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DRAFT EAST AFRICAN STANDARD

Handling, storage and distribution of liquefied petroleum gas in domestic, commercial, and industrial installations — Code of practice — Transportation of LPG in bulk by road, rail and sea

EAST AFRICAN COMMUNITY

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Foreword

Development of the East African Standards has been necessitated by the need for harmonizing requirements governing quality of products and services in the East African Community. It is envisaged that through harmonized standardization, trade barriers that are encountered when goods and services are exchanged within the Community will be removed.

The Community has established an East African Standards Committee (EASC) mandated to develop and issue East African Standards (EAS). The Committee is composed of representatives of the National Standards Bodies in Partner States, together with the representatives from the public and private sector organizations in the community.

East African Standards are developed through Technical Committees that are representative of key stakeholders including government, academia, consumer groups, private sector and other interested parties. Draft East African Standards are circulated to stakeholders through the National Standards Bodies in the Partner States. The comments received are discussed and incorporated before finalization of standards, in accordance with the Principles and procedures for development of East African Standards.

East African Standards are subject to review, to keep pace with technological advances. Users of the East African Standards are therefore expected to ensure that they always have the latest versions of the standards they are implementing.

The committee responsible for this document is Technical Committee EASC/TC 038*, Liquefied Petroleum and Natural Gas Equipment and Accessories.*

Attention is drawn to the possibility that some of the elements of this document may be subject of patent rights. EAC shall not be held responsible for identifying any or all such patent rights.

Handling, storage and distribution of liquefied petroleum gas in domestic, commercial, and industrial installations — Code of practice — Part 2: Transportation of LPG in bulk by road, rail and sea

1 Scope and field of application

1.1 This draft East African Standard outlines the code of practice to be followed while transporting Liquefied petroleum gas in bulk by road, rail and sea.

1.2 This standard does not cover transportation of LPG in cylinders.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2928, *Rubber hoses and hose assemblies for liquefied petroleum gas (LPG) in the liquid or gaseous phase and natural gas up to 25 bar (2,5 MPa) -- Specification*

IEC 60079; Part 1-25

EAS 901, *Inspection and testing of Liquefied Petroleum Gas (LPG) road tankers*

EAS 902, *Bulk Liquefied Petroleum Gas (LPG) road tankers — Assembling — Requirements*

EAS 903, *Road tankers — Welded steel tanks for Liquefied Petroleum Gas (LPG) — Design and manufacture*

IEC 60079 -10, *Explosive atmospheres — Part 10: Classification of areas - Explosive gas atmospheres*

IEC 60079-14, *Explosive atmospheres — Part 14: Electrical installations design, selection and erection*

IEC 60079-17, *Explosive atmospheres — Part 17: Electrical installations inspection and maintenance*

ASME B31, *Piping and piping systems*

BS 3351, *Piping systems for petroleum refineries and petrochemical plants*

BS 3602, *Specification for steel pipes and tubes for pressure purposes: carbon and carbon manganese steel with specified elevated temperature properties*

BS 4089, *Rubber hose and hose assemblies for liquefied petroleum gas lines*

IP 250, *Petroleum measurement tables based on a reference temperature of 20 ºC*

ASTM-IP,

ISO 3874, *Series 1 freight containers — Handling and securing*

International Maritime Organization (IMO) code for the construction and equipment of ships

NFPA section 59 regulation 4.5

International Safety Guide for Oil Tankers and Terminals) (ISGOTT) safety guidelines

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
approved
that which has been authorised by the approving authority

3.2
approving authority
within the scope of the relevant competent authority(ies) in the Partner States

3.3
filling ratio
ratio of the mass of LPG introduced into a storage vessel to the mass of water (determined at, or corrected to, 20 ˚C) that would fill the storage vessel

NOTE The term filling ratio applies when the filling of a liquefied gas into a storage vessel is controlled by the mass of the gas introduced.

3.4
LPG (Liquefied Petroleum Gas)
pure propane, butane or a mixture of the propane and butane

3.5
maximum working pressure
the maximum internal pressure that is permitted for a tank during service

3.6
semi-trailer
a trailer having no front axle and designed such that at least 15 % of its tare is superimposed on and borne by a vehicle drawing the trailer

3.7
tank
a pressure vessel designed for the conveyance of commercial propane, and where applicable complying with legislation in Partner States

NOTE A tank that is suitable for the conveyance of commercial propane may also be used to convey commercial butane and LPG mixtures.

4 Bulk handling for movement by road

LPG shall be moved in tank trucks by road. These trucks shall be designed and manufactured by competent firms and approved by competent authorities .

The trucks shall be fitted with various devices in accordance with EAS 901, EAS 902 and EAS 903.

