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Vapour control systems in gasoline distribution networks

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Vapour control systems in gasoline distribution networks

CETTE NORME NATIONALE DU CANADA EST DISPONIBLE EN VERSIONS FRANÇAISE ET ANGLAISE.

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Acknowledgment is made for the translation of this National Standard of Canada by the Translation Bureau of Public Works and Government Services Canada.

Preface

The second edition of this National Standard of Canada was developed in support of the Canadian Council of Ministers of the Environment (CCME)'s *Environmental Code of Practice for Vapour Recovery in Gasoline Distribution Networks*. The CCME's Code of Practice addressed initiatives to reduce emissions of gasoline vapours, which are part of the volatile organic compounds (VOCs), to the atmosphere. These compounds react with oxides of nitrogen on hot, sunny days to form ground-level ozone, a component of urban photochemical smog.

This standard applies to vapour control system (VCS) equipment for gasoline transfers to cargo tanks, bulk plant storage and service station storage tanks (commonly called Stage I controls). In some existing gasoline distribution networks, the air and gasoline vapour in empty tanks is vented to the atmosphere as the tank is being filled. The VCS equipment recycles the air/vapour mixture from the tank receiving the gasoline back to the tank delivering the gasoline, then back to a processing unit that recovers or destroys the vapours (Figure 1). The installation and use of standard vapour control systems will ensure that approximately 90% of the vapours on average are contained.

This standard provides guidance to federal, provincial and regional authorities having jurisdiction for vapour recovery in gasoline distribution networks and to owners who voluntarily implement vapour control systems.

This standard specifies technical details for the design, installation, operation and maintenance of Stage I vapour control system. Implementation of Stage I vapour control systems in Canada is through regulation by the authority having jurisdiction. This standard is referenced in various regulations or permit requirements, and it is recommended that users consult both the regulations and this standard to satisfy all requirements. Conformance to this standard is recommended in the absence of regulation whenever Stage I VCS technology is installed to ensure compatibility in any systems across Canada.

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Vapour control systems in gasoline distribution networks

1 Scope

This National Standard of Canada defines equipment requirements, performance criteria, and operating and testing procedures for the implementation of a vapour control system (VCS) in gasoline distribution networks including terminals, bulk plants, service stations and cargo tanks, commonly known as Stage I. (See Figure 1 for a schematic representation).

This standard does not include vapour control systems for vehicle refuelling commonly known as Stage II, rail car, marine transfers or aviation gasoline facilities.

This standard has been developed to provide regulators, users, installers and compliance authorities with a uniform installation reference for Stage I vapour control systems.

Extent of coverage — This standard provides performance criteria for equipment in use and specifies the type of interconnecting fittings to be used at terminals, bulk plants and service stations, and on cargo tanks. This standard does not provide design specifications for individual components such as mechanical design of a fitting or detailed piping layout.

This standard also includes procedures for operating the Stage I VCS facilities in the various locations.

Simplified schematics have been provided to illustrate possible field installations and checks.

The test procedures included in this standard provide the basis for assessing the compliance of the equipment and systems with the requirements of the authority having jurisdiction.

Application of this standard — The user of this standard shall refer to the authority having jurisdiction in the application of this standard.

Certain considerations are required in the application of this standard.

The maximum back-pressure at the cargo tank to provide sufficient head to drive the vapour recovery unit (VRU) is specified as a maximum 4.5 kPa (18 in. of water).

There is a concern with the flow characteristics of poppetted vapour connections. Poppetted adaptors with low restriction to flow may be necessary for some applications and are recommended for vapour connections to cargo tanks.

For equipment and safety protection, the use of pressure/vacuum (PV) vents on underground tanks is not recommended as such devices do not improve vapour recovery.

Flame arrestors conforming to U.S. Underwriters Laboratories Inc. (UL[1]) standards and documents are recommended in vapour recovery lines for the fire protection of VRU systems. Flame arrestors shall be sized so as not to increase system back-pressures beyond the levels specified in maximum back-pressure stated above.

Present test methods, outlined in 7, are based on U.S. Environmental Protection Agency (EPA) test methods and data gathered from a large-scale pilot program operated in the Greater Vancouver Regional District (GVRD) in 1989/1990.

[1] The required information may be obtained by contacting the Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096, U.S.A., telephone 847-272-8800, fax 847-272-8129, Web site www.ul.com.

Gasoline–alcohol blends — The owner/operator of distribution networks handling gasoline–alcohol blends shall ensure that the materials and processes of the vapour recovery facility are compatible with such blends.

Quantities and dimensions in this standard are given in SI units with imperial equivalents, mostly obtained through soft conversion, given in parentheses. The SI units shall be regarded as official in the event of dispute or unforeseen difficulty arising from the conversion.

The testing and evaluation of a product against this standard may require the use of materials and equipment that could be hazardous. This standard does not purport to address all the safety aspects associated with its use. Anyone using this standard has the responsibility to consult the appropriate authorities and to establish appropriate health and safety practices in conjunction with any applicable regulatory requirements prior to its use.

2 Normative references

The following normative documents contain provisions that, through reference in this text, constitute provisions of this National Standard of Canada. The referenced documents may be obtained from the sources noted below.

NOTE The addresses provided below were valid at the date of publication of this standard.

An undated reference is to the latest edition or revision of the reference or document in question, unless otherwise specified by the authority applying this standard. A dated reference is to the specified revision or edition of the reference or document in question. However, parties to agreements based on this National Standard of Canada are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below.

2.1 Canadian Standards Association (CSA)

B620 — *Highway Tanks and Portable Tanks for the Transportation of Dangerous Goods*

C22.1 — *Canadian Electrical Code, Part I – Safety Standard for Electrical Installations*

C22.2 — *Canadian Electrical Code, Part II – Consumer and Commercial Products.*

2.1.1 Source

The above may be obtained from the Canadian Standards Association, Sales, 5060 Spectrum Way, Suite 100, Mississauga, ON L4W 5N6., telephone 416-747-4044 or 1-800-463-6727, fax 613-747-2510, Web site www.csagroup.org, e-mail sales@csagroup.org.

2.2 National Research Council of Canada (NRC)

National Fire Code of Canada, latest applicable version.

2.2.1 Source

The above may be obtained from the National Research Council of Canada, Publication Sales, M-20, Institute for Research in Construction, 1200 Montreal Road, Ottawa, ON K1A 0R6. Telephone 613-993-2463 or 1-800-672-7990. Fax 613-952-7673. E-mail IRCpubsales@nrc-cnrc.gc.ca. Web site www.nrc-cnrc.gc.ca.

2.3 American Petroleum Institute (API)

RP 1004 — *Bottom Loading and Vapor Recovery for MC-306 & DOT-406 Cargo Tank Motor Vehicles.*

2.3.1 Source

The above may be obtained from American Petroleum Institute, 1220 L Street, Northwest, Washington, DC 200005-4070, U.S.A., telephone 202-682-8000, Web site www.api.org.

2.4 ASTM International

D5191 — *Standard Test Method for Vapour Pressure of Petroleum Products (Mini Method)*

E1 — *Standard Specification for ASTM Liquid-in-Glass Thermometers*

E29 — *Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications.*

2.4.1 Source

The above may be obtained from ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, U.S.A.,Web site www.astm.org, or from IHS Global Canada Ltd., 200-1331 MacLeod Trail SE, Calgary, Alberta T2G 0K3, telephone 613-237-4250 or 1-800-267-8220, fax 613-237-4251,Web site www.global.ihs.com.

2.5 California Air Resources Board (CARB)

Stationary Source Test Methods — *Volume 2: Certification and Test Procedures for Gasoline Vapor Recovery Systems*

CP 203 — *Certification Procedures for Vapor Recovery Systems of Terminals.*

2.5.1 Source

The above may be obtained from California Air Resources Board, 1001 “I” Street, Sacramento, California, CA 95812, U.S.A., telephone 916-322-2990 or 1-800-242-4450, fax 916-445-5025, Web site www.arb.ca.gov, e-mail helpline@arb.ca.gov.

2.6 U.S. Department of Defense (DoD)

A-A-59326D — *Coupling halves, Quick-Disconnect, Cam-Locking Type.*

2.6.1 Source

The above may be obtained from the Defense Automated Printing Service, Bldg. 4 Section D (Publications), 700 Robbins Avenue, Philadelphia, PA 19111-5094, U.S.A., telephone 215-697-2664, fax 215-697-9398, Web site https://assist.daps.dla.mil/online/start/.

2.7 U.S. Department of Transport (DOT)

Code of Federal Regulations (CFR) — Title 49: Transportation – Part 178 – Specifications for Packagings - Subpart J – Specifications for Containers for Motor Vehicle Transportation

Section 346: Specification DOT 406; cargo tank motor vehicle.

2.7.1 Source

The above may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402, U.S.A., telephone 202-512-1800, fax 202-512-2104, Web site www.gpoaccess.gov/cfr/index.html. (Begin search from the “e-CFR” tab on this Web site.)

3 Terms and definitions

For the purposes of this National Standard of Canada, the following terms and definitions apply.

3.1
authority having jurisdiction
officer or officers having authority under appropriate regulatory instruments to exercise enforcement functions or powers.

3.2
bottom loading
system for loading liquid petroleum products into a cargo tank from the bottom, through a system of pipes, valves and dry-disconnect fittings (see figure 4).

3.3
bulkhead
dished divider forming a compartment within a cargo tank.

3.4
bulk storage facility
one or more storage tanks, including the appurtenances thereof, where gasoline is received by pipeline, cargo tank, barge or fail car and is stored in bulk for subsequent transportation or distribution by cargo tank. There are two types of bulk storage facilities:

a) **terminal** — A primary distribution facility typically equipped with floating roof tanks that receives gasoline by pipeline, rail car or marine transfer. Gasoline truck loading facilities operated in association with petroleum refineries or other processing plants are included in the definition of terminal.

b) **bulk plant** — A secondary distribution facility normally equipped with fixed roof tanks that receives gasoline by cargo tank.

3.5
cam-and-groove coupler
machined fitting (typically hose end) designed to allow quick coupling and leak-free connection.

3.6
Canadian Council of Ministers of the Environment (CCME)
intergovernmental forum in Canada for discussion and joint action on environmental issues of national, international and global concern.

NOTE Environment ministers from each of the ten provinces, the federal government and the three territories participate in council meetings at least twice a year. They discuss environmental issues, exchange information, make decisions and establish policy for work to be carried out under the auspices of CCME.

3.7
cargo tank (truck), highway tank, tanker or tank truck
trailer having a bulk liquid tank on it or a motor vehicle having a bulk liquid tank mounted on the frame or chassis of the vehicle, used for transporting gasoline.

3.8
certified liquid product meter
liquid-measuring device calibrated by an authority having jurisdiction and used as the basis for legal trade.

3.9
coaxial vapour recovery system
means of collecting vapours on delivery of gasoline to an underground storage tank by the same connection as the liquid fill through a single coaxial tank connection (see figure 11).

3.10
dead weight tester
instrument used as a standard for calibrating pressure gauges in which known hydraulic pressures are generated by means of freely balancing (dead) weight loaded on a calibrated piston.

3.11
degassing
see 3.35 **purge**.

3.12
drop tube
length of tubing used to extend a top filling connection to within 100 to 150 mm from the bottom of the cargo (or underground storage) tank to provide submerged fill (see figures 10 and 11).

3.13
dry disconnect
mating fittings equipped with a poppet on both halves ensuring a leak free disconnection for liquids.

3.14
dual point vapour recovery system
means of collecting vapour during the delivery of gasoline to a service station underground storage tank by a tank connection other than the fill connection (see figure 3).

3.15
floating roof tank
tank, used in terminal operations, equipped with a floating “pan” roof cover that floats on top of the gasoline, and with seals to the sidewall to minimize vapour loss.

NOTE The airspace above a floating roof is vented to atmosphere and therefore cannot be used for vapour balancing. The tank may also have fixed roof (i.e., an internal floating roof tank).

3.16
fixed roof tank
tank with a fixed roof but with no internal floating roof or other internal vapour emission controls (e.g., bladder).

NOTE A fixed roof tank is normally equipped with a pressure/vacuum (PV) vent and can be vapour balanced.

3.17
gasoline
for the purpose of this standard, a petroleum product and/or a mixture of petroleum products, additives and oxygenates used as a fuel in spark ignition engines and having a vapour pressure greater than 41 kPa (6 psi).

[SOURCE: References [1] and [2].]

3.18
hydrocarbons
compound made up of carbon and hydrogen, which constitute the main components of petroleum products.

3.19
instantaneous loading rate
rate of product being loaded into the cargo tank at the moment the meter reading is taken.

3.20
interlock
mechanical or electrical device by means of which the functioning of one part of the system is controlled by the functioning of another.

3.21
leak free
equipment or connections that when assembled and in continuous normal service maintain a specific leak rate. See 4.3.1.

3.22
liquid drop elbow
standard hose-end fitting used to connect the cargo tank delivery hose to a liquid connection on an underground storage tank (see figures 3 and 10).

3.23
lower explosivity limit (LEL)
concentration of flammable gases or vapours in the air above which the mixture is explosive.

3.24
manifold
pipe connecting several inlets to a common outlet.

3.25
operating service factor
ratio of hours (during facility operation) that the VCS is operating normally (t_n), to the total operating hours of the facility (t_s), calculated over a calendar year:

Operating Service Factor, % = $100(t_n/t_s)$

3.26
operator
<facility>person who is responsible for the day-to-day operation of a terminal, bulk plant or service station and who is expected to be on the premises during the hours of operations.

3.27
operator
<cargo tank>driver in charge of the cargo tank.

3.28
overfill prevention device
<cargo tank>device connected to the loading pump controls that prevents overfilling of the cargo tank when liquid product is being delivered to the tank.

3.29
overfill prevention device
<underground storage tank>device that prevents liquid overfill.

3.30
owner
institution, a corporate entity, a government agency or a person who has legal ownership rights or has been assigned the custody to control, care for and manage a terminal, bulk plant, service station or cargo tank.

3.31
permissive system
system of mechanical or electrical interlocking devices that prohibits loading or unloading of gasoline unless the vapour recovery system is properly connected.

3.32
poppet
spring-loaded disk mounted in an adapter/coupler, which provides positive closure when the adapter/coupler is disconnected (see figure 10).

3.33
poppetted fitting
fitting equipped with a poppet for system closure when disconnected.

3.34
probe
finger type pin centrally located in a coupler, which pushes open the poppet in an adapter upon connection (see figures 10 and 11).

3.35
purge
displacement of gasoline vapours from a cargo tank by any safe means in accordance with regulations.

