Taylor-Wharton
Since 1742

INSTRUCTIONS MANUAL
FOR
VTLCO2 BULK STORAGE TANKS
(A.S.M.E PRESSURE VESSEL CODE)

Do not attempt to use or maintain these units until you read and understand these instructions. Refer to the Taylor-Wharton Safety First Booklet (TW-202) for handling cryogenic material. Do not permit untrained persons to use or maintain this equipment. If you do not understand these instructions, contact your supplier for additional information.

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SAFETY PRECAUTIONS FOR CARBON DIOXIDE

WARNING

Carbon Dioxide can cause asphyxiation and death in confined, poorly ventilated areas. Cold Carbon Dioxide gas can cause severe frostbite to the eyes or skin. Do not touch frosted pipes or valves. If accidental exposure occurs, consult a physician at once. If a physician is not readily available, warm the areas affected by frostbite with water that is near body temperature.

KEEP WORK AREA WELL VENTILATED

Carbon dioxide affects the important acid-base balance in the body. Carbon dioxide is formed from normal functioning of the body, but the body can tolerate increased amounts of carbon dioxide only in limited concentration. This is recognized in OSHA standards where a Threshold Limit Value of 5,000 parts per million by volume (0.5 percent concentration) has been adopted. For safety, concentrations above this level should not be permitted; increased concentrations can cause bodily harm or death. Additionally, carbon dioxide can cause asphyxiation by displacing oxygen resulting in dizziness, unconsciousness or death.

Ten percent carbon dioxide in air can be endured for only a few minutes; twelve to fifteen percent soon causes unconsciousness; twenty five percent may cause death if exposure lasts for several hours. Carbon dioxide cannot be detected by human senses and will be inhaled like air. Carbon dioxide is heavier than air and will accumulate in low-lying areas. Carbon dioxide concentrations will be greater in these areas. If adequate ventilation is not provided, carbon dioxide may displace normal air without warning that a life-depriving atmosphere is developing.

COVER EYES AND SKIN

If released to atmosphere, liquid carbon dioxide will turn to carbon dioxide snow. Accidental contact of carbon dioxide snow or cold gas with the eyes or skin may cause severe frostbite. Handle liquid so that it will not vent or spill. Protect your eyes with safety goggles or a face shield. Cover the skin to prevent contact with snow or cold gas, or with cold pipes and equipment. Protective gloves can be quickly and easily removed and long sleeves are recommended for protection.

GROUP ALL PIPING

The rapid discharge of liquid carbon dioxide through a line, which is not electrically grounded, will result in a buildup of static electricity. Contact with this electrical charge could be startling and potentially dangerous to operating personnel. Such lines should be grounded before use.

NOTE: *For additional information of properties of carbon dioxide and proper handling refer to CGA pamphlets G-6, "Carbon Dioxide" and G-6.1, "Standard for Low Pressure Carbon Dioxide Systems at Consumer Sites". These publications are available from the Compressed Gas Association, 1235 Jefferson Davis Highway, Arlington, VA, 22202.*

SAFETY PRECAUTIONS FOR NITROUS OXIDE

WARNING

The following safety precautions are for your protection. Before performing installation, operation, or maintenance procedures, read and follow all safety precautions in this section and in reference publications. Failure to observe all safety precautions can result in property damage, personal injury, or possibly death. It is the responsibility of the purchaser to adequately warn the user of the precautions and Safe practices for the use of this equipment and the cryogenic fluid stored in it.

Nitrous oxide is a gas, which has no color, taste, and practically no odor. It is obtained by the thermal decomposition of ammonium nitrate, which yields nitrous oxide and water. Due to the toxic impurities produced in this process, the water is condensed out and the gas is passed through scrubbing towers to remove impurities.

EXTREME COLD – COVER EYES AND EXPOSED SKIN

Accidental exposure or contact with skin or eyes can cause severe frostbite. Avoid contact with cold piping and equipment. Protect eyes with goggles or shield, especially if there is a possibility of liquid ejection or if cold gas may issue forcefully from equipment. Keep skin covered at all times.

KEEP WORK AREA WELL VENTILATED

Due to the difficulty of detecting nitrous oxide's presence, there is eminent danger of loss of consciousness and physical inability to function if exposed to low levels of this gas, and death by asphyxiation if exposed to medium or high levels. Since nitrous oxide is a non-toxic gas, these hazards are created when life-supporting oxygen is displaced. The American Conference of Governmental Industrial Hygienist (ACGIH) in it's "Threshold Limit Valves & Biological Exposure Indices for 1989 – 1990" recommends a 50 ppm threshold limit value – Time Weighted Exposure Limit (TLV – TWA). It is imperative to maintain a well-ventilated work environment to minimize the danger from a leaking system or activated safety relief device.

DANGER OF EXPLOSION

Nitrous oxide is non-flammable but, as with oxygen, ignition of combustible materials may occur more readily in a nitrous oxide-enriched atmosphere. Nitrous Oxide decomposes exothermically under conditions of high temperature and pressure. If sufficient heat is added, the decomposition can be self-sustaining and, with high temperature and pressure, nitrous oxide can explode. Open flame and smoking are strictly prohibited.