4.1 Loading and unloading facilities

Each loading and unloading facility shall consist of the following:

a) Liquid and vapour lines shall be fitted with pressure gauge, isolation valve and either an excess flow valve or break away coupling or both.

b) . In case of loading with vapour compressor only , a vapour return line with an isolation valve connected back to the storage vessel from which the loading compressor is drawing LPG. The vapour line be protected with an excess flow valve or break away coupling'

c) suitable loading arm/flexible hoses as per ISO 2928 shall be provided at the end of filling and vapour return lines for connecting to the tank truck vessel.

d) Where applicable weigh bridges of suitable capacity / mass flow meters shall be provided for custody transfer of product by mass otherwise LPG tanks should be filted with level gauges and valid calibration chart'

e) An excess flow valve or a break away coupling shall be provided in the vapour return line.

Typical sketches of loading and unloading facilities are as shown in Annex C and E respectively

A typical sketch of.

4.2 Safety precautions

a) Transfer of LPG to or from a tank truck requires special attention as accidental movement of vehicle may cause rupture in the transfer equipment.

b) No source of ignition shall be allowed in the area where loading and unloading of LPG is carried out.

c) Adequate firefighting extinguishers and firefighting system where applicable shall be available near the tank trucks during loading and unloading'

d) After positioning the truck, proper earthing connections shall be provided and shall be disconnected just before the release of the truck.

e) plugs or caps, shall be cracked open before removing to allow for release of trapped LPG and to ensure that the valves are effectively sealed.

f) Hoses shall be handled with care and inspected periodically as per ISO 2928.

g) While disconnecting hoses/pipes, connections shall be loosened only slightly at first to allow release of trapped pressure, if any.

h) personal protective equipment shall be be used while making or breaking the connections to avoid cold burns.

i) Suitable gas leak detection system may be provided.

j) The master switch shall be put off immediately after parking the truck in position. No electrical switch on the truck shall be turned " on" or " off" during the loading and unloading.

k) No repairs shall be made on the truck while it is in the loading and unloading area.

l) New tank truck vessels or vessels received after repair shall be purged before loading..

m) It is recommended that the receiving vessel having a pressure of less than 1 bar should not be filled. Such vessel shall be checked for oxygen content/explosive mixture and purged, if necessary.

n) Venting and purging of LPG during loading and unloading should not be carried out in an open atmosphere. It should be piped to a suitable flare system. Where such facility does not exist, vent pipes shall be provided to carry the LPG to a safe distance and released at a height not less than 3 m above the highest point of any building, shed or structure within 15 m radius. Snuffing steam facility may be provided for the vent line.

o) loading and unloading shall be stopped immediately in the event of;

i) leakage occurring;

ii) A fire occurring in the vicinity

iii) Lightning and thunder storm

p) Loading and unloading operations shall not be undertaken in the darkness unless flame proof lights are provided.

4.3 Procedures for operation

4.3.1 Loading operations

a) The following shall be checked in a tank truck before accepting it for filling:

— At least two safety valves are provided on the vessel.

— Fixed tube gauge is provided.

— Excess flow valve is provided.

— Pressure gauge is provided.

— Temperature gauge is provided.

— Fire screen between cabin and vessel is provided.

— 2 Nos. of 9 kg dry chemical powder fire extinguishers are provided.

— Spark arrestors of approved quality are fitted.

— No leakage in exhaust silencer pipe exists.

— Manufacturer's name plate with date of testing is fitted on the vessel.

— Valid explosive licence is available.

— Approved drawings of vessel are available.

— Blind flanges/caps are provided on vessel.

— Earthing cable is provided.

— Bonding between vessel and chassis is satisfactory.

— Bonding between flanges in manifold is satisfactory.

— Excess flow valve and control valve are available on water drain line.

— Bonding point is available.

— Third party inspection/test certificates for vessel/fittings are available and valid

— Liquid / vapour line valves are in good condition.

b) The truck shall be moved to the loading bay/weigh bridge and the tare weight of the empty tank truck recorded.

c) Residual LPG pressure shall be Checked and recorded using fitted devices.

d) The truck shall be stopped on a levelled ground and chock blocks placed at the front and rear wheels.

e) the engine shall be stopped and all electrical equipment shall be switched off.

f) All persons shall leave the driver's cabin.

g) Fire extinguishers shall be readily available.

h) bonding connections of the vehicle shall be made at specified point to the fixed grounding system.

i) liquid line and vapour lines shall be connected with the loading point

Note: Hoses should not be passed under the loading/offloading truck). The valves should be cracked open on loading and vapour return lines and inspection of hoses and connections for leakage. Loading should start only when the system is leak free.

j) the loading pump/compressor shall be started.