3.36
PV vent
pressure/vacuum vent designed to allow relatively small pressure increases or decreases to occur within a tank, without allowing vapour venting to the atmosphere or air in-breathing into the tank.

3.37
service station
any premises at which gasoline is dispensed into the fuel tanks of motor vehicles, including marinas with land-based storage.

3.38
submerges fill
system for loading liquid petroleum products into any tank using a pipe to provide entry below the liquid surface thereby minimizing splash and vapour formation (see figures 2, 6 and 10).

3.39
switch loading
alternate loading of gasoline and other liquid petroleum products in the same compartment of a cargo tank without purging.

3.40
thermal oxidation unit
installation that receives gasoline vapours from cargo tanks and combusts the vapours.

NOTE A thermal oxidation unit is normally located at a terminal.

3.41
top loading
loading of liquid petroleum products into cargo tanks from the top either through dome hatches using swivel arms and drop tubes (see figure 5), or using top tight fill (see figure 6).

3.42
top tight fill (connection)
top-loading equipment composed of a dry-disconnect adapter with submerged fill tube, fixed to the cargo tank (see figure 6).

3.43
Underground storage tank
storage tank that is completely buried by or covered with earth, backfill or concrete, or a partially buried tank. A partially buried tank means a storage tank that has 10% or more of its volume below the adjacent ground level.

3.44
Vapour Control System (VCS) (see figure 1)
vapour retrieval system incorporating the following subsystems:

a) **vapour balancing** — where vapours displaced from tanks receiving liquid product are returned to the tanks delivering the product;

b) **vapour recovery** — where vapours returned from bulk plants and service stations in cargo tanks are recovered in a vapour recovery unit (VRU) for subsequent use; or

c) **vapour destruction** — where vapours returned from bulk plants and service stations, in cargo tanks, are thermally destroyed in a vapour destruction unit (VDU).

3.45
vapour destruction unit (VDU)
thermal oxidation unit
installation, located at a terminal, that receives gasoline vapours from cargo tanks and destroys them by combustion or by other means.

3.46
vapour pressure
dry vapour pressure equivalent (DVPE) of gasoline at 37.8°C (100°F) measured according to ASTM D5191.

3.47
vapour recovery adapter
cam-and-groove connection, conforming to U.S. DoD A-A-59326D (see figures 10 and 11).

3.48
vapour recovery elbow
standard hose-end fitting used to connect a cargo tank vapour hose to a poppetted vapour adaptor on the underground storage tank (see figure 3).

3.49
Vapour Recovery Unit (VRU)
installation, located at a terminal, that receives gasoline vapours from cargo tanks and recovers them for subsequent use (see figure 1), thereby preventing their entry into the environment.

3.50
vapour tight
ability of the various elements that comprise the vapour control system to prevent emission of vapours to the atmosphere. (Refer to the test procedure in 7.2 for further details).

3.51
vent
opening to the atmosphere from the vapour space of a storage tank or cargo tank.

3.52
volatile organic compounds (VOCs)
Compounds composed of hydrocarbons and other organic chemicals that evaporate to the atmosphere at ambient conditions. The VOCs are also known as reactive organic gases or non-methane volatile organic compounds. The VOCs refer only to photo chemically reactive hydrocarbons and therefore exclude compounds such as methane, ethane and several chlorinated organics. Gasoline vapours are a type of VOC.

3.53
working day
any continuous 24 h period during which the VCS is in service.

4 General requirements

4.1 Components of Stage 1 vapour control systems (VRUs and VDUs) shall be installed, operated and maintained according to this standard. Performance requirements for various components are specified under their individual headings.

4.2 Fittings

4.2.1 Fittings and connections shall be standard and compatible among the various components of the Stage 1 VCS (terminals, bulk plants, cargo tanks and service stations), and interchangeable among different users, irrespective of location.

4.2.2 In general, these fittings and connections shall conform to API RP 1004, except where specified in this standard.

4.2.3 All dimensions shown for piping and fittings in the figures in this standard are nominal dimensions.

4.3 Facilities equipped with vapour recovery equipment shall have the equipment connected during normal operation.

NOTE Undersized or poorly located piping, vents and connections may reduce vapour recovery efficiency.

4.3.1 All connections shall be leak free and vapour tight.

4.3.1.1 Leak free

Liquid loading not exceeding four drops per minute excluding losses that occur upon disconnect. Upon disconnection, transfer losses shall not exceed 10 mL per dry disconnect of the same fitting, averaged over three disconnects.

4.3.1.2 Vapour tight

Vapour of less than 100% of the lower explosivity limit on a combustible gas detector measured at a distance of 25 mm from the source.

Caution: Improper connections will result in flammable vapours at ground level and may constitute a fire, explosion, human health and environmental hazard.

4.4 Caps on vapour recovery adapters shall be coloured orange, except for coaxial adapters at service stations, as a safety measure to prevent accidental connection to liquid filling lines. Vapour systems with more than one outlet should have positive shut-off devices (e.g. closed pressure vents, solid caps, valves or check valves, and poppetted couplers) installed at all outlets to prevent the escape of vapours when not in use.

4.5 Electrical installations in hazardous locations as defined in CSA C22.1 and C22.2 shall conform to those standards or other applicable codes or standards as required by the regulatory authority having jurisdiction.

4.6 In applying this standard, the fire prevention and safety requirements of the *National Fire Code of Canada, latest applicable version* or other applicable fire and safety regulations and codes shall take precedence in the event of conflicting requirements.

4.7 Numerical data shall be interpreted in accordance with the “rounding-off” method of ASTM E29.

4.8 The figures in this standard are typical installations and are for illustration only.

4.9 A cam-and-groove coupler vapour couplings shall conform to U.S. DoD A-A-59326D (see figures 2, 3 and 11).

5 Detailed requirements

5.1 Terminals

5.1.1 Vapour recovery connections

5.1.1.1 Each loading bay at a terminal shall be equipped with a 100 mm (4 in.) nominal diameter vapour return line as a permanent fixture of the loading rack. Vapour return line connections shall be 100 mm (4 in.) nominal diameter cam-and-groove poppetted couplers with a probe to mate with 100 mm (4 in.) nominal diameter vapour recovery adapters mounted on the cargo tanks (see figure 7). The system shall be designed so that vapours are not released into the atmosphere when the vapour return line is disconnected from the cargo tank and not in use.

NOTE 1 At least two vapour connections are recommended at each loading bay with the capability to load two or more cargo tanks simultaneously.

NOTE 2 It is recommended that vapour return line connections at the terminal loading bays be located in accordance with API RP 1004.

5.1.1.2 The terminal operator shall be responsible for the proper maintenance of the vapour recovery system.

5.1.1.3 The cargo tank operator shall be responsible for ensuring that proper vapour recovery connections are made prior to the commencement of product loading.

5.1.1.4 Permissive interlocks, when used at the terminal loading rack, shall

a) not require special equipment on cargo tanks;

b) not require intervention by the cargo tank operator.

5.1.1.5 The maximum back-pressure of the vapour recovery system at the terminal shall not exceed 4.5 kPa (18 in. of water) when measured at the cargo tank vapour outlet.

5.1.1.6 The vapour recovery system shall be designed for the collection of condensed hydrocarbons and water in closed vessels for recycling or safe disposal. Condensed hydrocarbons and water shall be collected or removed before reaching the carbon beds at the VRU.

5.1.2 Vapour recovery unit (VRU)/Vapour destruction unit (VDU)

5.1.2.1 Unless otherwise required by the authority having jurisdiction, the VRU and the VDU shall not emit more than 35 mg of hydrocarbons per litre of gasoline loaded into cargo tanks at the terminal, in accordance with the test procedures described in. 7.1.3 and 7.1.4.

5.1.2.2 The VRU or VDU annual operating service factor shall not be less than 95%.

5.1.2.3 During the period of May 1 to September 15

a) planned maintenance, requiring shutdown of the VDU or VRU during facility operation, shall be avoided as much as possible;

NOTE At high throughput terminals, planned maintenance is typically done on a quarterly basis and requires a temporary shutdown.

b) the authority having jurisdiction shall be notified if any repairs or adjustments result in VRU/VDU downtime longer than 24 h. The authority having jurisdiction may have other reporting requirements.

5.1.2.4 Test results and maintenance records shall be kept for a three-year period or longer if so required by the jurisdiction having authority.

5.2 Bulk plants

5.2.1 The vapour-balancing piping systems at the bulk plant shall not generate a back pressure exceeding 4.5 kPa (18 in. of water) when measured at the cargo tank vapour outlet.

5.2.1.1 Performance of the facility shall be established by

a) a visual inspection to ensure that the proper fittings are installed (see figures 1 and 8 for a typical installation);

b) using a combustible gas detector (see 3.21 b.) to ensure that the piping system and connections are leak free during unloading.

5.2.2 The authority having jurisdiction shall be notified if the bulk plant vapour-balancing system is not in normal operation because of any repairs or adjustments for a period exceeding 24 h.

5.2.3 Vapour recovery connections

When the bulk plant is equipped with a vapour return line as a permanent fixture of the loading/unloading rack, the vapour recovery connections to be provided at the bulk plant shall be the same as described for terminals in 5.1.1.1 (see figure 8).

5.2.4 PV vents shall be installed on above-ground fixed roof gasoline storage tanks. PV vents shall be set at maximum pressure and vacuum within the allowable limits of the tank design pressure with due consideration for safe operating pressures of storage tank and equipment. The design shall conform to the applicable Underwriters' Laboratories of Canada (ULC) standard or document[2] or to other applicable regulations by the authority having jurisdiction.

5.3 Cargo tanks

5.3.1 The cargo tank shall be tested annually for vapour tightness according to the test procedure described in 7.2. The pressure change shall not exceed 0.75 kPa (3 in. of water) in 5 min when the cargo tank is subjected to a pressure of 4.5 kPa (18 in. of water) or a vacuum of 1.5 kPa (6 in. of water). The operator shall keep records of test results on file for one year.

NOTE A 0.75 kPa (3 in. of water) pressure loss is approximately 99% vapour tight.

5.3.1.1 If the cargo tank fails the annual vapour tightness test, it must be repaired and retested prior to its return to service.

[2] The required information may be obtained by contacting the Underwriters' Laboratories of Canada, 440 Laurier Avenue West, Ottawa, ON K1R 7X6, telephone 613-755-2729 or 1-866-9373-ULC, fax 613-231-5977, e-mail sales@ulc.ca, Web site www.ulc.ca.

5.3.1.2 Cargo tanks meeting the requirement for vapour tightness shall have external identification, as required by the authority having jurisdiction. It shall be affixed to the front curb-side of the exterior of the cargo tank (see figure 9).

NOTE It is recommended that the external identification be the approved vapour tightness test-date, in minimum 50 mm (2 in.) size characters.

5.3.2 To load the cargo tank, it shall be confirmed that the cargo tank has met the vapour tightness requirements within the last year (see 5.3.1).

5.3.3 The fittings of the cargo tank shall be compatible with the fittings at the terminals, bulk plants and service stations.

5.3.3.1 The vapour recovery system on cargo tanks shall not affect the operation of the storage tank or terminal loading rack.

5.3.4 Vapour recovery connections

5.3.4.1 The VCS piping installed on a cargo tank shall have a minimum cross-sectional area equivalent to that of a 100 mm (4 in.) nominal diameter pipe, terminating in a 100 mm (4 in.) nominal diameter cam-and-groove poppetted adapter conforming to U.S. DoD A-A-59326D (see figure 9). The system shall be designed so that vapours shall not be released when piping is not in use. Connections from compartments to the system shall have a minimum cross-sectional area equivalent to that of a 75 mm (3 in.) nominal diameter pipe.

If small cargo tanks are loaded at reduced rates, the vapour recovery system may be sized accordingly, as long as it terminates in a 100 mm (4 in.) nominal diameter adapter.

NOTE Cargo tanks that have been fitted for vapour recovery prior to this standard with a 75 mm (3 in.) nominal diameter pipe of the 100 mm (4 in.) nominal diameter adapter do not require modification.

5.3.4.2 Two locations are recommended for the vapour recovery adapter used during bottom loading:

a) Not more than 2.1 m (7 ft.) to the front or rear of the centre line of the bottom-loading adapters.

b) At or near the rear or front bulkhead of the cargo tank.

In either case the adapter must be installed on a centre not more than 1.5 m (5 ft.) above grade when the cargo tank is empty and not less than 0.6 m (2 ft.) above grade when the cargo tank is full.

5.3.4.3 A minimum of two vapour recovery connections on the cargo tank is recommended, one for each drop, assuming double drop operation.

5.3.5 Pressure/vacuum (PV) vents

5.3.5.1 The PV vents (see figure 9) installed on cargo tank compartments shall have sufficient capacity to prevent

a) cargo tank overpressure damage at the maximum loading rates;

b) cargo tank collapse from excessive vacuum during unloading.

5.3.5.2 A PV vent shall be installed in the cargo tank piping system to protect against overpressure because of temperature fluctuations between loading and unloading operations.

5.3.6 When a cargo tank equipped for vapour is bottom loaded and vapour recovery is not available, the vapour recovery system shall be open to the atmosphere to prevent pressurization of the tank.

5.3.6.1 Vapours shall be discharged through an operator-activated bypass vent mounted below the top of the cargo tank to vent either horizontally or vertically upward, at a level no more than 0.3 m (1 ft.) from the top of the cargo tank (see figure 9).

Caution: The discharge of vapour in the loading area at ground level may constitute a fire, explosion, human health and environmental hazard.

5.3.7 When cargo tanks equipped for vapour recovery are unloaded and vapour recovery is not required, the tanks shall inbreathe through the bypass vent vapour control system as described in 5.3.6.1.

Caution: Any closure or restriction of the vent may create a vacuum sufficient to collapse the tank. (The small-capacity PV vent in each compartment design to handle temperature fluctuations may be inadequate for vacuum relief during unloading.)

5.3.8 Any portion of the VCS installed on the top of the cargo tank shall be in accordance with CSA B620 or U.S. DOT 406.

5.3.9 The VCS shall be designed to allow complete drainage by gravity of any liquid accumulating in the system. The design shall also provide for degassing the unit before repair.

5.4 Service stations

5.4.1 The vapour-balancing system shall be designed to ensure that the vapours displaced from the underground storage tank shall be returned to the cargo tank.

5.4.1.1 Performance of the facility shall be established by

a) a visual inspection to ensure that proper fittings are installed (see figures 10 and 11 for typical installations);

b) using a combustible gas detector (see 4.3.1.2) to ensure that the system is leak free during unloading.

5.4.2 The authority having jurisdiction shall be notified if the service station vapour recovery equipment is not in normal operation because of any repairs or adjustments for a period exceeding two working days.