Note: *For more detailed information concerning safety precautions and safe handling of nitrous oxide, consult CGA pamphlet G-8.1, "Standard for Nitrous Oxide at Consumer Sites", and CGA pamphlet G-8.2 "Commodity specification for Nitrous Oxide". These publications are available from the Compressed Gas Association, 1235 Jefferson Davis Highway, Arlington, VA 22202.*

INTRODUCTION

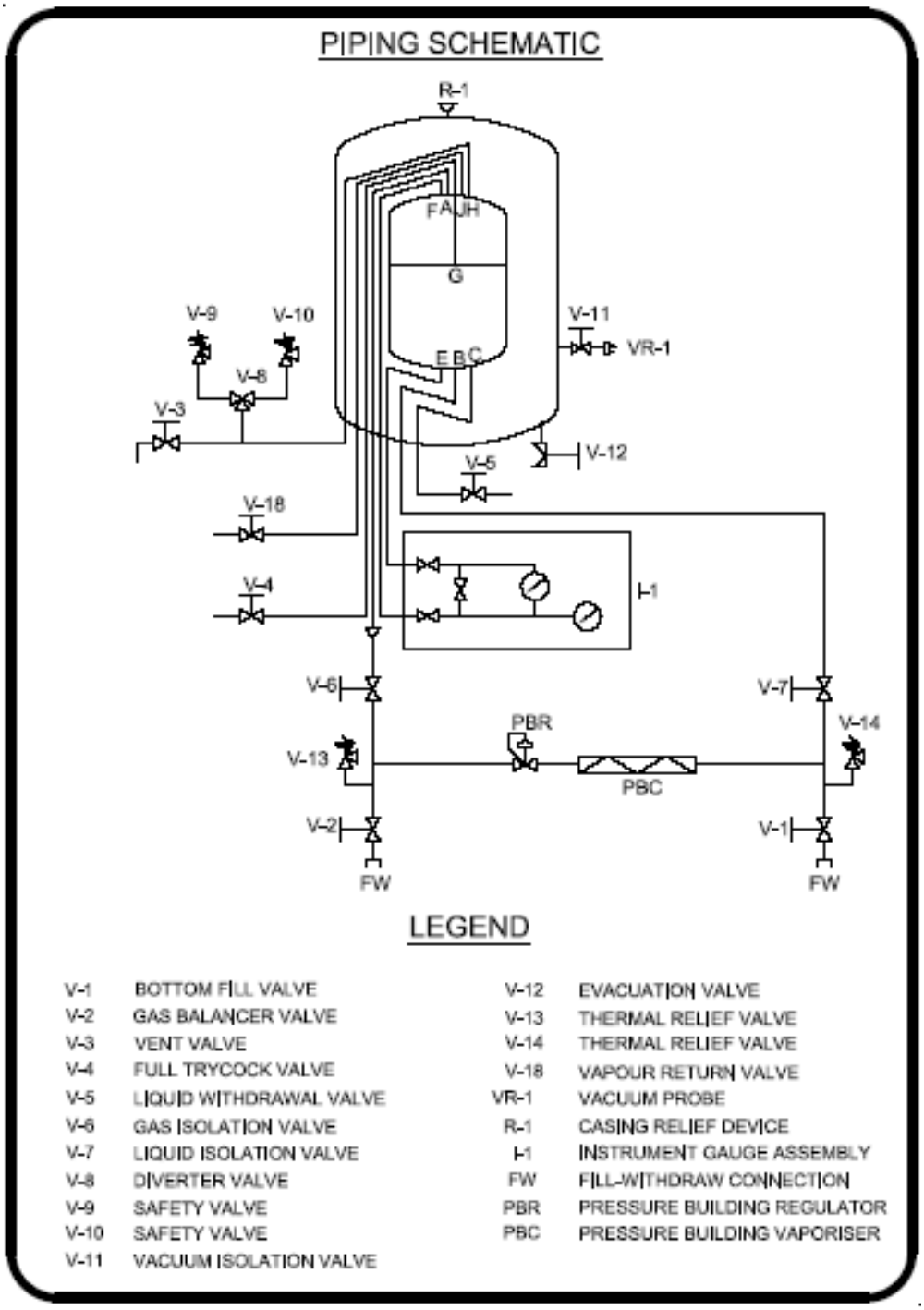
This manual provides information for the user to operate and maintain Taylor-Wharton Cryogenics VTLCO_2-Series Carbon Dioxide Storage Vessels. These tanks are primarily intended for liquid withdrawal at a maximum allowable working pressure of 350 psig (24 bar/2413 kPa). If your application requires the withdrawal of gaseous product, the flowrate must not exceed the ability of the tank to maintain a minimum pressure of 200 psig (14 bar/1379 kPa) at all times. The constant withdrawal of gaseous product at high flow rates will cause a decrease in tank pressure. This effect can be overcome by installing ambient or electric pressure building vaporizer come with pressure building regulator.

CAUTION: *To avoid unnecessary disruption, an internal pressure between 200 PSIG (14 bar/ 1379 kPa) and 350 PSIG (24 bar/2413 kPa) must be maintained at all times.*

These instructions are for experienced operators only. If you are not fully familiar with the principles of operations and safe practices for cryogenic equipment and supply systems, we urge you to read and fully understand the SAFETY PRECAUTIONS and REFERENCE PUBLICATIONS listed in this manual.