k) The quantity loaded into the truck may be determined by;

i) Liquid level;

ii) Weighing; and

iii) Positive displacement meter.

l) Liquid level may be determined by roto-gauge, magnetic gauge or fixed liquid level gauge. Percentage volume to be filled should be pre-determined.

m) Where weigh-bridge is used, it is necessary to determine the density of the product being loaded to avoid excess filling in terms of volume. The weigh bridge shall be periodically calibrated and stamped by relevant Authorities in Partner States.

n) Whether a gauging device is used or a weigh bridge is employed for filling operation, when the liquid content is approximately within 5% of the safe filling level, the operator should be in a position to control the shut off valve and starts to close the valve as the safe filling level approaches.

o) When the filling operation is in progress, the pressure within the tank truck vessel should be observed to ensure that it does not approach the start-to-discharge pressure of the relief valve. Filling rate may be regulated as required.

p) The couplings may then be removed and plugs/caps replaced on the tank truck valves. Recheck for leaks from the plugs/caps shall be done. In case of any leaks, they shall be rectified before commencement of transfer operations

q) All the operations shall be attended to by the driver and the loader at all times to actuate the stop button in the case of emergencies.

r) The loadings shall not exceed the load axle limits stipulated in the EAC regulations

4.3.2 Unloading operation

Operations prescribed below should be carried out.

a) Liquid line and vapour line of the tank truck should be connected to the respective hoses fixed to the unloading point.

b) Test the connections for leaks by slightly opening the valves for pressurising. When satisfied, valves on the tank truck and the receiving vessel should be opened.

c) Start the evacuation compressor..

d) Ensure that the pressure created within the delivering vessel does not reach or exceed the set pressure of the relief valve.

e) An authorised person of the company should supervise the unloading and loading and respond immediately in the event of an emergency.

f) After the liquid has been expelled, the vapour recovery operation should be started. Ensure that the pressure of the delivering vessel is not below 1.5 bar.

Operations prescribed in 4.3.1(a) should now be carried out.

4.3.3 Unloading at customers site

For all bulk deliveries the customer shall provide an assistant for the driver during the discharging operations, or an assistant shall accompany the driver.

The following is a typical unloading procedure at the customer`s site:

a) Properly position the bulk truck for unloading and stop engine. The truck cab shall face the exit.

b) Set the hand brake to 'on' position. Place chocks at the wheels of the bulk truck to prevent it from moving. Set brake interlock.

c) Isolate truck electrics where necessary.

d) Cordon off the area, put safety signages “LPG Unloading in Progress Keep Clear” and deploy fire extinguishers at convenient nearby location.

e) Ensure there are no naked lights or work where sparks can be generated in the area.

f) Ground or bond the bulk truck.

g) Check quantity of LPG in the customer's storage tank and ensure adequate space is available to take product from the bulk truck.

h) .

Hook up the discharge hose from the bulk truck to the inlet of the storage tank. Also hook up the vapour return line if it is installed. Vapour return line can only be used where delivery is recorded by using a weighbridge ,level gauges and valid calibration chart.

i) Take initial readings and open all the valves to the storage tank, leaving the truck valves closed. Check for leaks. j) When the absence of any leak is confirmed, open the truck vapour valve followed by the liquid valve, restart the truck engine and begin discharge operations.

k) Check flow through the delivery meter on bulk truck as well as from rotary gauge/ magnetic gauge on storage tank.

l) Once the desired quantity or level is reached, stop the pumping operations. Shut off the truck engine.

m) Isolate all valves.

n) where applicable, disconnect discharge and vapour hoses.

o) Remove the grounding or earthing connections.

p) Take the readings of level in the storage tank using rotary gauges/magnetic gauge as well as quantity discharged from bulk truck. Ensure the tank has not been overfilled. In case of overfilling the driver shall secure the customers tank and call in gas expert for emergency instruction.

NOTE 4: Ensure the tank has not been overfilled ,

q) Inspect the area again, checking that the storage tank and bulk truck are leak-free.

Remove the chocks from under the wheels of the bulk truck and open the barricade in the area After discharging operation of bulk LPG is completed.

Warning unloading the bulk truck shall not be done during lightning or rainstorm.

The unloading operation shall be fully attended by the bulk truck driver and the customer's representative, when provided, at all times. The driver shall stop the operation, if the driver needs to move away from the off-loading point, for any reason, unless accompanied by a fully trained assistant.

As with all bulk LPG transfers, the driver and the assistant shall wear protective clothing.

The essential checklist instructions shall be posted on a sign board at the customer bulk LPG fill point.

5 Bulk handling for movement by rail

LPG is moved in tank wagons by the railways. These wagons shall be designed and manufactured by a competent firms and approved by competent authorities.

