ±
2 PLACE DECIMAL ±
3 PLACE DECIMAL ±

NEXT ASS'Y | USED ON | NEXT ASS'Y | FINAL ASS'Y

APPLICATION | QUANTITY REQ'D

MVE MINNESOTA VALLEY ENGINEERING
CRYOGENICS NEW PRAGUE, MINNESOTA 56071

TITLE SCHEMATIC, VHR-120G/80G INSTALLATION

DRAWING NO. C- 27011 REV B

SCALE NONE | DO NOT SCALE DRAWING | SHEET 1 OF 1

A-3

A-4. AMBIENT AIR VAPORIZERS

MVE ambient air vaporizers, shown in Figure A-4, are available in free-standing or tank mounted versions. These units are used to gasify the liquid product. Standard sizes range from 250 to 5000 standard cubic feet per hour. MVE ambient air vaporizers use heat from the atmosphere to vaporize the cryogenic fluid.

Units are designed to operate at medium pressures up to 350 PSIG (not for high pressure pump applications). In MVE ambient air vaporizers, nominal flow capacity is the maximum continuous flow of nitrogen gas with outlet temperatures of 20°F under ambient. Peak flows (4 x nominal flow capacity) can be achieved for intervals of ten to fifteen minutes at a minimum outlet temperature of −20°F with 80°F ambient.

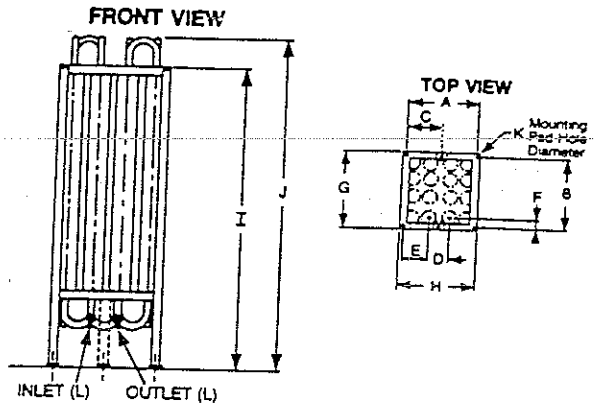

Figure A-6. MVE Ambient Air Vaporizers

Table A-1. Ambient Air Vaporizers Specifications

MODEL NO. NOMINAL FLOW CAPACITY	250 SCFH	500 SCFH	1000 SCFH	1500 SCFH	2000 SCFH	5000 SCFH
PART NO. DRWG. NO.	97-1450-9 D-9427	97-1451-9 C-9414	97-1454-9 C-12996	97-1452-9 D-9246	97-1453-9 D-12993	97-1455-9 D-12757
NO. AND LENGTH OF ELEMENTS	4-3'	4-6'	6-6'	9-6'	12-6'	30-6'
SHIPPING WEIGHT	80#	150#	175#	250#	310#	510#
MAXIMUM WORKING PRESSURE	350 PSIG	350 PSIG	350 PSIG	350 PSIG	350 PSIG	350 PSIG
MATERIAL	6063 ALUMINUM	6063 ALUMINUM	6063 ALUMINUM	6063 ALUMINUM	6063 ALUMINUM	6063 ALUMINUM
A	7½"	8⅛"	10⅜"	14⅜"	20⅝"	35⅜"
B	14"	10⅜"	14⅜"	16⅝"	16⅝"	29⅛"
C	—	—	—	—	—	17⅝"
D	6¼"	6¼"	6¼"	12½"	6¼"	18¾"
E	⅝"	15/16"	2 1/16"	15/16"	7 3/16"	8 1/16"
F	3⅞"	2 1/16"	15/16"	2 1/16"	2 1/16"	1 13/16"
G	11 7/16"	12¼"	18⅜"	18⅜"	18⅜"	30⅞"
H	11 7/16"	12¼"	12⅛"	18⅜"	24⅝"	37⅛"
I	42"	84 3/16"	84⅜"	84⅜"	90⅜"	90 7/16"
J	48"	89 7/16"	89¾"	89¾"	95¾"	95 7/16"
K	7/16" dia.	17/32" dia.	17/32" dia.	17/32" dia.	17/32" dia.	17/32" dia.
L*	⅜" MPT FEMALE COUPLING, LOCATED ON TOP OF UNIT	1" NPT MALE HALF NIPPLE	1" NPT MALE HALF NIPPLE	1" NPT MALE HALF NIPPLE	1" NPT MALE HALF NIPPLE	1" NPT MALE HALF NIPPLE

*Optional flange fitting available.