SPECIFICATIONS

Please refer to the following drawing.

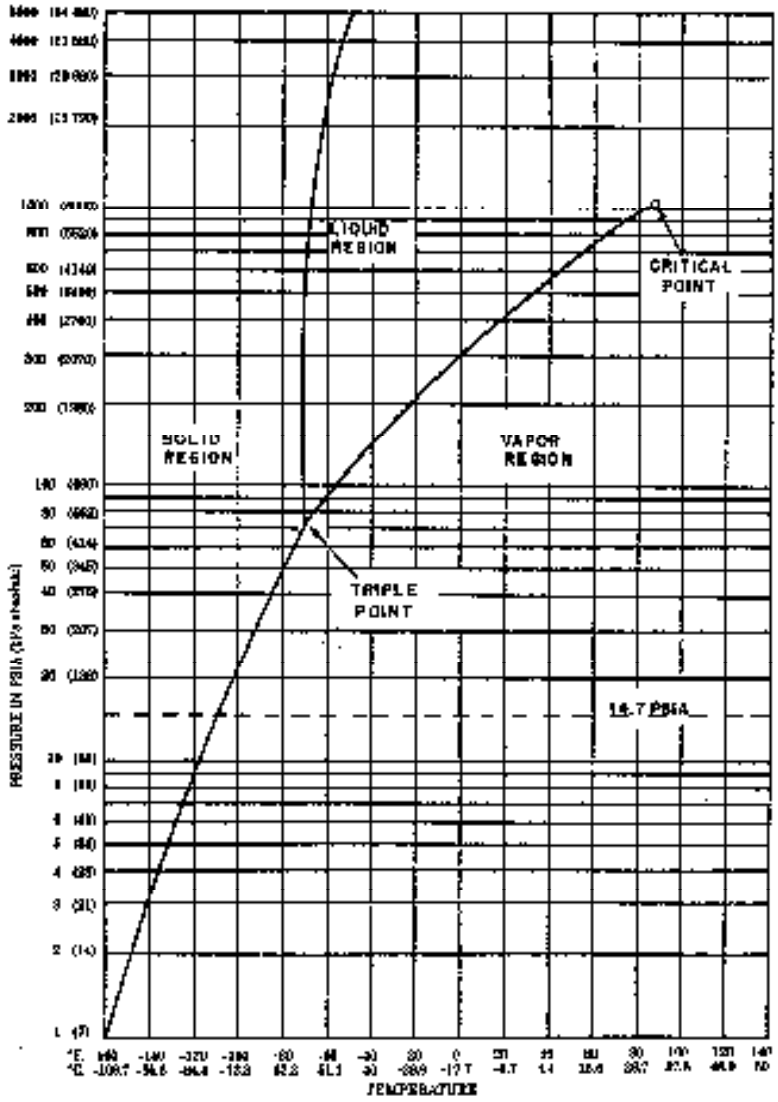


PROPERTIES OF CARBON DIOXIDE

Under normal atmospheric conditions, Carbon Dioxide exists as a colorless, odorless gas, which is about 1.5 times heavier than air.

When confined to storage tank, carbon dioxide can exist in any three states of matter; SOLID, LIQUID and GAS; depending on conditions of temperature and pressure. The point at which all three states may exist is -69.9ºF (-57ºC) and 75 psia [60.4 psig (4 bar)]. This is the triple point. At temperatures and pressure below these values, carbon dioxide may either be a solid or a gas, depending on the conditions.

At temperatures and pressures above the triple point, carbon dioxide liquid with overlaying gas may exist in equilibrium within a closed vessel.



FUNCTIONAL DESCRIPTION

The pressure vessel is suspended inside the vacuum jacket and insulated with perlite powder. The liquid and gas phase lines to the pressure vessel pass through the lower head of the vacuum jacket. All piping is designed to withstand the stresses caused by expansion and contraction of the pressure vessel, its support system, and the piping itself.

The pressure vessel is designed and constructed in accordance with the ASME VIII dev.1. The inner vessel is constructed of SA-240 type 304, stainless steel and the piping is SA-312 type 304. The vacuum jacket and support legs are made of structural grade carbon steel.

The insulation space between the pressure vessel and the vacuum jacket is filled with perlite powder and evacuated to a high vacuum through an EVACUATION VALVE which is sealed at the factory. Insulation space vacuum is measured in the field by connecting a vacuum gauge to the VACUUM GAUGE TUBE located on the lower head of the tank. The VACUUM GAUGE TUBE is isolated from the vacuum jacket by a VACUUM GAUGE VALVE.

INSTALLATION

HANDLING

Tank installation is the customer's responsibility. The tank is shipped in the horizontal position and secured on wooden cradles. These cradles must be removed prior to erection of the tank. Make certain the foundation used for the tank is designed for the conditions at the installation site, and that it is suitable for the tank weight. Refer to local codes for recommended foundation specifications. Employ experienced personnel to move and install the tank. Ensure that rigging equipment has adequate rated capacity to handle the tank weight listed in the specifications. This tank must be shipped and lifted empty, and with a warm inner vessel.