5.1 Facilities

5.1.1 Loading

Each loading point shall consist of the following:

a) A filling line with excess flow check valve and an isolation valve.

b) A vapour line with a check valve and an isolation valve to be connected back to the vessel from which LPG is drawn.

c) Flexible hoses with break-away couplings to be connected with the filling and the vapour return lines.

d) A check valve to be provided at the end of flexible hose with the filling line.

A typical sketch of loading facility is shown in Annex C.

5.1.2 Unloading

Unloading of LPG from tank wagons shall be done with the help of compressor.

NOTE The compressor is used to create a differential pressure between the receiving and discharging vessels by withdrawing vapours from the receiving vessel and forcing it at high pressure into the discharging vessel thereby establishing a smooth flow.

The content of tank wagons can be ascertained by weighing on weighbridge before and after emptying or, alternatively, the quantity can be determined based on wagon gauge readings and differential in storage tank gauge readings before and after receipt, wherever physical weighing is not possible.

5.2 Safety precautions

a) the locomotive shall not be allowed to come on the weigh bridge due to its capacity limitation. Sufficient number of dummy wagons may be used to avoid locomotive coming closer to the gantry.

b) In the event of a leak:

   i) the loading pump/compressor shall be stopped.

   ii) the movement of locomotive on the adjoining rails shall be stopped.

   iii) all internal combustion engines that may be running in the nearby area shall be switched off.

   iv) hot works, if any, in the within the facility shall be stop.

   v) all the vehicular traffic in the vicinity shall be stop.

   vi) In the event of a leak, water monitors shall be started to form a blanket covering the leak and the wagon/piping from which LPG is coming out.

   vii) Emergency response team shall be put on alert and where available the fire engine with crew shall be put on standby

   viii) All the maintenance jobs in the area shall be stop.

   ix) The system shall be depressurised before attending to the leak.

   x) if the leak is from wagon, immediate steps shall be taken to decant the wagon.

   xi) the area shall be cleared of all the people except those who are required to meet the emergency situation.

   xii) power supply in the area where leak is detected shall be cut off.

c) The first operation after positioning the wagon shall be to provide for proper earthing. Earthing shall be disconnected just before the release of the wagon.

d) For connecting and disconnecting hoses, only non-sparking type of tools shall be.

e) After the wagons are placed on weigh bridge and before the locomotive is detached, the hand brakes on each and every wagon shall be applied.

f) Before the wagons are moved from the weigh bridge, brakes on all the wagons shall be released.

g) Only footwear made from conductive rubber shall be used.

h) the lower portion of flapper bridge at wagon side shall be fitted with rubber or wooden padding or any other recommended material.

i) The coir matting/rubber sheet shall be spread on the platform.

j) Ensure that electrical continuity of the system is intact.

k) all fittings on the wagons shall be physically checked.

l) Hoses shall be hydraulically tested at least twice a year (six monthly).

m) Excess flow check valve will stop the flow of LPG in case the flow is in excess due to accidental rupture of hoses etc. The isolation valve at grade level shall be closed.

n) During the loading/unloading, the operator shall be present near the wagons.

o) During unloading, after the liquid transfer is over, the wagon pressure shall not be reduced below 1.5 bar

5.3 Operating procedures

5.3.1 Loading operation

Place the wagon on weigh-bridge ensuring that all the four wheels are properly accommodated on the platform. Engage hand brakes and put chocks. Check the residual LPG pressure in the wagon.

move the locomotive away from the weighbridge and exhibit safety signs at suitable distance away from the wagons on both ends.

Switch off the locomotive engine, if it is parked nearby.

Note down the wagon numbers and placement time.

Take loading advice.

Note the time of receipt of advice.

Connect earthing lugs to the wagons.

Lower the flapper bridge slowly on the wagon.

Open the lid of the wagon.

Take the tare weight reading and set the pointer of the scale to zero. Compare this with the marked tare weight on the wagon.

Connect the filling hose and vapour return line hose to the wagon. Ensure that the flare connection valves are closed.

Ensure that the header is charged with LPG and the bulk loading pump is running.

Open the tanker filling line valve and vapour return line valve.

Open the LPG isolation valve, located near the weigh scale.

Check the system for leaks.

Open the valve on the vapour return line. Slowly open the valve on the filling line. Increase the valve opening and gradually open the valve fully.

Gradually open the throttle valve on return line.

Keep a check on the weigh scale readings. As soon as it shows the required weight of LPG to be filled, stop the compressor/pump and close the LPG isolation valve near the weigh scale.

Close the wagon filling and vapour return lines valves and also valves on filling and vapour return lines at the loading point.