CBM	Center Back Male
CGA	Compressed Gas Association
DOT	Department of Transportation
DTL	Detail
HCS	Horizontal Customer Station
HLS	Horizontal Liquid Station
HCSH	Horizontal Customer Station—Hydrogen
FPT	Female Pipe Thread
MPT	Male Pipe Thread
MVE	Minnesota Valley Engineering
NPT	National Pipe Thread
NR	Not Required
ODT	Outside Diameter-Tube
P/N	Part Number
P.S.F.	Pounds Per Square Foot
SCFH	Standard Cubic Feet per Hour
SS	Stainless Steel
VCS	Vertical Customer Station
VCSH	Vertical Customer Station—Hydrogen
VLS	Vertical Liquid Station

MVE STANDARD MODEL KEY

VCS - 1500 - - - - -

MODEL
VCS
VLS
HCS
HLS
VCSH
HCSH

CAPACITY
APPROX.
GALLONS
315 to 30,000

REVISION LEVEL (OPTIONAL)

INNER MATERIAL
S = STAINLESS
N = 9% NICKEL

INSULATION TYPE
S = SUPER INSULATION
P = POWDER INSULATION

MAXIMUM ALLOWABLE WORKING PRESSURE (PSIG)

DESIGN TYPE (MVE OR CUSTOMER ABBREVIATION)

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, 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 retumed 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 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 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 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.

If an oxygen deficient atmosphere is suspected or known to exist:

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

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

C-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 nonflammable, ignition of combustible materials can occur more readily in an oxygen-rich atmosphere than in air; and combustion proceeds at a faster rate although no more 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.

C-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°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 and liquid cylinders 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 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.

CONVERSION FACTORS

OXYGEN

	WEIGHT		GAS		LIQUID	
	POUNDS Lb	KILOGRAMS Kg	CUBIC FEET SCF	CUBIC METERS Nm^3	GALLONS Gal	LITERS L
1 Pound	1.0	0.4536	12.076	0.3174	0.1050	0.3977
1 Kilogram	2.205	1.0	26.62	0.6998	0.2316	0.8767
1 SCF Gas	0.08281	0.03756	1.0	0.02628	0.008691	0.0329
1 Nm^3 Gas	3.151	1.4291	38.04	1.0	0.3310	1.2528
1 Gal Liquid	9.527	4.322	115.1	3.025	1.0	3.785
1 L Liquid	2.517	1.1417	30.38	0.7983	0.2642	1.0

NITROGEN

1 Pound	1.0	0.4536	13.803	0.3627	0.1481	0.5606
1 Kilogram	2.205	1.0	30.42	0.7996	0.3262	1.2349
1 SCF Gas	0.07245	0.03286	1.0	0.02628	0.01074	0.04065
1 Nm^3 Gas	2.757	1.2506	38.04	1.0	0.4080	1.5443
1 Gal Liquid	6.745	3.060	93.11	2.447	1.0	3.785
1 L Liquid	1.782	0.8083	24.60	0.6464	0.2642	1.0

ARGON

1 Pound	1.0	0.4536	9.671	0.2543	0.08600	0.3255
1 Kilogram	2.205	1.0	21.32	0.5605	0.18957	0.7176
1 SCF Gas	0.1034	0.04690	1.0	0.02628	0.008893	0.03366
1 Nm^3 Gas	3.933	1.7840	38.04	1.0	0.3382	1.2802
1 Gal Liquid	11.630	5.276	112.5	2.957	1.0	3.785
1 L Liquid	3.072	1.3936	29.71	0.7812	0.2642	1.0

SCF (standard cubic foot) gas measured at 1 atmosphere and 70°F
Liquid measured at 1 atmosphere and boiling temperature
All values are consistant with standards adopted by the Compressed Gas Association on June 19, 1962

Nm^3 (normal cubic meter) gas measured at 1 atmosphere and 0°C
All values rounded to nearest 4/5 significant numbers.

VOLUME	MULTIPLY UNITS IN LEFT COLUMN BY PROPER FACTOR BELOW							
	cu in	cu ft	cu yd	cu cm	cu meter	liter	US gal	Imp gal
1 cu inch	1	—	—	16.387	—	0.0164	—	—
1 cu foot	1728	1	0.0370	28.317	0.0283	28.32	7.481	6.229
1 cu yard	46.656	27	1	—	0.7646	764.5	202.0	168.2
1 cu centimeter	0.0610	—	—	1	—	0.001	—	—
1 cu meter	61,023	35.31	1.308	1,000,000	1	999.97	264.2	220.0
1 liter	61.025	0.0353	—	1,000	0.001	1	0.2642	0.2200
1 US gallon	231	0.1337	—	3,785.4	—	3.785	1	0.8327
1 Imperial gallon	227.4	0.1605	—	4,546.1	—	4.546	1.201	1

PRESSURE	MULTIPLY UNITS IN LEFT COLUMN BY PROPER FACTOR BELOW						
	lb/sq in	lb/sq ft	Int ata	kg/cm^2	mm Hg at 32°F	In Hg at 32°F	ft water at 39.2°F
1 pound/sq in	1	144	—	0.0703	51.713	2.0359	2.307
1 pound/sq ft	0.00694	1	—	—	0.3591	0.01414	0.01602
1 Int atmosphere	14.696	2116.2	1	1.0333	760	29.921	33.90
1 kilogram/sq cm	14.223	2048.1	0.9678	1	735.56	28.958	32.81
1 millimeter mercury— torr (torricelli)—	0.0193	2.785	—	—	1	0.0394	0.0446
1 inch mercury	0.4912	70.73	0.0334	0.0345	25.400	1	1.133
1 foot water	0.4335	62.42	—	0.0305	22.418	0.8826	1