Caution: *To prevent possible tip over, do not leave the tank standing upright unless it is on a specified foundation or other hard surface capable of supporting its weight. Loading on the tank legs is great enough to cause them to sink into most surfaces other the reinforced concrete.*

INSTALLATION CHECKS

Before erecting the tank, inspect it carefully for possible shipping damage. Report any damage to the carrier and the factory. In addition, check tank pressure and vacuum as follows:

1. Tanks are shipped pressurized with nitrogen gas at 20 psig (1.4 bar/138 kPa). Open the gauge ISOLATION VALVE and read tank pressure indicated on the PRESSURE GAUGE. Record the "as received" tank pressure. Close the ISOLATION VALVE. Tank pressure may change due to temperature variations, accidental opening of valves, packing leaks, or minor leaks at the fill connections. If a positive pressure is not indicated on the PRESSURE GAUGE and no repairable leaks are found, contact the factory in accordance with conditions specified in the tank warranty.

2. Check insulation space vacuum by connecting a Hasting-Raydist Model TV-4A or VT-6 vacuum gauge to the tank VACUUM GAUGE TUBE. Open the tank VACUUM GAUGE VALVE, wait 30 minutes, and take a reading. If the "as received" vacuum (tank at ambient temperature) is greater than 100 microns (0.10 mm Hg) absolute, contact the factory.
3. Remove shipping screws from all LIQUID LEVEL GAUGES, which are equipped with adjustable level switches.

4. Attach a tag to the tank PRESSURE GAUGE indicating the normal operating pressure range of the tank. This information enables and operator to monitor tank pressure during a tank fill, and to prevent pressure upsets caused by improper fill procedures.

CUSTOMER INSTALLED EQUIPMENT/PIPING

External piping may employ carbon steel or stainless steel pipe. Liquid lines should be insulated with several inches of polyurethane insulation.

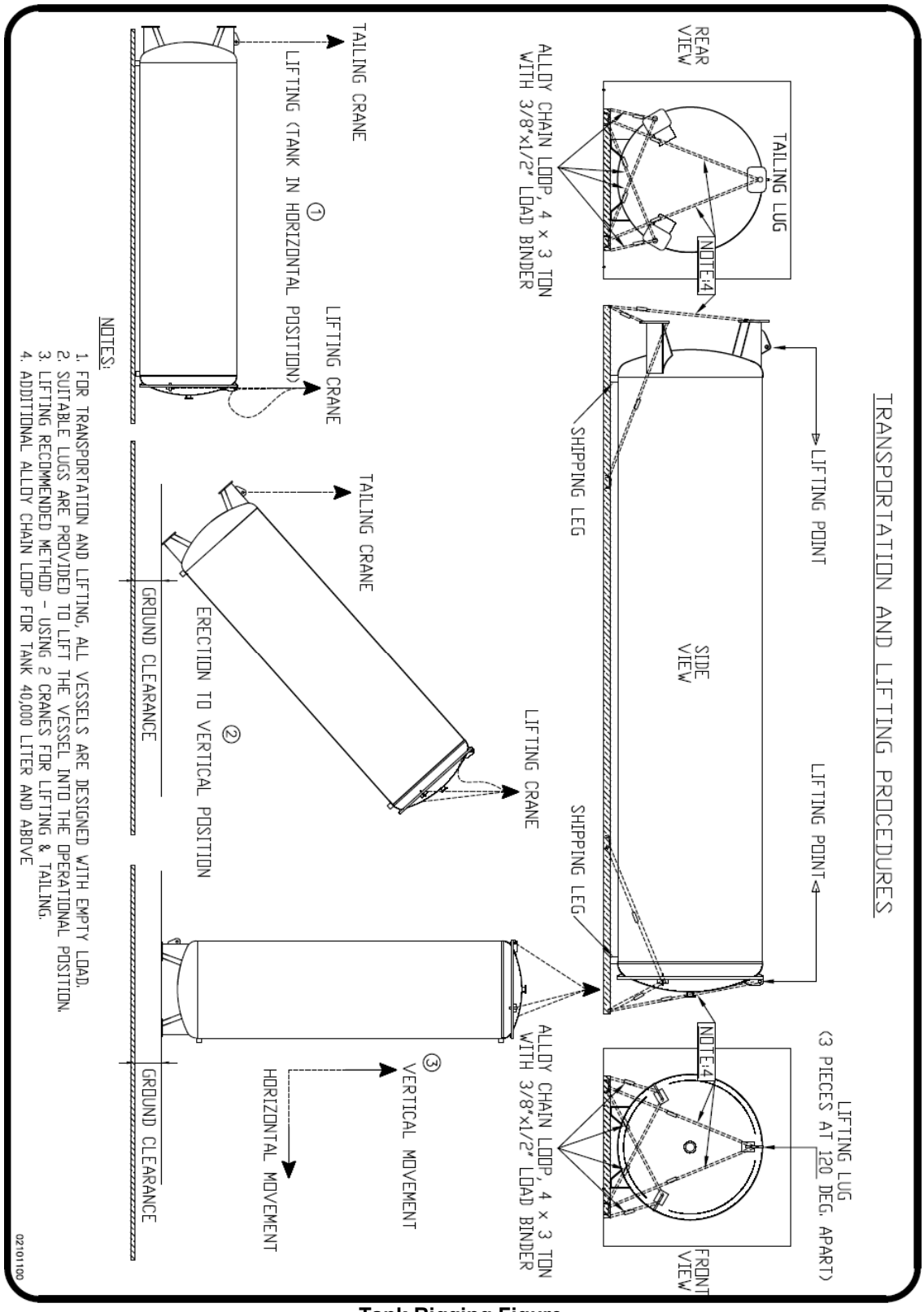
When installing vaporizing and control equipment, be sure to follow accepted design practices for your gas services. Be sure to include pressure relief valves in piping where liquid product could be trapped between closed valves, regulators, etc.