Recheck final weight and record it. ensure that final gross weight does not exceed the permissible axle load of the wagon.

Open the valve on flare line connection to both feed line and vapour return line. Thus, the hoses are depressurised. Then, close the flare line connection valves.

Disconnect the filling and vapour return line hose connections from the wagon. Replace and tighten the plugs on filling and vapour return lines.

Close the top cover of the wagon and seal it properly. Remove earthing connections.

Prepare the gate pass.

Release the hand brake of the wagon.

Release all the wagons on the loading points in the lot.

5.3.2 Unloading operations

Ascertain that the liquid discharge valve and the vapour valve within the tank wagon cover are in the closed position.

Open the port covers in the side of the dome shell, if they exist. Unscrew the plugs in the outlets of the vapour valve and the liquid valves using a box wrench. This shall be done slowly.

If there is any sound of escaping vapour or if there seems to be pressure behind the plugs, the pressure shall be allowed to relieve itself past the threads before the plugs are entirely disengaged.

If the vapour discharge continues or if there is evidence of a liquid discharge, the valves should be retightened.

With the plugs removed, screw pipe nipples into the outlets of the valves after first having applied a modest quantity of sealant to the male threads, keeping the sealant away from the end of the thread. Tighten nipples with a pipe wrench.

Connect the two liquid transfer unloading swing arms or hoses to the nipples attached to the liquid discharge valves. Connect the vapour or equalizing swing arm or hose to the nipple attached to the vapour valve. In most cases, these connections should be made by means of either a ground joint union or a hose coupling.

In the event, a ground joint union is used, no gasket will be required. If a hose coupling is employed, ensure that the appropriate gasket is in place. Make sure that they are secured tightly by appropriate means.

After the vapour and liquid hoses have been connected and before any valve is opened, the valves on the tank wagon shall be cracked open in order to apply pressure to the hoses as a test for leaks.

If any leak appears, the valve shall be immediately closed and corrective measures applied.

Recheck the lines and connections to ensure that they are connected correctly.

After the liquid and vapour lines have been secured and tested, both liquid reduction valves shall be opened slowly and completely. Then, open all other valves in the liquid line working from the tank wagon to the storage tank.

Open the storage tank filling valve slowly, if the tank wagon pressure is in excess of the storage tank pressure otherwise the tank wagon excess flow check valves may get closed.

If the tank wagon pressure is higher than that in the storage tank, do not open the valves in vapour line or operate the compressor. When the rate of liquid flow drops to an unsatisfactory level with the storage tank filling valve wide open, open the vapour valves between the tank wagon and the storage tank.

At this point, ensure that the control valves at the compressor are in a position which allow the compressor to draw vapours from the storage tank and force it into the tank wagon, then start the compressor.

When the tank wagon is held at a pressure of 2.0 to 2.5 bar above the storage tank pressure, the tank wagon shall be emptied into the storage vessel.

A flow of gas instead of liquid through the sight-flow glass in the unloading line indicates that the wagon is empty of liquid. Recheck this by opening the sample valve in the tank wagon dome.

When the tank wagon is emptied of all liquid, stop the compressor and close the liquid valves beginning at the storage tank and progressing to the tank wagon.

If the facilities are arranged such that vapours may be removed from the tank wagon, the pipeline at the compressor should be arranged such that the compressor will draw vapour from the tank wagon and force it into the storage tank. The sequence of piping line-up during unloading liquid LPG and vapour LPG is shown in Annex B.

In this operation, the vapour should be discharged below the surface of the liquid in the storage tank to hasten the liquefaction and, in turn, help prevent excessive pressure in the storage tank.

Restart the compressor and when the tank wagon pressure is reduced to about 1.5 - 2.0 bar, stop the compressor and close all the valves in the vapour line.

After bleeding off the pressure in the hoses, disconnect both the liquid and vapour lines. Replace all the plugs in the tank wagon valves and the unloading fittings.

Recheck sample valve, gauging device and thermometer well to determine that they have been returned to their original condition and are closed tight. Lower the dome cover carefully and lock it in place with the locking pin or secure by appropriate means.

Remove bonding/ earthing connections.

Reverse or remove and replace the "Flammable" placard with "Dangerous - Empty" placard, if applicable.

Remove the "Stop - Tank Wagon Connected" sign and wheel blocks (chocks).

Any defect observed in the tank wagon shall be noted on the appropriate forms and routed in accordance with acceptable procedure.

Notify the railway operator in writing about release of wagon and ensure that it is removed from the siding promptly.

Gauge the storage tanks, within the plant, which have received the LPG to determine that the liquid level is appropriate.

In the event of LPG received on weight basis, the tank wagon may require weighing following the completion of the unloading operation.