5.4.3 PV vents are not normally required on underground storage tank venting systems for effective vapour control. If a design decision is taken to use PV vents, they shall conform to the requirements of the *National Fire Code of Canada, latest applicable version* and other applicable regulations required by the authority having jurisdiction.

Caution: The users of PV vents are cautioned about potential freezing problems in cold climates. Failure of PV vents can cause residual pressure to be contained in the underground tank after product drop is completed. Spills may occur on disconnection.

5.4.4 Use of manifolded vents is permitted on underground storage tanks. The manifold system shall be designed so that, at the maximum anticipated product drop rate, the vacuum at the truck vapour connection does not exceed the set pressure on the tank vacuum vent, 1.5 kPa (6 in. of water).

5.4.4.1 An overfill prevention device is recommended on underground storage tanks if the vapour vent lines are manifolded.

5.4.5 Vapour recovery connections

5.4.5.1 For dual point unloading systems, the service station underground storage tank shall be equipped with a 100 mm (4 in.) nominal diameter cam-and-groove poppetted vapour recovery adapter (see figure 10). It is recommended that the vapour recovery adapter be located within 1000 mm (3 ft.) of the liquid fill pipe.

5.4.5.2 For coaxial unloading systems, the service station underground storage tank shall be equipped with a 100 mm (4 in.) nominal diameter tight-fill coaxial vapour recovery adapter (see figure 11).

5.4.5.3 The cargo tank vapour hose shall be a minimum of 75 mm (3 in.) diameter with a 100 mm (4 in.) nominal diameter cam-and-groove coupler at the cargo tank end and a 75 mm (3 in.) nominal diameter cam-and-groove coupler with probe at the elbow end (see figures 10 and 11) for combined use at bulk plants and service stations.

5.4.5.4 The cargo tank vapour hose shall connect to a 75 mm (3 in.) nominal diameter cam-and-groove adapter on the vapour recovery elbow for dual point systems. The vapour recovery elbow shall connect to a poppetted adapter on the underground storage tank vapour recovery connection (see figure 10).

The cargo tank vapour hose shall connect to a 75 mm (3 in.) nominal diameter cam-and-groove coaxial adapter on the vapour recovery elbow for coaxial systems (see figure 11).

6 Operating procedures

6.1 Loading at terminals

6.1.1 All equipment associated with loading of gasoline and vapour recovery operations shall be maintained leak free, vapour tight and in good working condition. The cargo tank operator shall be responsible for the operation of vapour recovery equipment installed on the cargo tank. The terminal owner/operator shall be responsible for the operation of vapour recovery equipment installed at the loading rack.

6.1.2 The vapour recovery hose coupler provided at the terminal loading rack shall be connected to the vapour recovery adapter installed on the cargo tank before product-loading connections are made.

6.1.3 The vapour recovery hose shall be disconnected after product loading is completed. The system shall be designed so that vapours are not released when the line is disconnected and not in use.

6.1.4 No device other than matching probe fittings shall be used to open poppetted couplers and adapters during normal operation.

6.1.5 The cargo tank operator shall not vent vapour to the atmosphere during transfer operations when vapour recovery equipment is available. Dome hatches may be opened for inspection of the product except during loading and unloading. Maximum opening time shall be 3 min to ensure minimum vapour escape.

6.2 Cold weather operation of vapour recovery units (VRUs)/Vapour destruction units (VDUs)

6.2.1 The following cold weather considerations shall be reviewed before the final design is completed for the VRU/VDU. Consultation with experts who maintain cold weather installations is recommended.

6.2.1.1 VRU gear box actuators

There is a potential for ice to form because of condensation in the gear box on the swing valve actuators in the VRU.

6.2.1.2 VRU/VDU glycol concentration

The prescribed glycol concentration for the VRU shall be maintained in circulating systems to prevent freezing and corrosion problems. Similarly, the same consideration shall be given to the VDU seal system.

6.2.1.3 VRU liquid lines

Water vapour entering the VRU with gasoline vapours will condense with the gasoline in cold weather, which may lead to freezing in the liquid lines.

6.2.1.4 VRU/VDU vapour piping

Attention shall be given to any valve in low point areas of the piping system because of the potential to collect condensed water, which could freeze. This could lead to valve actuator damage.

6.2.1.5 The manufacturer's recommendations and guidelines shall be followed for heat tracing and insulation of vapour and liquid piping within the VRU/VDU system.

6.3 Loading and unloading at bulk plants

6.3.1 All equipment associated with the loading and unloading of gasoline and vapour-balancing operations shall be maintained leak free, vapour tight and in good working condition. The cargo tank operator shall be responsible for the operation of vapour recovery equipment installed on the cargo tank. The bulk plant owner/operator shall be responsible for the operation of vapour recovery equipment installed at the loading rack.

6.3.2 The vapour recovery hose coupler provided at the bulk plant loading rack shall be connected to the vapour recovery adapter installed on the cargo tank **before product loading/unloading** connections are made (see figure 8).

6.3.3 The vapour recovery hose shall be disconnected after product loading/unloading is completed. The system shall be designed so that vapours are not released when the line is not in use.

6.3.4 No device other than matching probe fittings shall be used to open poppetted adapters during normal operation.

6.3.5 The cargo tank operator shall not vent vapour to the atmosphere during transfer operations when vapour recovery equipment is available. Dome hatches may be opened for inspection of product except during loading and unloading. Maximum opening time shall be 3 min to ensure minimum vapour escape.

6.4 Unloading at service stations

6.4.1 All equipment associated with unloading of gasoline and vapour-balancing operations shall be maintained leak free, vapour tight and in good working condition. The cargo tank operator shall be responsible for the operation of vapour recovery equipment installed on the cargo tank. The service station owner/operator shall be responsible for vapour recovery equipment installed at the service station site.

6.4.2 The recommended sequence for connecting dual point and coaxial recovery systems for vapour recovery is as follows:

6.4.2.1 Dual point systems (see figure 10)

a) Connect the vapour elbow to the vapour recovery adapter on the underground tank vapour connection.

b) Connect the vapour return hose to the vapour elbow.

c) Connect the vapour return hose coupler to the vapour recovery adapter mounted on the cargo tank.

NOTE Liquid connections should be made after the vapour connections are complete.

6.4.2.2 Coaxial systems (see figure 11)

a) Connect the coaxial delivery elbow to the tight-fill vapour recovery adaptor on the underground tank connection.

b) Connect the vapour return hose to the vapour connection on the coaxial delivery elbow.

c) Connect the vapour return hose coupler to the vapour recovery adapter mounted on the cargo tank.

NOTE Liquid connections should be made after the vapour connections are complete.

6.4.3 The recommended sequence for disconnecting both the liquid hose and the vapour return hose in dual point and coaxial systems is as follows:

6.4.3.1 Dual point systems

a) Disconnect the liquid hose at the cargo tank.

b) Walk the hose with any residual product sloped back into the connected fill pipe.

c) Disconnect the liquid hose from the liquid drop elbow after the hose is clear of product.

d) Disconnect the liquid drop elbow from the tank drop tube connector fitting.

e) Disconnect the vapour return hose coupler from the vapour recovery adapter on the cargo tank.

f) Walk the vapour hose with any residual condensation sloped back into the connected vapour elbow.

g) Disconnect the vapour return hose from the vapour elbow.

h) Disconnect the vapour elbow from the vapour recovery adapter on the underground tank vapour connection.

Caution: Do not disconnect the vapour line prior to the liquid line disconnection. Discharge of flammable vapours may constitute a fire, explosion, human health and environmental hazard.

6.4.3.2 Coaxial systems

a) Disconnect the liquid hose at the cargo tank.

b) Walk the hose with any residual product sloped back into the connected fill pipe.

c) Disconnect the liquid hose from the coaxial delivery elbow after the hose is clear of product.

d) Disconnect the vapour return hose coupler from the vapour recovery adapter on the cargo tank.

e) Walk the vapour hose with any residual condensation sloped back into the coaxial delivery elbow.

f) Disconnect the vapour return hose from the coaxial delivery elbow.

g) Disconnect the coaxial delivery elbow from the tight-fill vapour recovery adapter on the underground tank vapour connection.

Caution: Do not disconnect the vapour line prior to the liquid line disconnection. Discharge of flammable vapours may constitute a fire, explosion, human health and environmental hazard.

6.4.4 No device other than matching probe fittings shall be used to open poppetted adapters during normal operation. Do not vent vapour to the atmosphere during normal operation as this will defeat the operation of the vapour recovery system.

7 Terminal vapour control system (VCS) emissions performance and cargo tank test procedures

7.1 Terminal vapour control system

The test procedure described herein may be used to determine the effectiveness of the control of gasoline vapour emissions during the loading of gasoline into cargo tanks at terminals equipped with a VRU or VDU. Alternate test procedures may be used (see note below).

NOTE One of the following procedures may also be used to determine emissions performance (see. 5.1.2.1**)**

1) An automated data system such as continuous emissions monitoring analyzer that collects the appropriate information under maximum gasoline loading on a one-hour averaged basis; or

2) An alternate test procedure acceptable to the authority having jurisdiction.

7.1.1 Principle

The volume of gasoline loaded from the terminal storage tanks to the cargo tanks is recorded, and the total flow rate and concentration of hydrocarbons in VRU/VDU vents are determined. The mass emission rate is calculated from these determinations, and is expressed as milligrams of hydrocarbon emitted per litre of gasoline loaded. The operator has the option to include the volume of diesel fuel switch loaded.

7.1.1.1 The VDU exhaust flow is determined by mass balance assuming no auxiliary fuel. An alternate test method to the method described herein is CARB CP-203. Organic carbon concentration and flow rate are determined for the VDU inlet. Unburned hydrocarbon, carbon monoxide and carbon dioxide concentrations are determined for the VDU flue gas. The ratio of total carbon at the VDU inlet and outlet (inlet/outlet) is used to establish the outlet gas flow rate, corrected to standard conditions (1 atm and 15°C).

7.1.1.2 Vapour volume flow rates are normally measured directly at the VRU vent(s) or VDU inlet. Certified liquid product meters may be used to estimate the flow to the inlet of the vapour-processing unit if the operator can demonstrate that such a method meets the accuracy requirements specified for such measurements.

7.1.2 Test conditions

The VRU/VDU shall be operated in accordance with the owner or operator's established and documented operating procedures that are normally in effect, without unusual modifications to enhance system performance for the purpose of the test.

7.1.2.1 The VRU/VDU shall be tested for a minimum of six consecutive one-hour test periods throughout the normal hours of operation for the terminal. Tests should be conducted between May and September with gasoline appropriate to the season. Loading patterns during test procedures shall reflect normal operations. At sometime during at least two of the one-hour periods, the number of loading positions in use shall equal the maximum number normally used during peak loading at the terminal**.**

NOTE These provisions are intended to preclude the use of any "optimized" loading pattern for the purpose of enhancing test performance.

7.1.2.2 Where vapour storage, accumulation or other flow-moderating systems are installed, the test shall continue under normal operation until vapours accumulated during the test period are processed.

7.1.2.3 Each loading position's vapour return line in the terminal shall be tested at least once during the period of the test to check the back pressure.

7.1.3 Test procedure for vapour recovery units (VRUs)

7.1.3.1 Test equipment

a) Vapour flowmeter with a capacity sufficient to determine the volume of exhaust from the vent of the VRU, with an accuracy of ±2% of full scale.

b) Coupler for attaching the flowmeter to the vent of the VRU with temperature and pressure-sensing devices and hydrocarbon analyzer taps.

c) Barometer accurate to ±1 kPa, or alternatively, the barometric pressure calculated from hourly readings at the nearest Environment Canada weather station.

d) Hydrocarbon (HC) analyzer with a precision of ±5% of full scale and a range appropriate for the test. Offscale results void the test. However, if the VRU inlet concentration is measured, this concentration can be used as the outlet concentration. The analyzer output shall be expressed in percent by volume of vent gas. The analyzer shall be equipped with a continuous strip chart recorder or data logger reading at intervals of 15 s or less.

NOTE A second optional HC analyzer may be used for the determination of VRU inlet concentration.

e) Temperature-sensing device with a range of 0 to 60°C having an accuracy of ±2°C.

f) Pressure-sensing device (transducer or equivalent) capable of measuring 0 to 2.5 kPa (0 to 10 in. of water), reading to ±0.025 kPa (±0.1 in. of water), with a recorder or data logger.

g) Coupling with pressure tap for cargo tank vapour return line. The coupling shall have the same inside diameter as the vapour return line.

h) Manometer (or equivalent) capable of measuring 0 to 5 kPa (0 to 20 in. of water) reading to ±0.05 kPa (±0.2 in.).

7.1.3.2 Calibration

a) **Vapour flowmeter**

Acceptable standard methods and equipment shall be used to calibrate the flowmeter. The calibration curves shall be traceable to the U.S. National Institute of Standards and Technology (NIST).[3]

b) **Continuous recording or data logging instruments**

Calibrate daily within the expected range of the test. The temperature-recording device shall be verified by duplicate thermometers conforming to ASTM E1, compensated platinum resistance thermometers or the equivalent known to be accurate to within ±2°C of full scale.

The pressure-recording device shall be verified using a static pressure calibrator, a dead weight tester, a liquid manometer or equivalent.

c) **Total hydrocarbon (HC) analyzer**

Follow the manufacturer's instructions concerning instrument warm-up and operation. On each test day immediately prior to testing, zero the analyzer with a zero gas (less than 0.3 ppm by volume HC as propane) and span with standard gas mixtures at 30%, 50% and 85% of full scale on all ranges to be used during the test. The meter calibration shall be verified after the test. If this check indicates a "drift" of more than 5% from the initial calibration,

[3] Information about the flowmeter may be obtained from the National Institute of Standards and Technology, 100 Bureau Drive, Stop 1070, Gaitherburg, MD 20899-1070, U.S.A., telephone 301-975-8295, e-mail inquiries@nist.gov, Web site www.nist.gov.

the test can be declared void, or the test results can be calculated and reported using the calibration that gives the largest emission rate. A record of calibration checks shall be maintained.

7.1.3.3 Procedures

See figure 12 for typical test connections.

a) Visually inspect the VCS for the use of proper equipment and recommended equipment connections.

b) Connect appropriate coupler to VRU vent and connect flowmeter, pressure and temperature-sensing devices and hydrocarbon analyzer to the appropriate taps on the coupler.

c) Connect the coupling to the vapour return line at the cargo tank adapter. Connect manometer to the pressure tap on the coupling. Record the pressure in the vapour return line at least once during the filling of the cargo tank. Repeat for each cargo tank loaded.

d) Record the exhaust gas flow, pressure, temperature and hydrocarbon concentration in the VRU vent for the required period, with a least twelve observations per hour taken at five-minute intervals.

e) Record the volume of gasoline loaded during the test period. The operator has the option to include the volume of diesel fuel switch loaded.

f) At the end of the required period, disconnect all instrumentation and couplings from the VRU vent line.

g) All calculations shall be averaged over a one-hour period.