Designing safe and effective systems for handling liquefied gases requires extensive knowledge and experience. Persons lacking the necessary skills are urged to seek help from the manufacturer. Design and consultation services are available from the Customer Service Department.

WARNING

To protect the purity of the pressure vessel, all tanks are shipped with a charge of nitrogen at 20 PSIG (1.4 bar/138 kPa). Before removing the pipe plugs for attachment of customer piping, the pressure vessel must be relieved to prevent personal injury to installation personnel.

To relieve shipping pressure for piping, open the LIQUID FILL VALVE and ISOLATION VALVE until the PRESSURE GAUGE drops to zero.



Tank Rigging Figure

OPERATION

Normal operation of a properly installed unit requires some operator intervention. Frequent checks should be made to ensure pressure and liquid levels are within normal range. Low pressure could cause damage to the tank due to resulting liquid temperature below the design parameters of the steel in the pressure vessel.
A daily inspection that includes checks for frost, leaks, low pressure, low liquid level and physical damage is recommended.

CONTROLS

FILL / WITHDRAWAL
LIQUID FILL VALVE – This valve admits liquid to the bottom of the tank during a filling operation.

VAPOR EQUALIZATION AND FULL TRYCOCK VALVE – is used during tank fill to indicate fill termination. A line from this valve is connected to the trailer during fill to allow equalization of tank and trailer pressures throughout the pump transfer.

INSTRUMENTATION

LIQUID LEVEL GAUGE – The contents indicator on these tanks is a 6" gauge that reads in lbs/tons of CO2.

PRESSURE GAUGE – The tank pressure indicator is a 0-600 psi gauge with 4-1/2" face. It is mounted beside the liquid level gauge.

BYPASS (EQUALIZATION) VALVE – is used to equalize the pressure between the high and low-pressure sides of the contents gauge.

LIQUID PHASE ISOLATION VALVE – isolates contents and pressure gauges from the tank liquid (bottom) phase.

VAPOR PHASE ISOLATION VALVE – isolates contents and pressure gauges from the tank gas (top) phase.

SAFETY

SAFETY VALVES – The purpose of this valve is to relieve excess tank pressure in the event that the maximum allowable working pressure of the tank is exceeded. Once activated, the valve will reclose when the pressure falls below 350 psig (24 bar/2413 kPa).

DIVERTER VALVE – permits operation of one set of protection devices while the other set is isolated for maintenance.

FILLING PROCEDURE

1. Attach a liquid fill line from the supply trailer to the *LIQUID FILL VALVE* connection, and a gas phase line from the trailer to the *FULL TRYCOCK VALVE* connection on the tank.

2. Open the trailer and the tank *VAPOR EQUALIZER (FULL TRYCOCK) VALVE* and wait until both the tank and the trailer pressure gauges reach the same pressure.

3. Open the *LIQUID FILL VALVE* on the tank and the corresponding trailer valve. Start the pump and observe the *LIQUID LEVEL GAUGE* during transfer for fill termination.

   CAUTION: DO NOT OVER FILL.

4. When transfer is complete as indicated by the *LIQUID LEVEL GAUGE*, stop the pump, close *LIQUID FILL VALVE* and liquid valve to transfer truck, then close the *VAPOR EQUALIZER (FULL TRYCOCK) VALVE* and gas valve to the transfer truck.

5. Blowdown the transfer lines and disconnect from storage tank.

MAINTENANCE

No attempt at maintenance of this equipment should be undertaken without a thorough understanding of the pressures, procedures and specialized skills involved.

WARNING

Isolated components and slowly depressurize the plumbing to be repaired before attempting repairs. The sudden release of pressure could cause personal injury. Observe safety precautions to prevent a dangerous accumulation of gas.

Before installing, be sure to properly clean any replacement parts that are not packaged and marked for cleaned for oxygen service. Keep all parts clean during installation to prevent contamination.

Caution: *Carbon dioxide may form into solid phase (dry ice) if the pressure over the liquid is allowed to drop below 70 psig (4.8 bar/483 kPa). Pressure in the container must be maintained above this valve to insure CO_2 will not form inside the container. Before performing maintenance, components must be isolated and depressurized, or the contents must be transferred to another container so that the container pressure can be released.*

LEAK TEST

After making repairs requiring disassembly or replacement, leak test all valves or piping joints that were taken apart and reconnected. Apply leak detector to the test surface per the component manufacturer's instructions. Large leak instantly from large bubble clusters, while fine leaks produce white foam that builds up more slowly. All leaks must be repaired and re-tested before the tank is returned to service.