5.4 Degassing of sick/leaky tank wagons

5.4.1 Recommended procedure

In the degassing system recommended for LPG wagons, vacuum cycle purging technique shall be followed as outlined below:

1) Vessel shall be evacuated repeatedly by a vacuum pump.

2) Vapour shall be discharged through high rise vent, keeping the steam on.

3) Maximum possible vapours shall be sucked out in first step depending on the capacity of vacuum pump/compressor. Between the two vacuum cycles, nitrogen/inert gas shall be used for breaking the vacuum.

4) Cycle shall be repeated until the LPG concentration is found below the end point of LPG (for butane, it is 4% by volume when purging is done by nitrogen). Periodically, samples shall be drawn from suitable location and analysed for LPG concentration.

5) The vessel shall be flushed with air to displace the nitrogen. Barrel shall be tested with explosive meter to ensure that hydrocarbon concentration is below 10 % of Low Explosive Limit (LEL).

5.4.2 Alternate procedure

Alternately, wagons may be degassed by flaring, steaming or filling with water. However, it should be ensured that wagon is made water free after degassing.

6 Bulk handling for movement by sea

Transportation of LPG in bulk by marine tankers may be carried out under fully-pressurised, semi-pressurised (semi-refrigerated) or fully refrigerated at atmospheric pressure conditions.

6.1 Pressurised ships

The cargo is carried in a number of cylindrical pressure vessels (or cargo tanks) capable of withstanding the maximum pressure likely to be met in service (usually 17 bars).

6.2 Semi-refrigerated ships

The pressure of the cargo is reduced by lowering its temperature to about 0 ˚C by the process of refrigeration and tanks containing the cargo need not be so strong as those of pressurised ships. The tanks are thermally insulated.

6.3 Fully refrigerated ships

The cargo is carried at atmospheric pressure and the cargo tanks are "box-shaped" as opposed to cylindrical/ spherical in case of pressurised/semi-refrigerated tankers for better utilisation of the ship's space.

Pressure ships usually range from very small capacity to excess of 2,000 M^3. capacity. The capacity of semi-refrigerated ships usually ranges from 1,000 to 15000M^3. Fully-refrigerated tankers could be made larger and, lighter for any given size.

6.4 Cargo carrier design and construction

Some of the factors to be taken into consideration, which affect the design and construction of ships carrying LPG, are as follows:

a) Types of cargo to be carried,

b) Condition of the carriage (i.e. fully pressurised, semi-refrigerated or fully refrigerated),

c) Type of trade, which in turn, determines the degree of cargo handling flexibility required by the tanker,

d) Terminal facilities available when loading or discharging the vessel,

e) Cargo containment systems (IMO code identifies five different types),

f) Materials of construction (Fully refrigerated LPG cargoes shall have tanks capable of withstanding temperatures down to -55 ˚C. Alloy steels such as fully killed fine grain carbon manganese steel, sometimes alloyed with 0.5 % Nickel are used.),

g) Tank insulation (for refrigerated cargo),

h) Tanker layout and safety features,

i) Survival capability and tank location,

As specified by IMO codes, LPG carriers are required to undergo five different types of survey and have the certificates of fitness issued or endorsed. The certificate of fitness signifies that a minimum standard of constructional safety has been achieved. In order for a tanker to comply with code throughout its life time, it shall be subjected to re-inspection to maintain its validity in compliance with National Maritime rules and regulations.

6.5 Facilities in the tanker

The cargo handling equipment in a tanker may comprise of the following:

a) Cargo pumps (submersible and booster),

b) Compressors,

c) Condensers,

d) Heat exchangers,

e) Vapourisers,

f) Cargo heaters.

The deep well pump supplies liquid to the booster pump to send the product ashore. In pressurised ship, liquid shall be withdrawn by pressurising the tank through vapour compression from other tanks. All semi and fully-refrigerated tankers shall be provided with cargo heaters to enable the vessels to discharge into pressure storage ashore and a booster pump if the discharge pressure is significantly above 9 bars. Each cargo tank shall be provided with the following equipment:

a) Two cargo pumps, one each on either side of the longitudinal bulk head.

b) Liquid discharge line from the tank dome, connected to the main liquid line.

c) All emergency pump trunk way.

d) A liquid loading line connected to the main liquid line.

e) Two liquid level indicating devices one on each side. These usually consist of a float attached to a self-winding tape which moves up and down, either on guide wires or inside a guide tube. The liquid level is read off the tape through a gas-tight window at the top of and outside the tank.

f) Two sets of purge lines at the top and bottom of the tank. These are used to distribute inert gas or vapour for gas-freeing or gassing-up of the cargo tanks.

g) A vapour line for withdrawal of vapour to the compressor.

h) Sample tubes.