7.1.3.4 Calculations

a) Calculate the volume of vapour discharged through the VRU vent, in standard cubic metres (see 7.1.3.4, Note 1).

$V = V_m \times (P_a / 101.3) \times ((T_{std} + 273) / (T_m + 273))$

where:

V = Volume of vapour discharged through VRU vent, corrected to 15°C (288 K) and 1 atm (101.3 kPa), scm

V_m = Volume of vapour measured by the flowmeter on the VRU vents, scm (see 7.1.3.4, Note 2)

P_a = Absolute pressure measured at the flowmeter inlet, kPa

T_{std} = 15°C, standard temperature

T_m = Average temperature of carbon adsorption beds, °C (see 7.1.3.4, Note 3)

b) Calculate the mass of hydrocarbons discharged through the VRU vent per volume of gasoline loaded into cargo tanks, mg/L.

$W = K \times V \times C / (G \times 10^2)$

where:

W = Mass of hydrocarbons discharged through the VRU vent, per volume of gasoline loaded into cargo tanks, mg/L

K = 1.83×10^6 mg/scm, density of propane at 15°C

V = Corrected total volume of vent gas from 7.1.3.4 a. above, scm

C = Average of vent hydrocarbon concentration observations, percent by volume

G = Total volume of gasoline loaded into cargo tanks, L (see 7.1.3.4, Note 4)

NOTE 1 One standard cubic metre (1 scm) is equivalent to 1000 L.

NOTE 2 V_m may be equated to the volume of products loaded onto tank cars, provided tank car and VRU connections are annually verified as vapour tight.

NOTE 3 All inlet vapours are adsorbed into the carbon beds and brought to the temperature of the beds. These vapours or inlet flow then goes into the atmosphere via the VRU vent, but the temperature has been changed when passing through the beds.

NOTE 4 The operator has the option to calculate G on the basis of the volume of gasoline loaded plus the diesel fuel switch loaded.

7.1.4 Test procedure for vapour destruction units (VDUs)

7.1.4.1 Test equipment

a) Vapour flowmeter or equivalent to determine the volume flow of vapour to the VDU with a measurement uncertainty of less than ±10% at the maximum flow rate to be measured.

b) Two hydrocarbon analyzers having a precision of ±5% of full scale and ranges appropriate for the test. The analyzers shall be equipped with continuous strip chart recorders or data loggers reading at intervals of 15 s or less.

c) Carbon monoxide (CO) analyzer with a test uncertainty of less than ±5% in the range of the test.

d) Carbon dioxide (CO_2) analyzer with a test uncertainty of less than ±5% in the range of the test.

e) Two temperature sensors are required: one with a range of 0 to 60°C ± 2°C for the inlet and one with a range of 0 to 65°C for the outlet.

NOTE The VDU outlet temperature is used to monitor the operation of the unit. It is not used in any calculations.

f) Pressure-sensing device (transducer or equivalent) capable of measuring 0 to 5 kPa (0 to 20 in. of water), reading to ±0.05 kPa (±0.2 in. of water), with a recorder or data logger.

g) Sample conditioner capable of adjusting the temperature of the exhaust gas sample to a range acceptable to the hydrocarbon, carbon monoxide and carbon dioxide analyzers.

h) Continuous strip chart recorders, electronic data loggers or equivalent for the VDU exhaust HC, CO and CO_2 readings.

i) Coupling with pressure tap for cargo tank vapour return line. The coupling shall have the same inside diameter as the vapour return.

j) Manometer (or equivalent) to be used for measuring the cargo tank pressure, with a range of 0 to 5 kPA (0 to 20 in. of water) reading to ±0.05 kPa (±0.2 in. of water).

7.1.4.2 Calibration

a) **Vapour flowmeter**

Acceptable standard methods and equipment shall be used to calibrate the flowmeter. The calibration curves shall be traceable to the U.S. National Institute of Standards and Technology (NIST).[3]

b) **Continuous recording or data logging instruments**

Calibrate daily within the expected range of the test. The temperature-measuring device at the VDU inlet shall be verified using duplicate thermometers conforming to ASTM E1 or compensated platinum resistance thermometers or the equivalent known to be accurate to within ±2°C of full scale.

The pressure-recording device shall be verified using a static pressure calibrator, a dead weight tester, a liquid manometer or equivalent.

c) **Total hydrocarbon (HC) analyzer**

Follow the manufacturer's instructions concerning instrument warm-up and operation. On each test day immediately prior to testing, zero the analyzer with a zero gas (less than 0.3 ppm by volume HC as propane) and span with standard gas mixtures at 30%, 50% and 85% of full scale on all ranges to be used during the test. The meter calibration shall be verified after the test. If this check indicates a "drift" of more than 5% from the initial calibration, the test can be declared void, or the test results can be calculated and reported using the calibration result that gives the largest emission rate. A record of calibration checks shall be maintained.

7.1.4.3 Procedures

See Figure 13 for typical test connections.

a) Visually inspect the VCS for the use of proper equipment and recommended equipment connections.

b) Insert the flowmeter into the pipe supplying the VDU, connect temperature and pressure sensors, and record initial volume.

c) Connect the coupling to the vapour return line at the cargo tank adapter. Connect the manometer to the pressure tap on the coupling. Record the pressure in the vapour return line at least once during the filling of the cargo tank. Repeat for each cargo tank loaded.

d) Mark the data record at the beginning of the test. During periods of processing interruption and halting of gas flow (when only the pilot flame is on), mark the data record so that this data is not included in the final calculations. At the end of test, mark the data record and record the final parameters for VDU inlet flow volume.

e) Record the VDU inlet gas flow, pressure, temperature and hydrocarbon concentration. Record the VDU vent temperature, CO, CO_2 and hydrocarbon concentrations. The frequency of the measurements shall be at least twelve observations per hour taken at five-minute intervals for the duration of the test.

f) Record the volume of gasoline loaded during the test period. The operator has the option to include the volume of diesel fuel switch loaded.

g) All calculations shall be averaged over a one-hour period.

NOTE The VDU outlet temperature is used to monitor the operation of the unit. It is not used in any calculations.

7.1.4.4 Calculations

a) Calculate the volume of vapour going to the VDU in standard cubic metres (see 7.1.4.4, Note 1)

$V_i = V_m \times (P_a / 101.3) \times ((T_{std} + 273) / (T_i + 273))$

where:

V_i = Volume of vapour going to the VDU inlet, corrected to 15°C (288 K) and 1 atm (101.3 kPa), scm

V_m = Volume of vapour going to the VDU inlet measured by flowmeter, scm (see 7.1.4.4, Note 2)

P_a = Absolute pressure in the pipe at the flowmeter inlet, kPa

T_{std} = 15°C, standard temperature

T_i = Average temperature of the vapour to the inlet, °C

b) Measure and calculate the average VDU flue gas concentrations for CO, CO_2 and HC_0, and the VDU inlet concentrations for HC_i

where:

CO = Average concentration of CO in VDU outlet, ppm volume

CO_2 = Average concentration of CO_2 in VDU outlet, ppm volume

HC_i = Average VDU inlet gas hydrocarbon equivalent concentration based on propane calibrant gas, parts per million in volume

HC_0 = Average VDU outlet gas hydrocarbon equivalent concentration based on propane calibrant gas, parts per million in volume

c) Calculate the VDU exhaust volume.

$$V_0 = V_i \times K_c \times HC_i / [(K_c \times HC_0) + CO_2 + CO - CO_{2a}]$$

where:

V_0 = Volume of exhaust gas from the VDU, corrected to 15°C (288 K) and 1 atm (101.3 kPa), scm

V_i = Volume of vapour going to the VDU inlet, corrected to 15°C (288 K) and 1 atm (101.3 kPa), scm

K_c = Calibration gas constant, 3 for propane, 4 for butane, or as appropriate for other calibrations

HC_i = Average VDU inlet gas hydrocarbon equivalent concentration based on propane calibrant gas, parts per million in volume

HC_0 = Average VDU outlet gas hydrocarbon equivalent concentration based on propane calibrant gas, parts per million in volume

CO_2 = Average concentration of CO_2 in VDU outlet, ppm volume

CO = Average concentration of CO in VDU outlet, ppm volume

CO_{2a} = Ambient CO_2 concentration, taken to be 300 ppm volume if not determined during the test

d) Calculate the mass of hydrocarbons discharged through the VDU vent, in milligrams of hydrocarbon per litre of gasoline loaded into cargo tanks.

$$W = K \times V_0 \times HC_0 / (G \times 10^2)$$

where:

W = Mass of hydrocarbon discharged through the VDU vent, per volume of gasoline loaded into cargo tanks, in mg/L

$K = 1.83 \times 10^6$ mg/scm, density of propane at 15°C

V_0 = Volume of exhaust gas from VDU, according to 7.1.4.4 c.

HC_0 = Average VDU outlet gas hydrocarbon concentration, percent by volume

G = Total quantity of gasoline loaded into cargo tanks, L (see 7.1.4.4, Note 3)

NOTE 1 One standard cubic metre (1 scm) is equivalent to 1000 L.

NOTE 2 V_m may be equated to the volume of products loaded onto tank cars, provided tank car and VDU connections are annually verified as vapour tight.

NOTE 3 The operator has the option to calculate G on the basis of the volume of gasoline loaded plus the diesel fuel switch loaded.

7.2 Cargo tank — The following test procedure is for determining the vapour tightness of cargo tanks equipped with vapour recovery systems. The overall performance of vapour recovery and vapour-balancing equipment throughout the distribution system relies on vapour tightness of cargo tanks. Cargo tanks are under slight pressure when loading and under slight vacuum when unloading. The leakage that can occur during loading or unloading will decrease the system efficiency. See figure 14 for some typical leak sources on cargo tanks.

7.2.1 Principle — Following purging to remove gasoline vapours, the cargo tank is pressurized with air or an inert gas to 4.5 kPa (18 in. of water), isolated from the pressure source and the pressure drop recorded to determine the rate of pressure change. A vacuum test is to be conducted in the same manner. The test equipment must incorporate PV type vents or functionally equivalent provisions to prevent over or under pressurizing the cargo tank.

7.2.2 Test conditions — The cargo tank shall be tested in a location where it is protected from direct sunlight to minimize interference from thermal effects. Testing of the entire cargo tank includes domes, dome vents, tank compartments, piping, hoses, hose connections, etc.

7.2.3 Test equipment

a) Source of air or inert gas of sufficient quantity to pressurize a cargo tank to +5 kPa (+20 in. of water) gauge pressure, with associated hoses and fittings.

b) Source of vacuum sufficient to depressurize a cargo tank to -2.5 kPa (-10 in. of water) gauge pressure, with associated hoses and fittings.

c) Liquid manometer or equivalent capable of measuring 5 kPa (20 in. of water) with a precision of ±0.025 kPa (±0.1 in. of water).

d) Low-pressure regulator for controlling pressurization of tank.

e) Test cap for the vapour line with a shut-off valve for connection to the pressure and vacuum supply hoses. The test cap is to be equipped with a tap for connecting the pressure-sensing device.

f) Caps for the liquid delivery line.

g) In-line, pressure-vacuum relief valve(s) set to activate at +6.8 kPa (+7 in. of water) and -2.5 kPa (-10 in. of water), with a capacity equal to the pressurizing or evacuating pumps.

h) Vacuum gauge with range to -2.5 kPa (-10 in. of water) and accuracy to ±0.025 kPa (±0.1 in. of water).

7.2.4 Procedures

7.2.4.1 Pressure test

See figure 15 for typical pressure test connections.

a) Purge the cargo tanks of gasoline vapour and test empty. The cargo tank may be purged by any safe method not in violation of other regulations. An example of such safe methods is the delivering of one complete load of diesel fuel or heating oil.

NOTE Purging gasoline vapours ensures that the vapour space is below the lower explosive limit (LEL) and that ambient conditions that would otherwise cause condensation of vapours or evaporation of liquid will not affect the results of the test.

b) Open and close the dome covers.

c) Connect static electricity ground connections to the cargo tank.

d) Cap the liquid delivery fittings. Attach the test cap to the vapour recovery line.

NOTE The operator has the option to do the pressure test with the vapour hose connected.

e) Connect the test equipment to the cargo tank.

f) For multi-compartmented cargo tanks equipped with a common vapour manifold, open all vent valves for the test.

g) Apply air or inert gas pressure slowly, pressurize the cargo tank, or alternatively the first compartment, to 4.5 kPa (18 in. of water).

h) Close the shut-off valve and allow the pressure in the cargo tank to stabilize. Record the start time and initial pressure.

i) At the end of 5 min, record the final time and pressure.

j) Repeat for each compartment, if they are not manifolded to the same vapour header.

k) Disconnect pressure source and release pressure from cargo tank.

7.2.4.2 Vacuum Test

a) Connect vacuum source to the cargo tank.

b) Slowly evacuate the cargo tank, or alternatively the first compartment, to 1.5 kPa (6 in. of water).

c) Close the shut-off valve and allow the vacuum (negative pressure) to stabilize. Record the initial vacuum (negative pressure) and time.

d) At the end of 5 min, record the final vacuum (negative pressure) and time.

e) Repeat for each compartment of a cargo tank not manifolded to the same vapour header.

f) Disconnect vacuum source and allow cargo tank to return to atmospheric pressure.

Annex A
(informative)

Provincial and territorial acts and regulations applicable to vapour control systems in gasoline distribution networks[4]

Provincial and territorial regulations

A1 British Columbia

A1.1 Requirements for gasoline vapour control

Requirements for Gasoline Vapour Control are controlled under the latest version of the *Gasoline Vapour Control Regulation* (B.C. Reg. 226/95).[5]

A2 Ontario

A2.1 Requirements for recovery of gasoline vapour

Requirements for recovery of gasoline vapour in bulk transfers is controlled under the latest version of *Recovery of Gasoline Vapour in Bulk Transfers* (O. Reg. 455/94).[6]

A3 Quebec

A3.1 General requirements

Communauté Métropolitaine de Montréal (CMM), Règlement -2001-10 (former règlement 90 of the Communauté Urbaine de Montréal (CUM)). Articles 6.14 to 6.21 of the *Règlement relatif à l'assainissement de l'air.*

[4] This list is not necessarily complete. It is the user's responsibility to refer to the appropriate regulations.