HAND VALVES

The most common trouble with manual valves will be leakage at the stem packing. Packing leaks are usually indicated by ice emerging from the packing gland or retainer threads. If packing leakage cannot be stopped by tightening, replace packing. Use pre-formed packing which can be ordered from the valve manufacturer.

1.

PRESSURE AND LIQUID LEVEL GAUGES

The major cause of a malfunctioning tank *PRESSURE GAUGE* or *LIQUID LEVEL GAUGE* is an open *BYPASS (EQUALIZATION) VALVE* or leakage in the gauge lines. Refer to the Trouble-Remedy Guide in this manual for maintenance procedures. If the problem is not readily corrected, replace the gauge with a spare. Field repair and recalibration of *LIQUID LEVEL GAUGES* is not recommended. Return the defective gauge to the manufacturer for repair. Include a description of difficulty encountered.

CASING VACUUM MAINTENANCE

CHECKING VACUUM

Taylor-Wharton Cryogenic tanks are carefully designed, manufactured, and tested with every effort made to eliminate vacuum space leakage. An absorbent system is sealed inside the casing to help maintain the vacuum over a long period of time. However, some vacuum deterioration over time can be expected due to out-gassing of materials inside the vacuum space. To detect vacuum deterioration, periodic measurement of casing vacuum is recommended. A thermocouple-type vacuum gauge tube, located on the bottom head of the tank, is provided for this purpose.

To check casing vacuum:

1. Remove the protective plastic cap from the gauge tube connector.

2. Connect a Hastings-Raydist Vacuum Gauge to the gauge tube.

3. Open the gauge tube isolation valve and wait at least 30 minutes before reading the vacuum gauge.

4. After the vacuum reading is recorded, close the isolation valve, disconnect the Vacuum Gauge, and replace the protective cover on the gauge tube connector.

The vacuum reading obtained on a cold tank is initially less than 100 microns (0.1 mm Hg) absolute; however, gradual deterioration over a period of many months or years is normal. A complete log of vacuum readings, along with dates when they were taken, can be very helpful in evaluating vacuum performance and scheduling work.

NOTE: *If the tank is empty and warm, vacuum space pressure will tend to be high because of the release of gases from adsorbent package inside the vacuum space.*

Because re-evacuation is time consuming and usually requires taking the tank out of services, it is not normally attempted until tank performance becomes unacceptable. Even a relatively high degree of deterioration can be tolerated in a tank from which high rates of withdrawal are being made. However, if vacuum deterioration seriously affects tank operation by producing excessive pressure buildup and high loss rates, use the information in this section to determine and correct the cause of the trouble.

Necessary repairs must be made before the casing is re-evacuated and the tank returned to service. Leak detection and repair procedures are often complicated and difficult. Only persons who are trained and experienced in cryogenic equipment, troubleshooting and repair procedures should attempt such work. If difficulties in troubleshooting and repair are either anticipated or encountered, consultation services can be obtained from Taylor-Wharton Malaysia Sdn. Bhd. Contact the Customer Service Department at the Shah Alam factory.

VACUUM GAUGE TUBE

If the gauge tube is damaged or is suspected of giving inaccurate readings, replace it as follows:

1. Make certain that the gauge tube isolation valve is closed.

2. Unscrew the gauge tube from the valve. Use two wrenches, one on the valve.

3. Clean the threads and opening of the valve.

   NOTE: Do not use Teflon tape as a sealant on vacuum system fittings.

4. Thread the new gauge tube into the valve by engaging one thread. Apply Airserco high vacuum sealant to remaining exposed threads. Tighten tube into valve, using two wrenches. Do not over tighten.

5. Check vacuum following previously described procedure. The waiting period to obtain a stable reading with a new gauge tube may exceed the specified 30 minutes. This is due to out-gassing of the new gauge tube and the thread sealant.

6. After reading has been recorded, close gauge tube valve and disconnect Vacuum Gauge. Install new vinyl cover over the gauge tube connector.

NOTE: If corrosion of the gauge tube is a problem, spray the tube housing with "Krylon Crystal Clear Coating 1301" or equivalent acrylic spray. Do not spray the contact pins of the electrical connector; this could cause erroneous vacuum readings.

ANALYZING VACUUM DETERIORATION

If you decide to re-evacuate because of slow deterioration over a long period of time, go directly to the re-evacuation procedure. If vacuum deterioration occurs over a relatively short period and pressure is greater than 1,000 microns (1 mm Hg) absolute, suspect that a leak has developed in the external casing of the tank. If deterioration is rapid and causes the bursting disk to rupture, suspect leakage from the liquid container or internal piping.

NOTE: An abnormally high vacuum reading without other evidence of vacuum loss (excessive pressure, rapid venting, etc.) may be caused by a fault in the gauging equipment or by improper operation of the equipment. Be sure that the vacuum gauge and the gauge tube are in good condition and follow operating instructions carefully. Always be sure that the gauge tube valve has been open for at least 30 minutes before taking a reading.