6.6 Safety devices

a) At least two safety valves in each cargo tank,

b) High and low level alarms,

c) Overfill alarm. When actuated, this will shuttle main loading valve and sound an alarm.

The design of the tankers with regard to provision of facilities, equipment, accessories and safety features shall be in accordance with the IMO requirements.

The electrical equipment of all gas tankers are subject to the requirements of the Flag Administration, the Classification Society and of IMO. The certified safe electrical equipment found on gas tankers are;

a) Intrinsically safe;

b) Flameproof;

c) Pressurised or purged; and

d) Increased safety

6.7 Transfer pipework

The following facilities on transfer piping between terminal and shore tanks shall be provided:

a) Remotely operated valves (ROVs) at both the ends of transfer line. (Additional ROV may be provided at critical locations along the pipe line route.)

b) Relief valves on liquid line to surge vessel with an audible alarm system connected to high safe venting system

c) Physical protection against impact to vent/drain pipes

d) Protection of pipeline against corrosion, particularly when the pipeline passes under public road way, which is likely to be water-logged

e) Pipe work passing public road way shall be designed to acceptable public highway authority standard in terms of roadway axle weights

f) Pipelines shall be provided with insulating flanges to avoid pickup of stray currents and possible sparking from the Jetty to the receipt terminal.

6.8 Terminal facilities

Transfer of LPG from ship to terminal and vice versa is accomplished using hoses or loading arms. If terminal authorities supply the cargo transfer hoses, NFPA section 59 regulation 4.5 shall be followed and complied

with. However, if the hoses are ship hoses, these should conform to section 5 of IMO (IGC). Provision of vapour return facility depends on economics, transfer rates, distance of jetty from storage tanks, product pressures and temperatures etc.

In case of pressurised gas transfer, it is observed that the pumping rate falls off gradually due to back pressure of the shore tank. A suitable vapour recovery system or liquefaction of the gas from the receiving tank is recommended.

6.9 Ancillary equipment

6.9.1 The ancillary equipment include:

a) Pipe work, valves, relief valves, rotating equipment (pumps, compressors), exchangers, instrumentation, gas detection systems etc.

b) Transfer line inerting facilities such as inert gas generation combined with water base foam generator and pipeline pig system or water storage with corrosion inhibitor chemical dosing transfer and supply facilities.

c) Nitrogen cylinders with attendant facilities for hose purging/testing and alternate supply to ROVs and other instruments.

6.9.2 The following agents may be incorporated in terminal fire control system:

a) Water;

b) Foam; or

c) Dry chemical powder.

6.10 Unloading operations

It is essential that the ship and terminal operators are familiar with the basic characteristics of each other's facilities, are aware of the precise division of responsibilities and are able to communicate effectively during the time they are together involved in the joint operation of cargo handling. It is important that the terminal operators are versed with the current International Safety Guide for Oil Tankers and Terminals (ISGOTT) safety guidelines.

6.11 Communication

Reliable and effective communications, irrespective of whether they are directly between the tanker and the terminal or indirectly via third party, are pre- requisites of safe and efficient cargo operations before the tanker comes alongside and during the period of cargo operations and until the tanker departs. Terminal communication shall be compatible with tanker's system.

6.12 Pre-cargo transfer discussions

Before any cargo transfer operation is commenced, it is imperative that the intended procedures are thoroughly discussed and a meeting held between the responsible personnel from the tanker and the terminal.

The purpose of the meeting is primarily to make both sides fully conversant with the characteristics of the tanker and shore cargo handling systems, the envisaged operational and safety procedures and requirements and the parameters to be adhered to during the transfer.

The content of the meeting will depend on a wide variety of circumstances but the following broad outlines form the basis of such meetings:

a) The names and roles of terminal and ship personnel who will be responsible for cargo transfer operations may be noted.

b) The terminal representatives shall check that pre-arrival instructions to the ship on cargo, cargo disposition and cargo conditioning have been carried out. They shall also check that all necessary tanker equipment, inspection and tests have been performed.

c) the tanker's officers shall ensure that the relevant terminal equipment and inspection checks have been carried out satisfactorily.

d) Terminal representatives and customs and/or independent surveyors, where necessary, will be informed of the cargo tank data e.g. temperature, pressure, whether free of cargo, liquid heel or arrival dip, composition of tank vapour and quantity of cargo on board.

6.13 Ship/shore safety checklist

Sample checklist for ship/shore safety is given in Annex G.