[5] Available from the British Columbia Ministry of Water, Land and Air Protection Web site at http://www.qp.gov.bc.ca/statreg/reg/E/EnvMgmt/498_95.htm. The official version of the legislation is available through http://www.qplegaleze.ca/default.htm, the Web site for the British Columbia Queen's Printer.

[6] Available from Ontario e-Laws Web site at www.e-laws.gov.on.ca/.

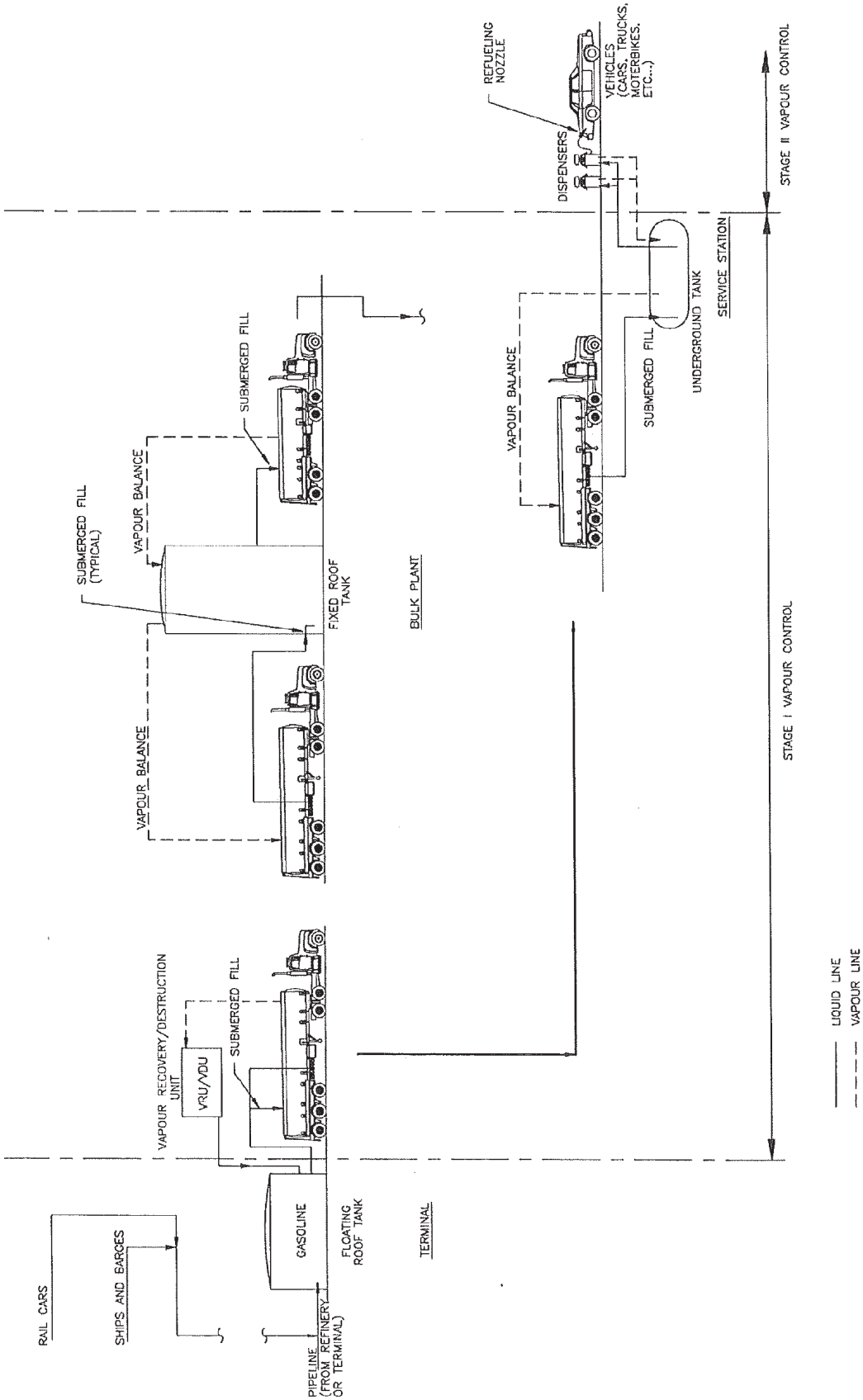


Figure 1 — Gasoline distribution network with vapour control systems (VCS)