Try to determine the source of leakage in cases where the casing safety device has not ruptured; visually inspect the exterior of the casing. Check the following areas in the order in which they are listed:

a. Vacuum gauge tube,
b. Vacuum gauge tube valve,
c. Casing evacuation valve,
d. Casing bursting disk,
e. All liquid and gas phase lines at exit point from casing,
f. Any area of the casing that might have been exposed to cryogenic liquid spray or contact.

Look for signs of damage, corrosion, operated valves, and other abnormal conditions. Make repairs to any suspicious area and proceed with re-evacuation.

If there is complete loss of vacuum and rupture of the casing safety device accompanied by ejection of perlite insulation, the cause is probably leakage from the liquid container or internal piping. Field repair of such internal leakage is beyond the scope of these instructions. Contact the Customer Service Department at the Shah Alam factory for advice or assistance.

TESTING FOR CASING LEAKAGE

If leakage appears to be form atmosphere and there is no evidence of casing safety device failure, check for leaks in the casing and/or casing/piping connection. This involves breaking any remaining partial vacuum, pressurizing the casing, and checking all casing welds, especially those around piping.

BREAKING VACUUM

If it is necessary to break vacuum (allow insulation space to return to atmospheric pressure) of a tank that is still under partial vacuum, it is important to minimize the entry of moisture into the insulation space. Removing such moisture during re-evacuation is difficult and time consuming. This problem can be minimized by breaking vacuum with dry nitrogen gas admitted through the evacuation valve.

1. Remove the pipe plug from the evacuation valve inlet.

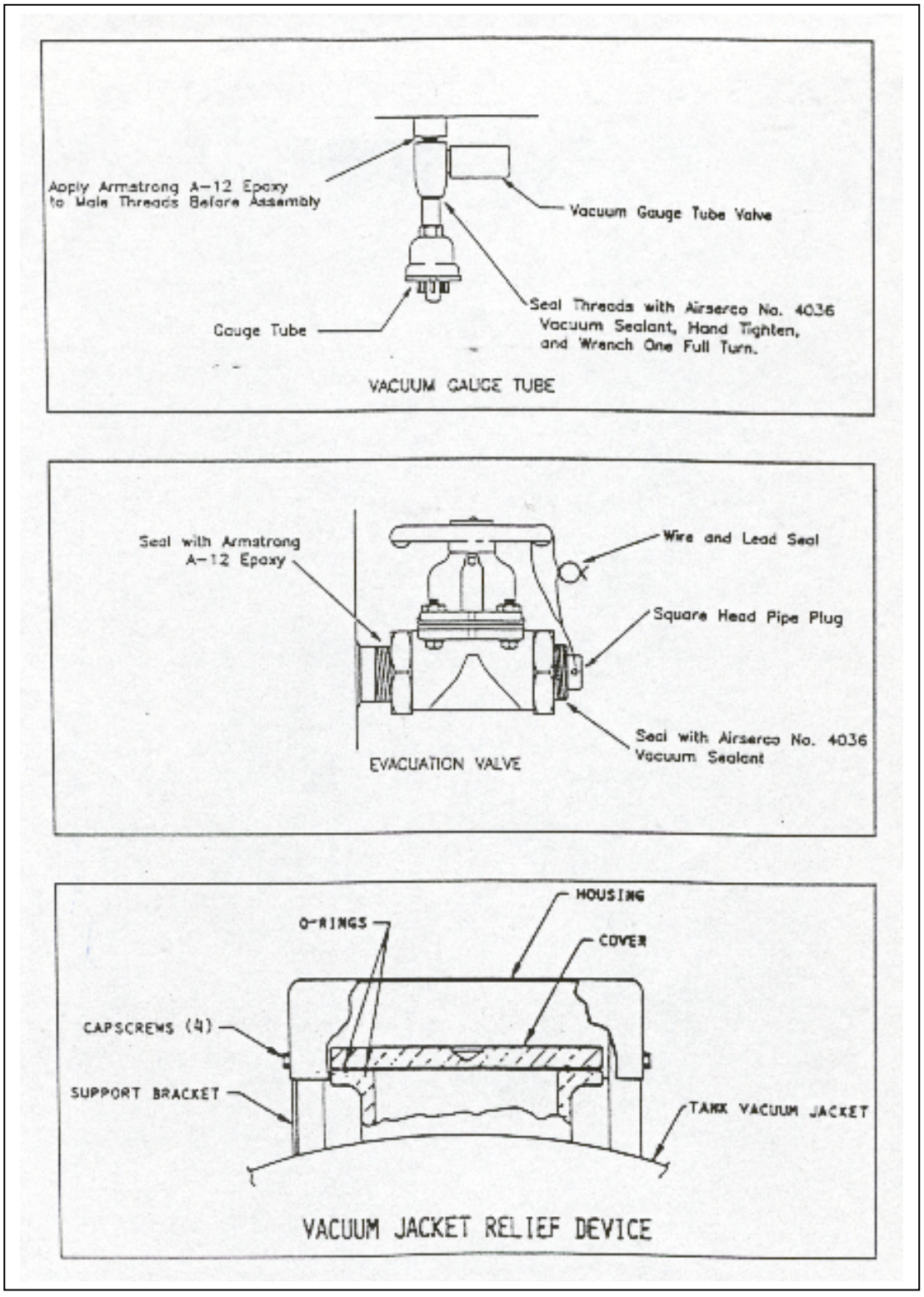
2. Connect a cylinder of dry nitrogen gas, equipped with a pressure regulator and an accurate 0-5 psig (35 kPa) pressure gauge, to the evacuation valve inlet.