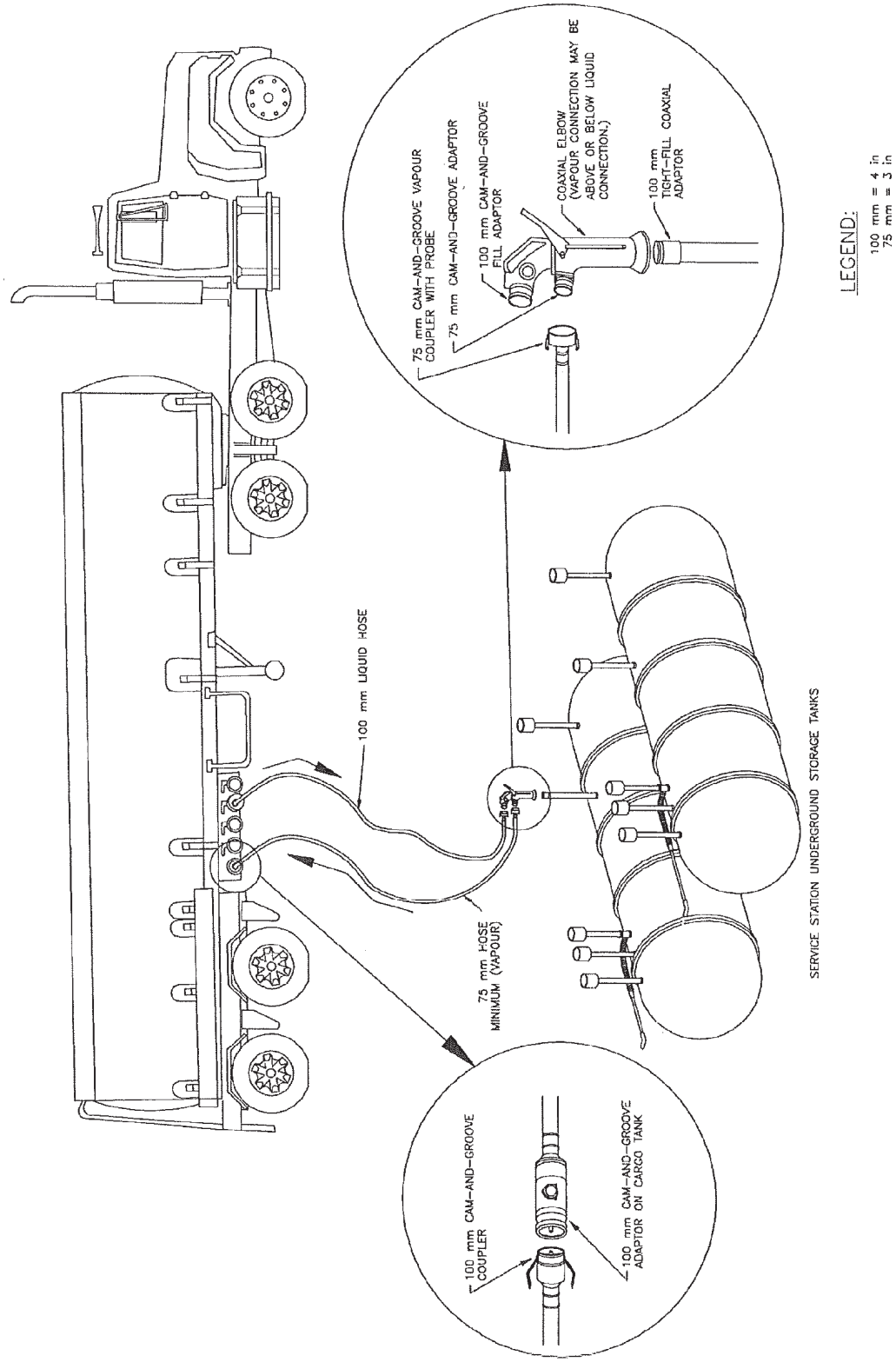


Figure 2 (typical) — Coaxial vapour control system

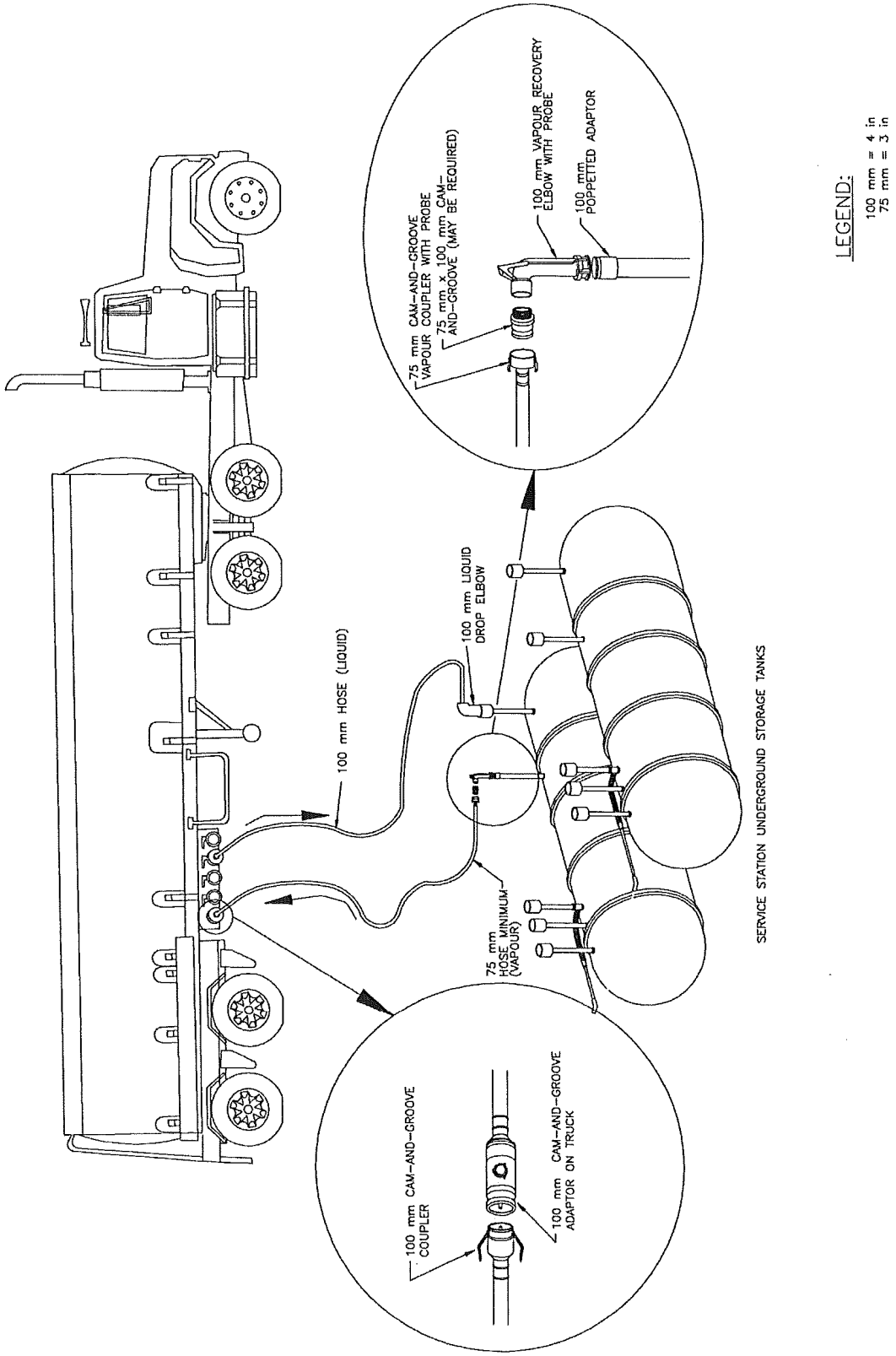


Figure 3 (typical) — Dual point vapour control system

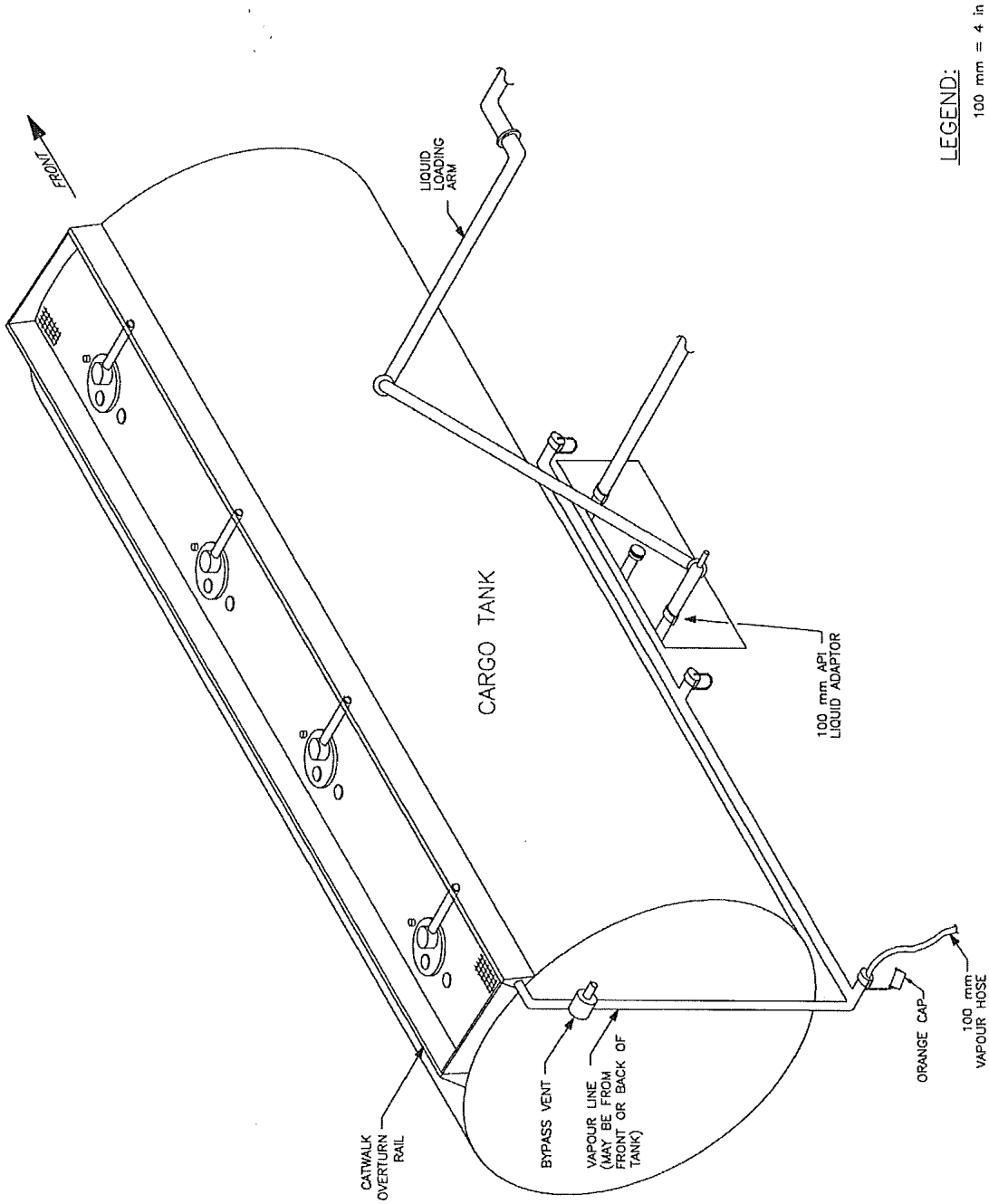


Figure 4 (typical) — Cargo tank bottom loading

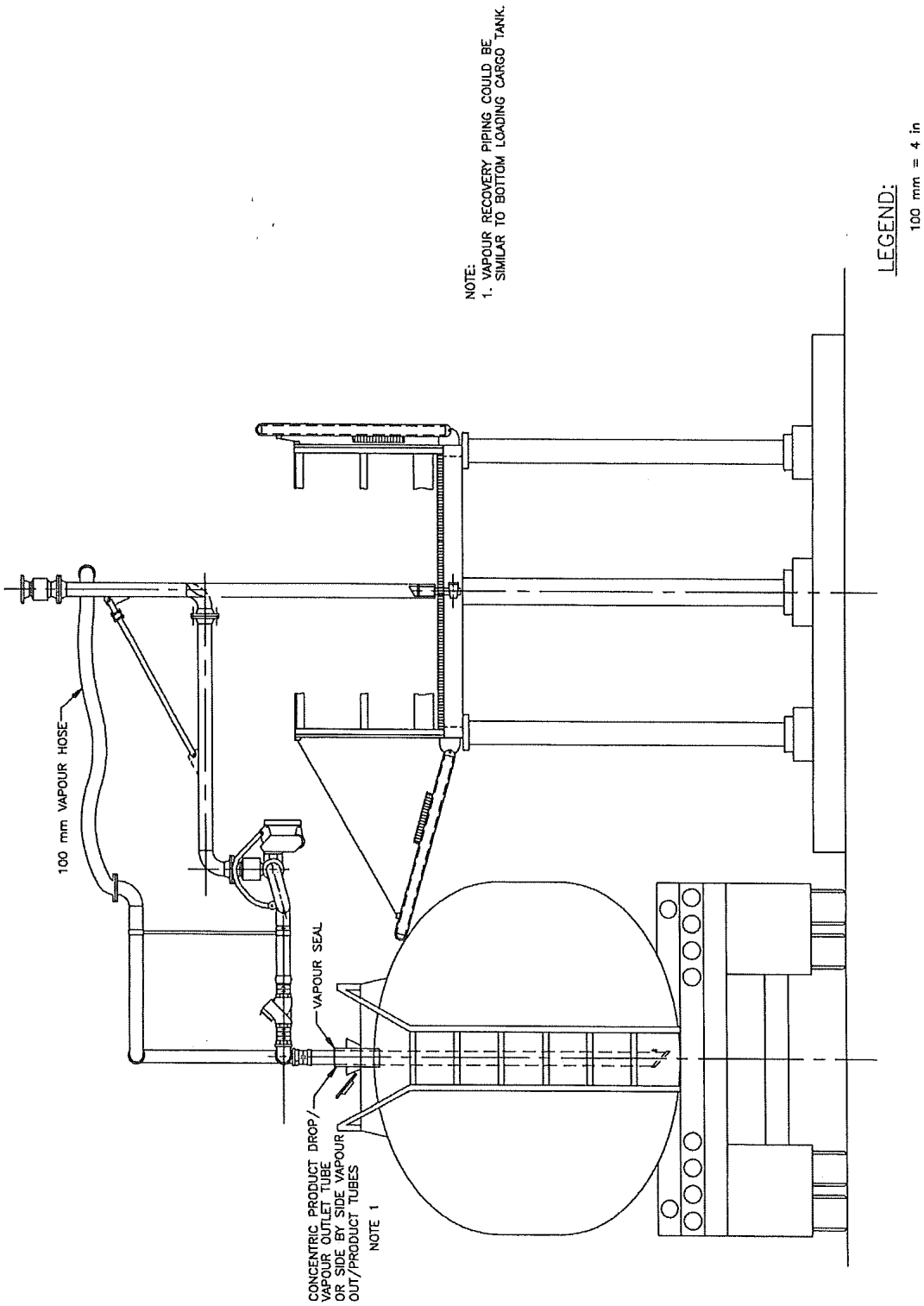


Figure 5 (typical) — Vapour recovery with product drop tube cargo tank top loading

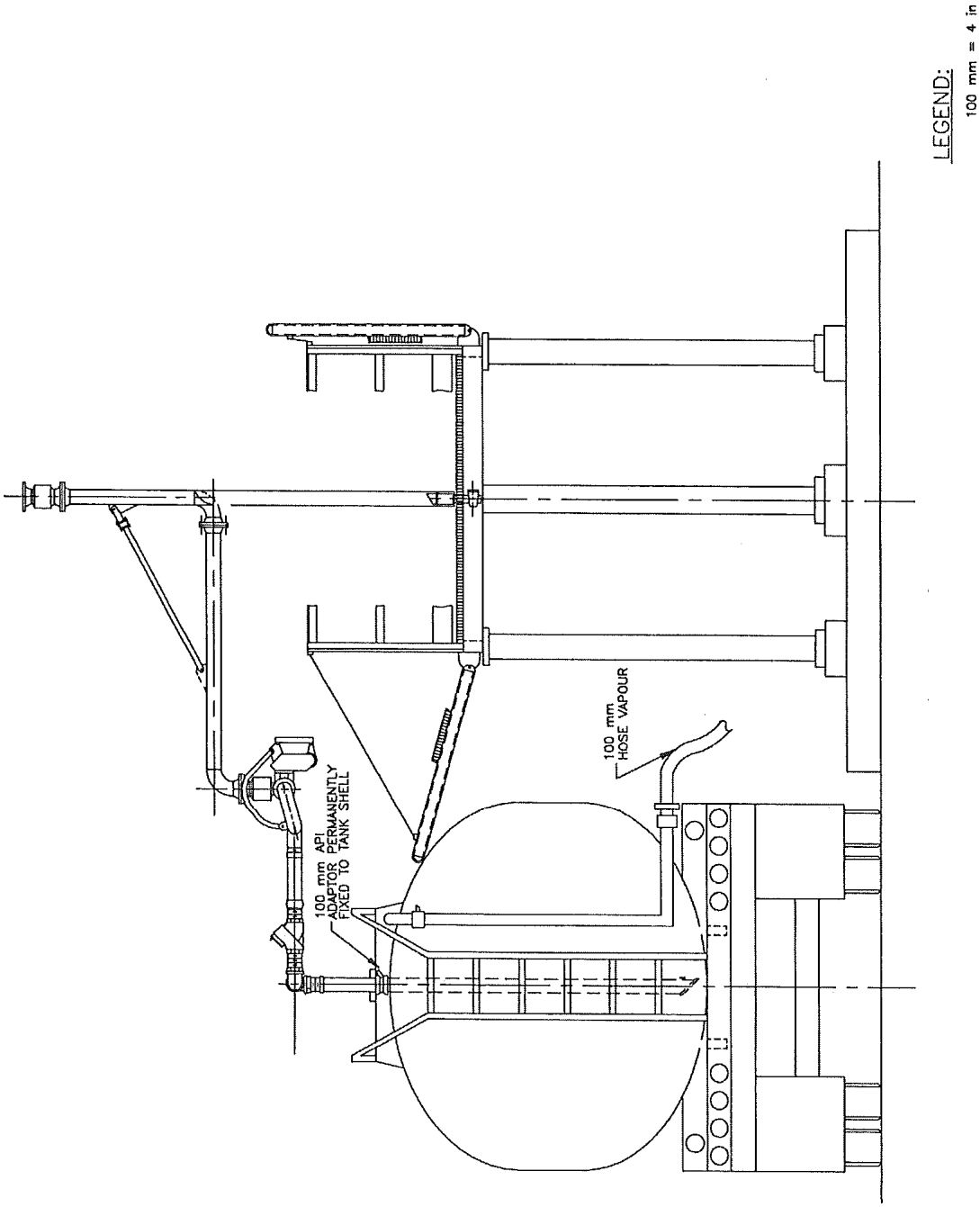
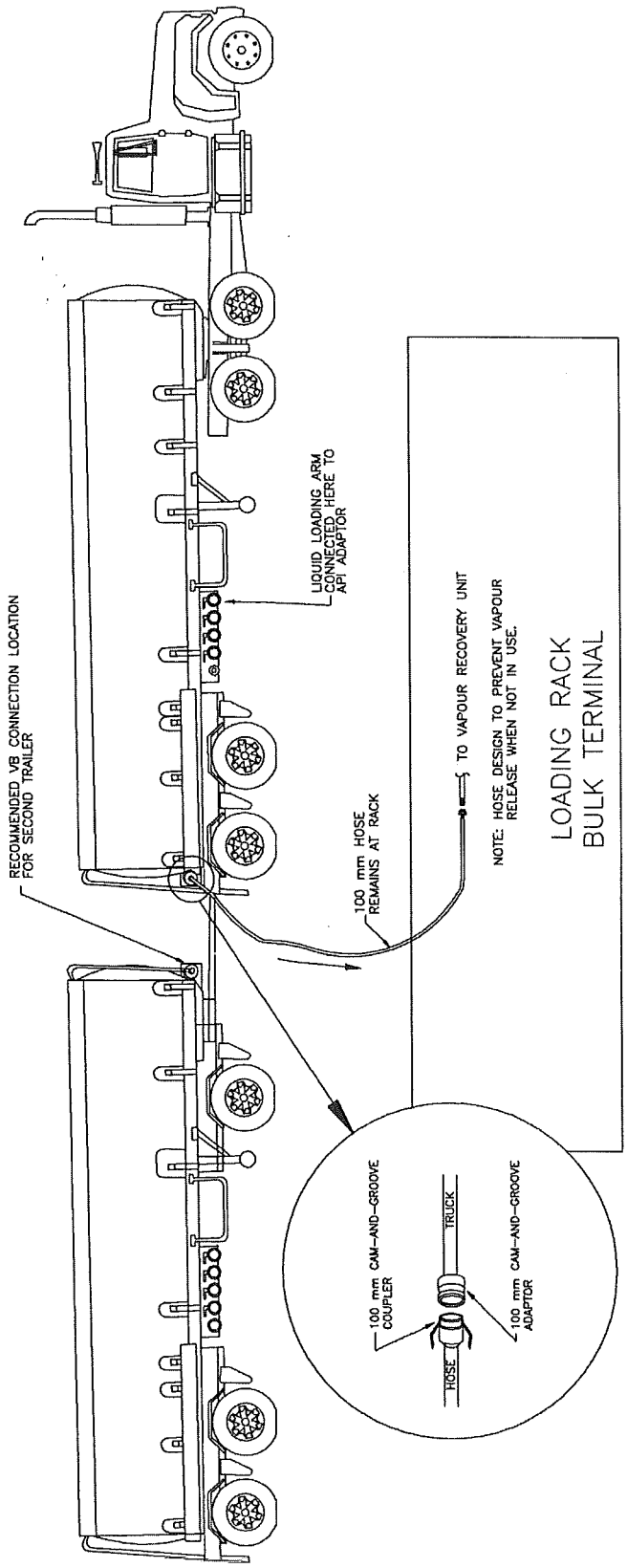
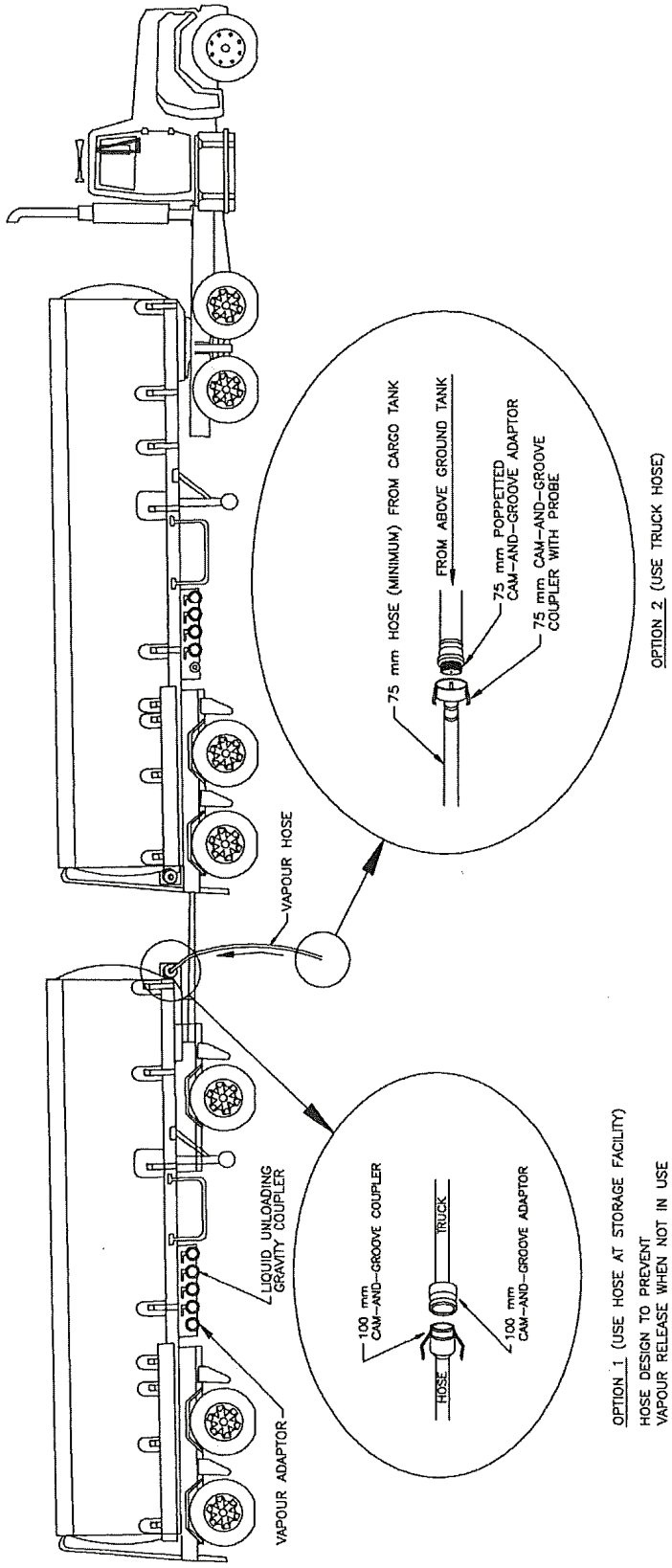