3. Open the cylinder valve and adjust the regulator to a delivery pressure of about 2 psig (15 kPa).

4. Slowly open the evacuation valve to allow nitrogen gas to enter the insulation space.

5. When the vacuum has been broken, shut off the nitrogen supply and disconnect it from the evacuation valve.

6. Leave evacuation valve open for at least 60 minutes to allow the insulation space pressure to equalize. Then close the evacuation valve.



Vacuum System Components Figure

RE-EVACUATION PROCEDURE

After any required vacuum repairs have been completed, re-evacuate the insulation space as follows:

1. Break the seal wire and remove the pipe plug from the evacuation valve. Use two wrenches, one on the valve, the other on the plug.

2. Be sure that there is not positive pressure in the casing. If necessary, crack open the evacuation valve to relieve the pressure.

3. Check that the inner container is empty, warm, and pressurized to at least 10 psig. Refer to “Warming the Tank”.

4. Attach vacuum pump to the evacuation valve.

5. With the evacuation valve open, evacuate the insulation space to at least 150 microns (0.15 mm Hg) absolute.

   NOTE: Vacuum level will decrease to an acceptable level when the liquid container is filled with product.

6. When proper vacuum has been obtained, close the evacuation valve and disconnect the vacuum pump.

7. Thread the pipe plug into the valve port, engaging one thread. Apply Airserco high vacuum sealant to the remaining threads. Tighten plug using two wrenches. Install new seal wire to prevent tampering.

PAINTING

If repainting the tank is required, be sure materials that are compatible with the factory-applied finish. The tank was painted with the following materials:

Primer:	HEMPADUR, MASTIC GREY
Finish Coat:	HEMPATHANE ENAMEL WHITE

SAFETY PRECAUTIONS PERTAINING TO PAINTING OPERATIONS

All paint components contain volatile solvents, mainly petroleum distillates, alcohols, xylene. Normal precautions for flammable materials should be observed including exclusion of heat, sparks, and open flame. Containers should be grounded before pouring.

All the ingredients present physiological hazards both from inhalation and absorption through the skin. Breathing of the vapor and spray mist must be avoided. Protective clothing including rubber gloves must be worn. Allergy-prone individuals may be sensitized and should not be exposed to isocyanates.

MOVING THE TANK

Purge and warm tank prior to removal and shipping. The tank must not be shipped cold because the internal supports are not designed to withstand the shipping loads when the tank is cold. Before moving the tank, refer to rigging information in “Installation” section when relocating the tank.

TROUBLE-REMEDY GUIDE

TROUBLE	POSSIBLE CAUSES	REMEDY
1. Tank Pressure too low	a. Pressure Vessel Safety Valve leaking b. Piping leaks to atmosphere c. Low liquid level d. Excessive product withdrawal e. Improper filling procedure	a. Thaw out valve or replace it b. Test and repair tank c. Refill tank d. Install higher capacity Pressure e. Refer to filling instruction in
2. Excessive tank pressure	a. Extensive shutdown time b. Low withdrawal rate. c. Malfunction of Pressure Building d. Malfunction of tank Pressure Gauge e. Lack of refrigeration caused by low f. Malfunction of Back Pressure Valve	a. No Remedy b. No Remedy c. Refer to Step 3, this section d. Replace Pressure Gauge e. Refill tank f. Refer to Step 3, this section
3. Malfunction of Back Pressure Valve.	a. Improper valve set point b. Dirt on valve seat or valve	a. Check valve set point reset accordingly b. Disassemble, inspect, clean, and reinstall
4. Erratic or erroneous Liquid Level	a. Leaking gauge lines b. By-pass valve open c. Contents Gauge needle stuck d. Contents Gauge needle not zero e. Gauge line reversed f. Contents Gauge damaged or faulty g. Plugged gauge lines	a. Test and repair leaks b. Close by-pass valve c. Tap Contents Gauge slightly. Inspect d. Adjust as required. e. Connect properly f. Replace Contents Gauge. g. Disconnect lines at Contents Gauge
5. Leaking safety valve	a. Dirt or ice under valve or disc b. Improper valve set point c. Damaged valve set or disc	a. Thaw out valve. Replace if necessary. b. Replace valve c. Replace valve
6. Tank vacuum leak	a. Leak in Vacuum Jacket Relief b. Evacuation Valve leak c. Vacuum Probe or Vacuum Valve d. Tank Vacuum Jacket leak.	a. Refer to Analyzing Vacuum b. Replace Evacuation Valve c. Replace faulty components. d. Refer to Analyzing Vacuum
7. Inability to obtain desired vacuum when re-evacuating.	a. Defective vacuum pump b. Incorrect vacuum reading c. Detective Vacuum Gauge Tube d. Leak in connections between vacuum e. Excessive moisture in insulation f. Moisture in pump lubricant	a. Repair or replace vacuum pump b. Repeat vacuum measurement. c. Replace Vacuum Gauge Tube d. Repair Leaks e. Evacuate insulation space with cold f. Replace lubricant.