Figure 6 (typical) — Vapour recovery with top tight fill cargo tank top loading



LEGEND:
100 mm = 4 in

Figure 7 (typical) — Terminal vapour control connections



LEGEND:
100 mm = 4 in
75 mm = 3 in

Figure 8 (typical) — Bulk plant vapour control connections

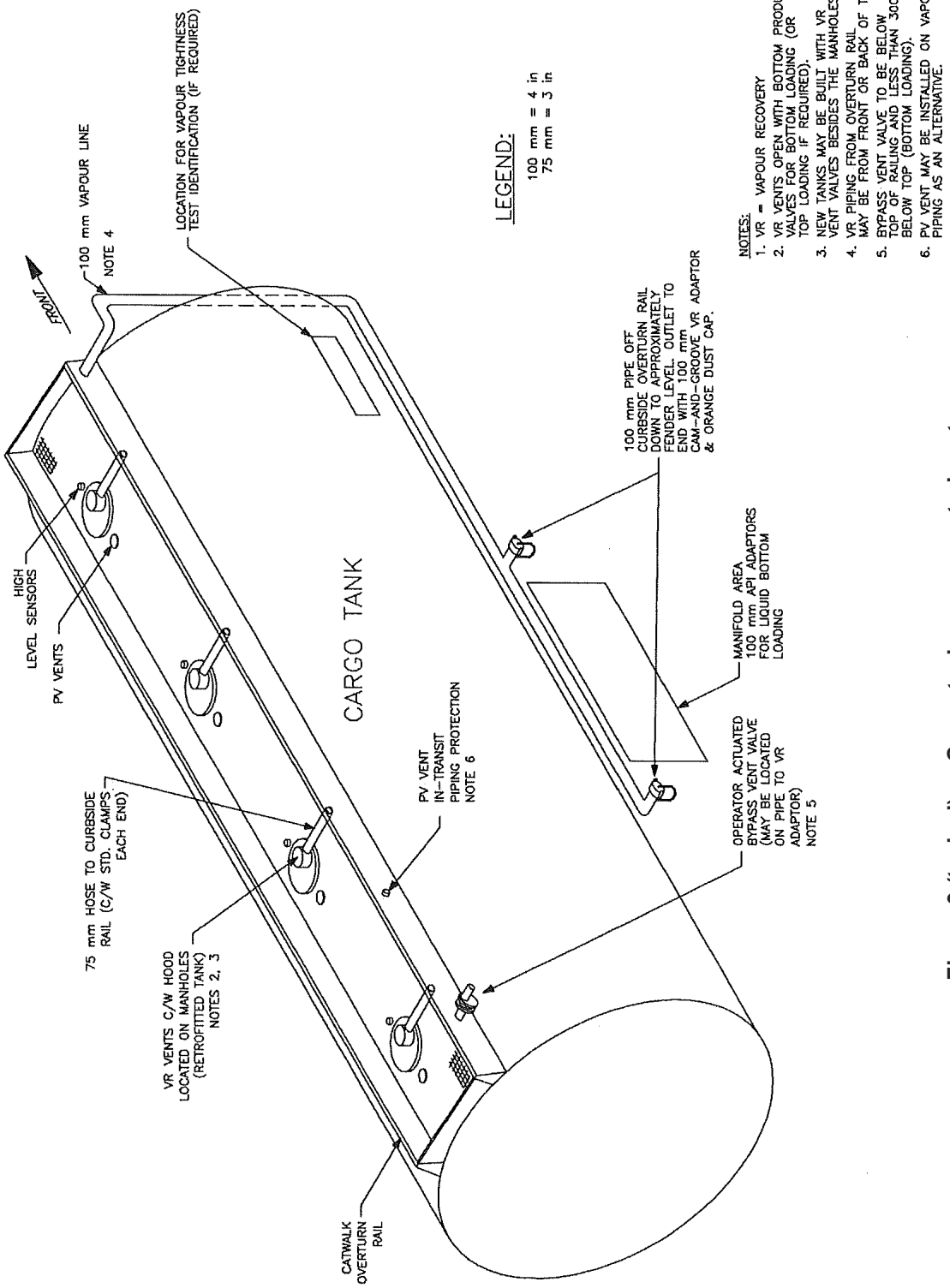


Figure 9 (typical) — Cargo tank vapour control system

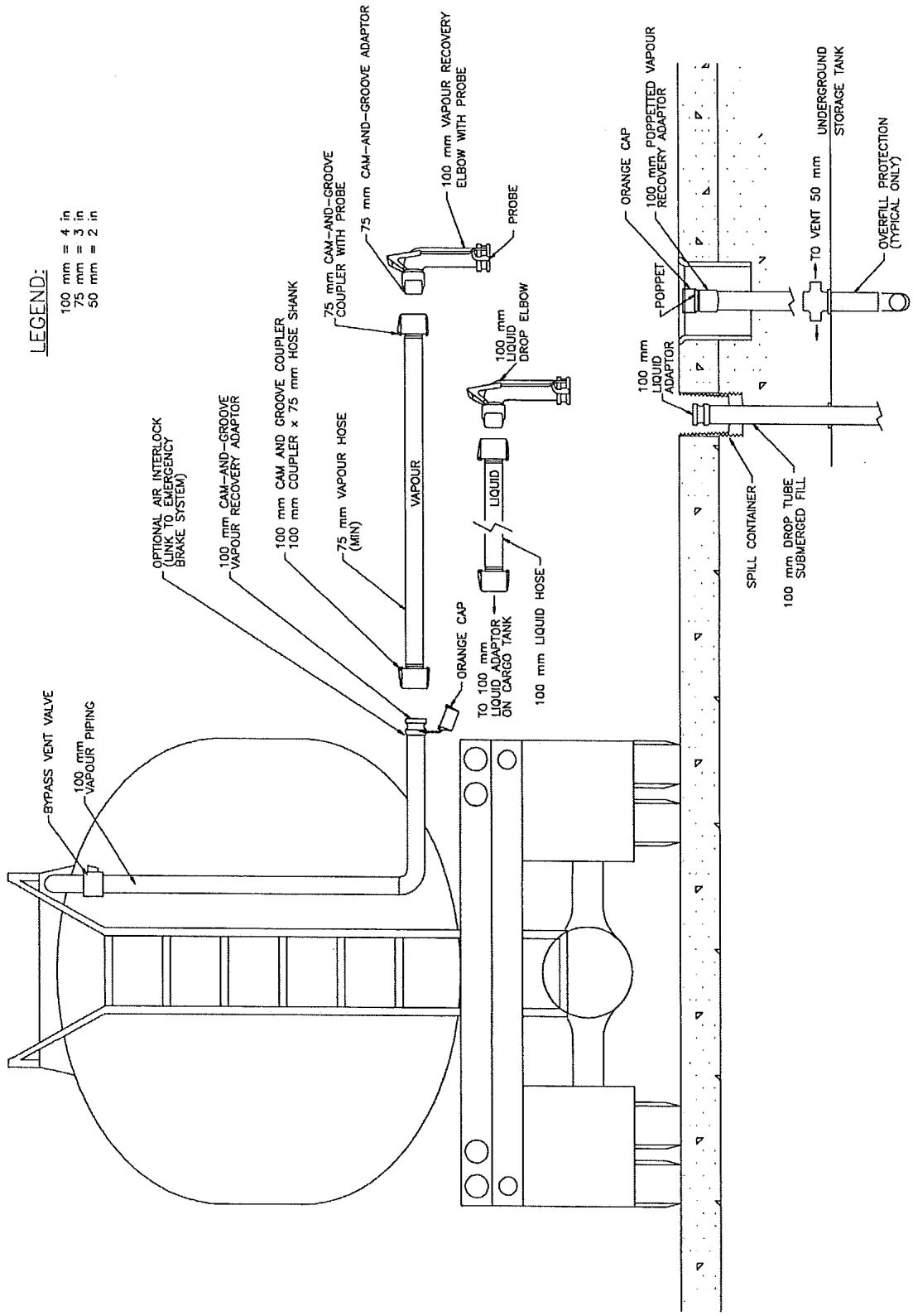


Figure 10 (typical) — Dual point vapour balance connections

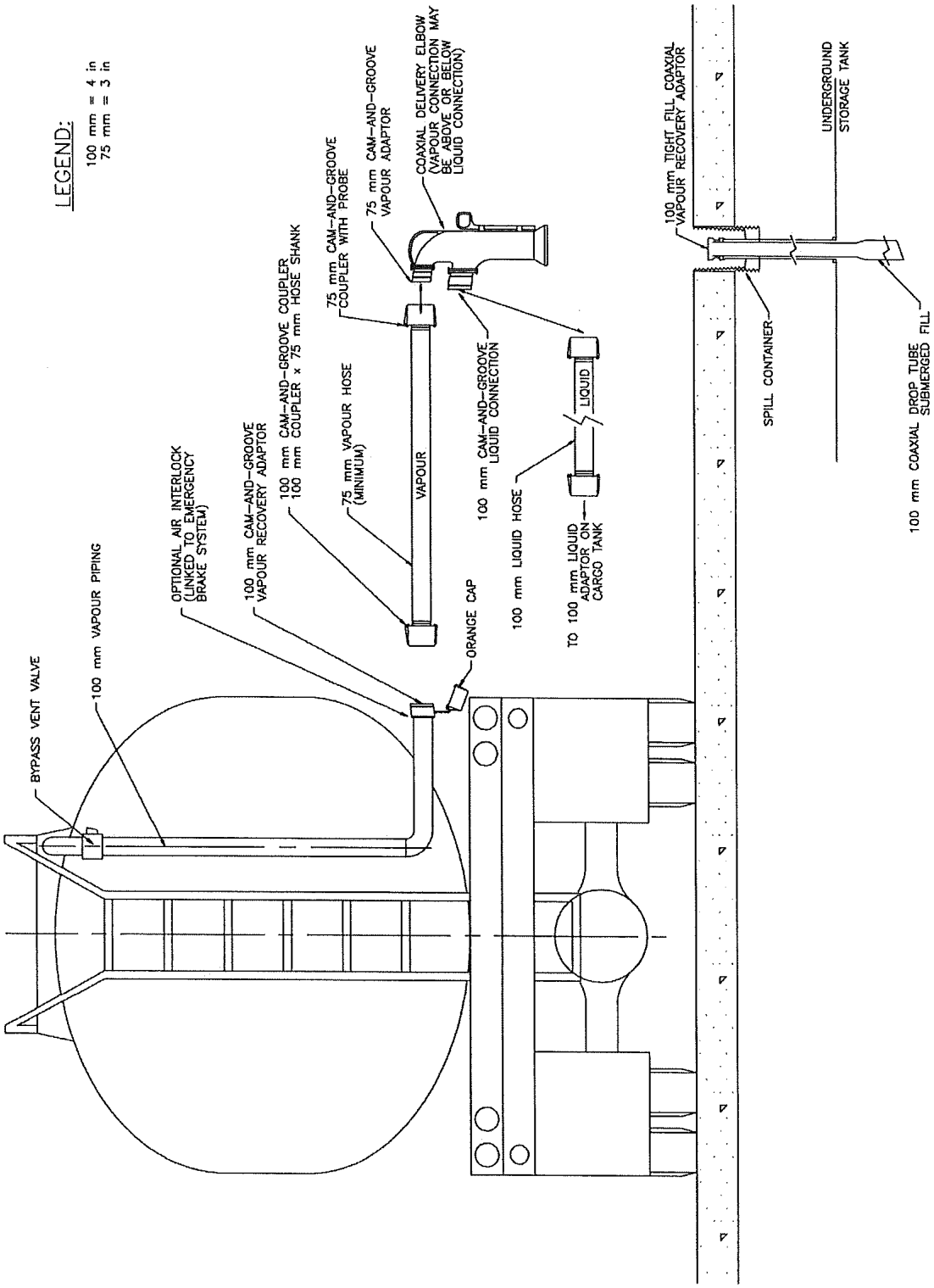


Figure 11 (typical) — Coaxial vapour balance connections

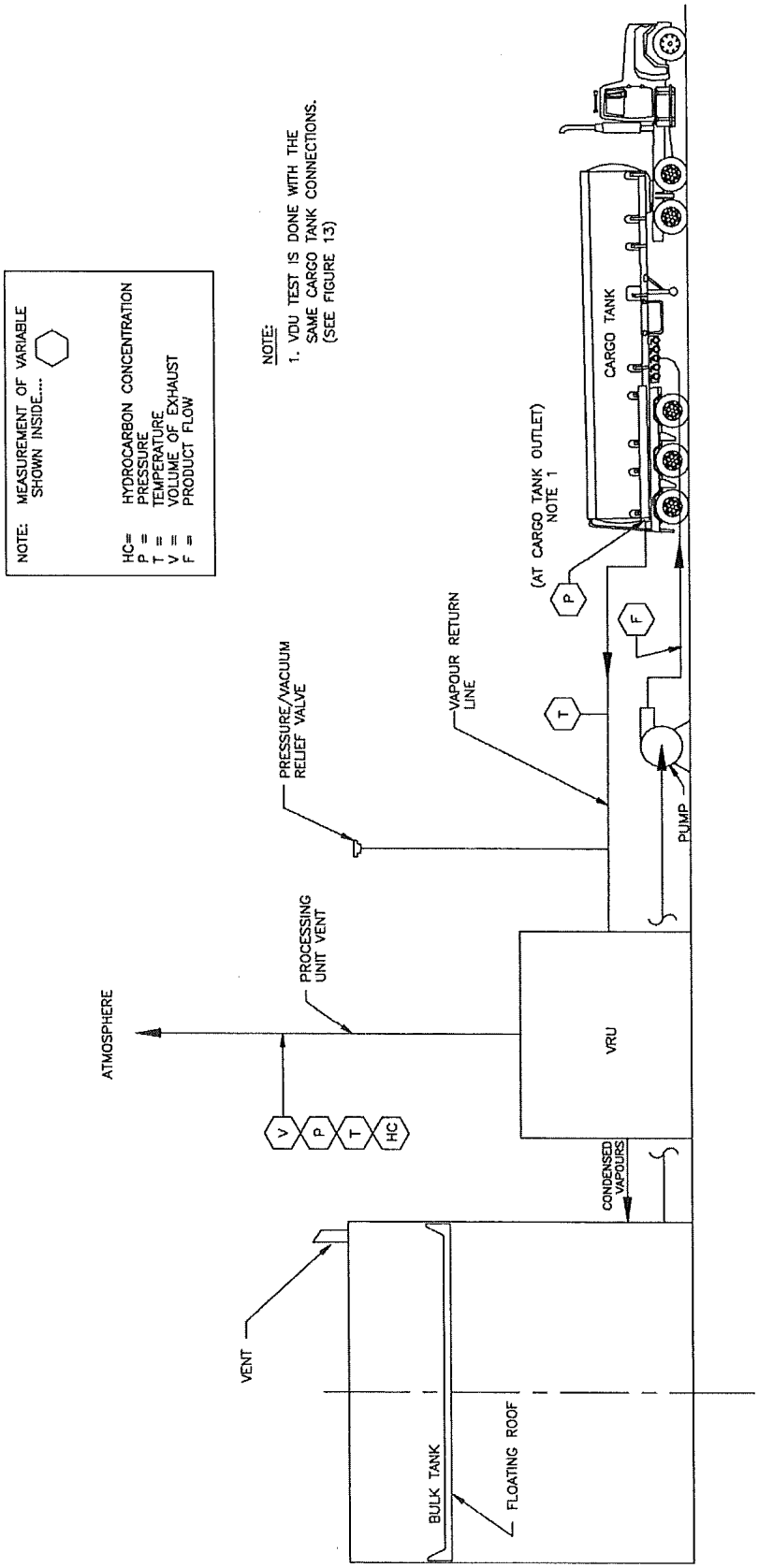


Figure 12 (typical) — VRU test method connections

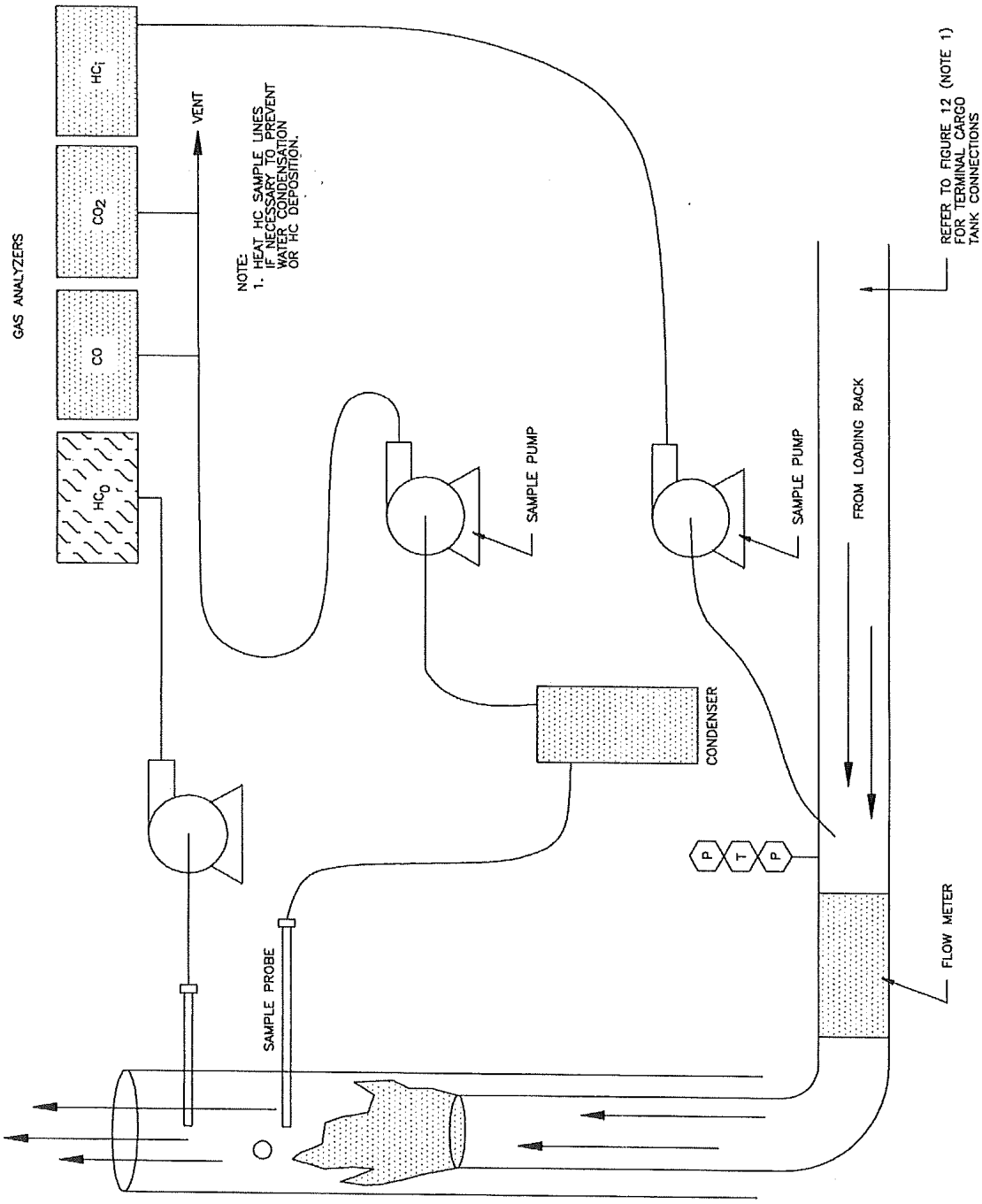


Figure 13 (typical) — VDU sampling diagram

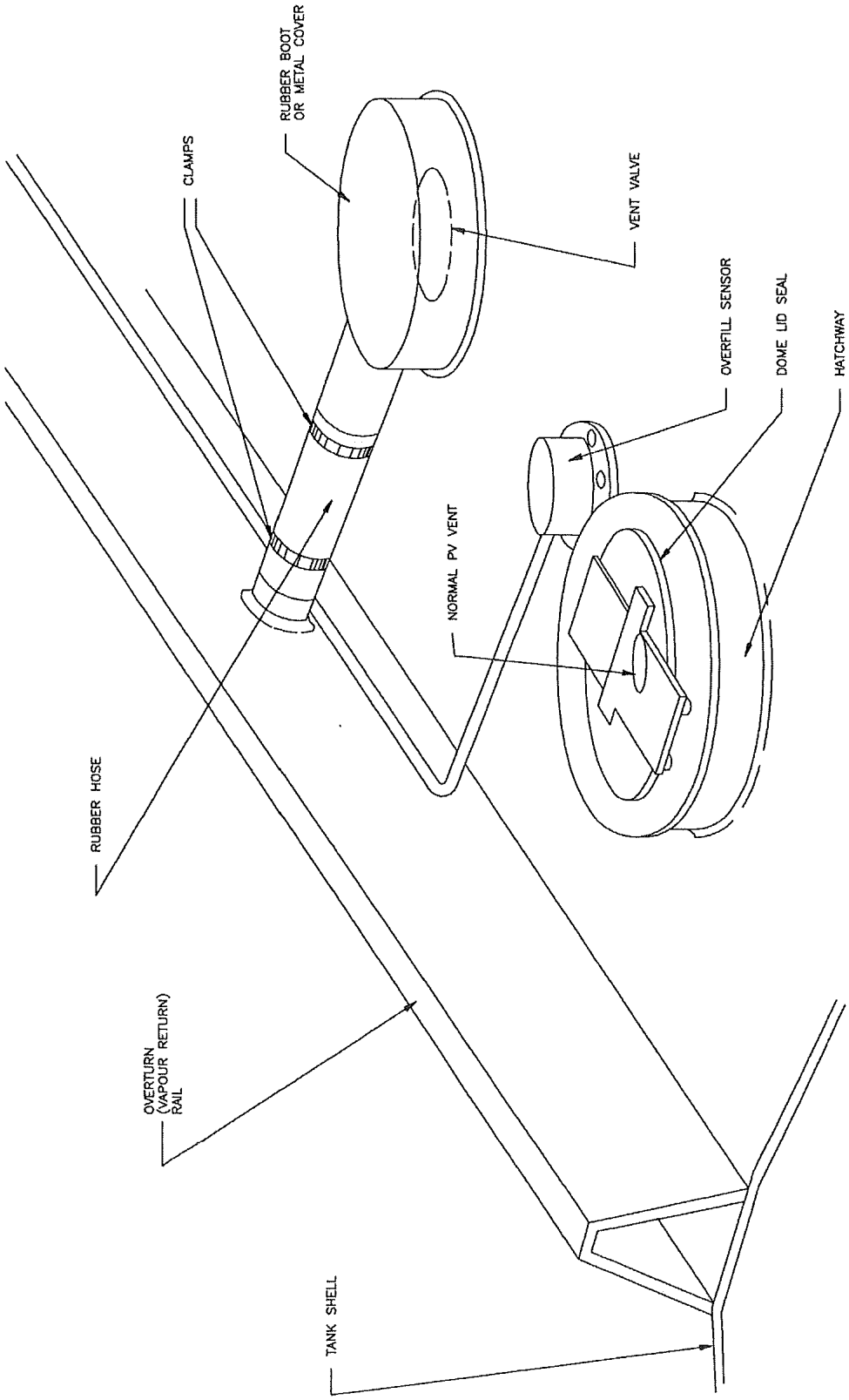


Figure 14 (typical) — Vapour leakage points on a tank truck compartment (bottom loading only)

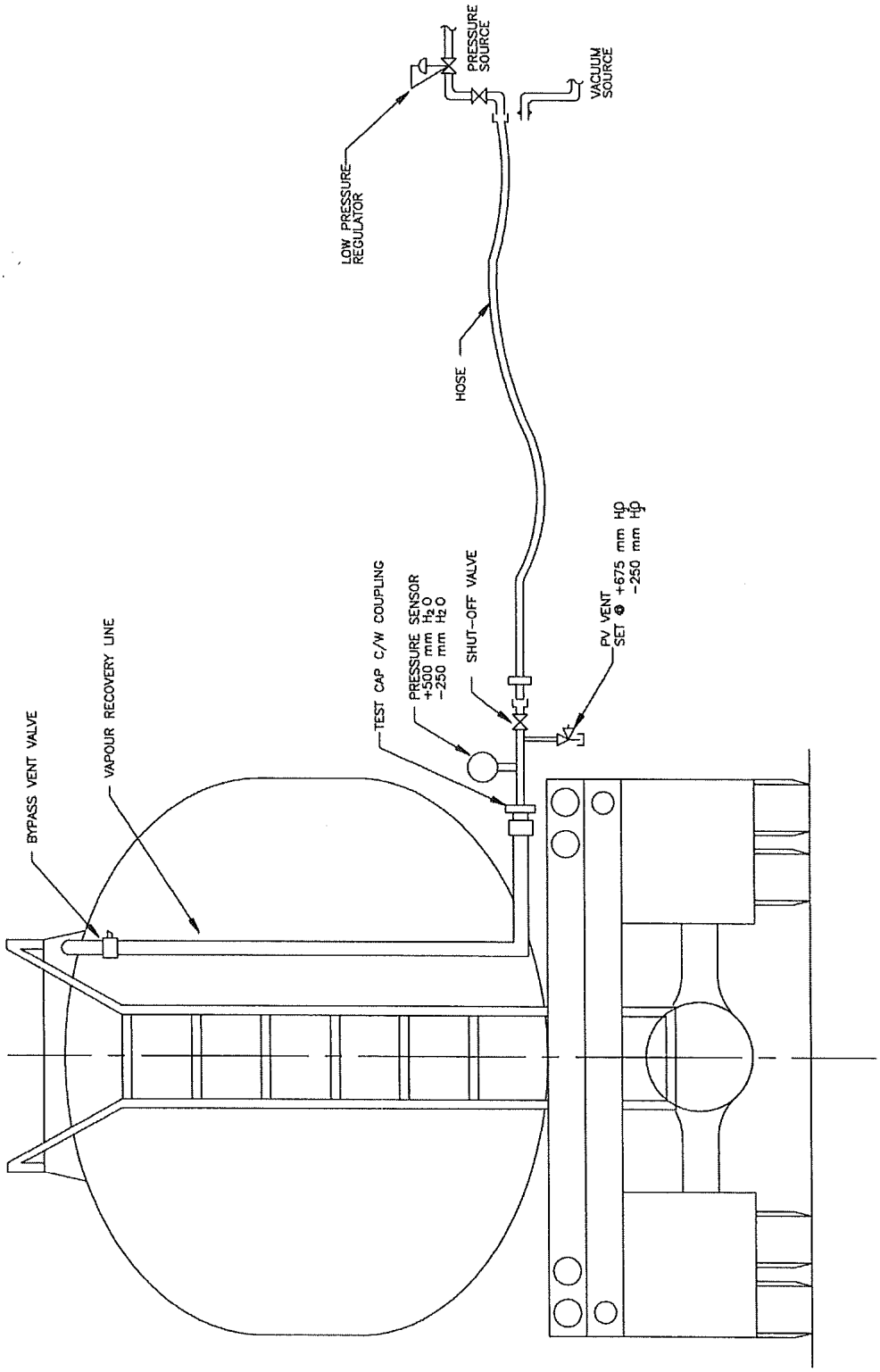


Figure 15 (typical) — Cargo tank truck testing connections

Bibliography

[1] CAN/CGSB-3.5, *Unleaded Automotive Gasoline*

[2] CAN/CGSB-3.511, *Oxygenated Unleaded Automotive Gasoline Containing Ethanol*

[3] CAN/CGSB-3.512, *Automotive Ethanol Fuel (E50–E85)*

[4] Truck Trailer Manufacturers Association (TTMA). Recommended Practices and Technical Bulletins

[5] U. S. Environmental Protection Agency (EPA). *Code of Federal Regulations (CFR)* : *Title 40: Protection of the Environment — Part 60: Standards of Performance for Stationary Sources*

Appendix A-4:

Method 10 — Determination of Carbon Monoxide Emissions From Stationary Sources

Appendix A-7:

Method 25 — Determination of Total Gaseous Non-Methane Organic Emissions as Carbon

Method 25A — Determination of Total Gaseous Organic Concentration Using a Flame Ionization Detector

Method 25B — Determination of Total Gaseous Organic Concentration Using a Non-dispersive Infrared Analyser

Appendix A-8:

Method 27 — Determination of Vapour Tightness of Gasoline Delivery Tank Using Pressure-Vacuum Test.