6.14 Disconnection of hose/ unloading arm

On completion of unloading operation, the tanker discharge pipeline shall be purged to push liquid LPG to the receiving tank. Purging may be done by LPG vapour, inert gas or water as per the design of the system. However, before disconnecting hoses or unloading arm, it is to be ensured that there is no liquid LPG left between the tanker main valve and shore isolation valve. LPG Product from this length of pipeline is to be safely vented.

6.15 Calculating the quantity of liquid on board

Before commencement of tanker discharge operation, tank readings for temperature, pressure liquid levels etc. are jointly agreed by the shore and marine tanker representatives. The corrections applied to assess the quantity of cargo on board are:

a) Trim correction — to make allowance for the liquid level indicating devices not centrally located.

b) Shrinkage factor — for correction of volume at 20 ˚C

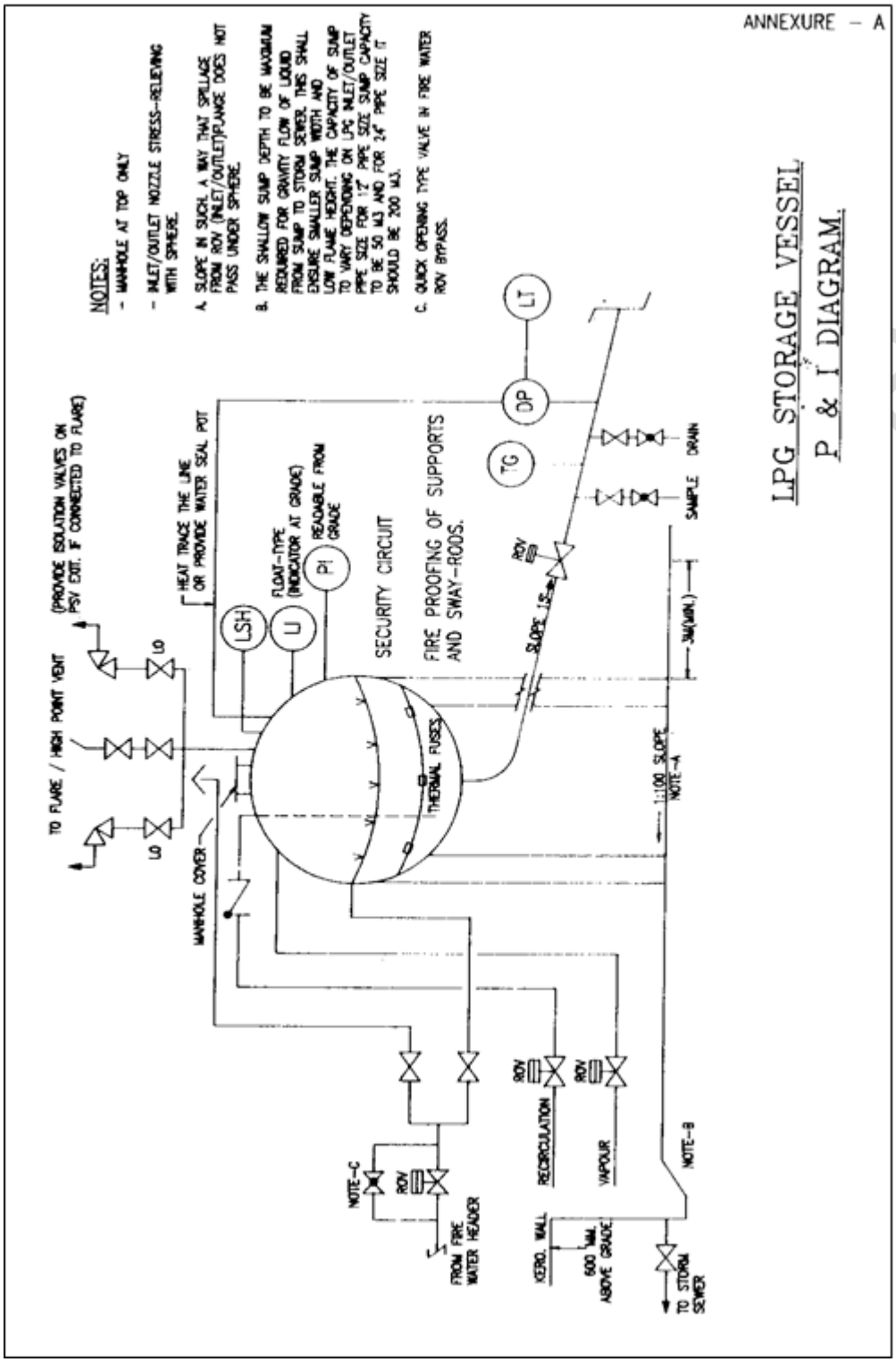
c) Low sounding trim corrections to allow for the wedge shaped volume.

Volume at 20 ˚C = Corrected Volume X VRF

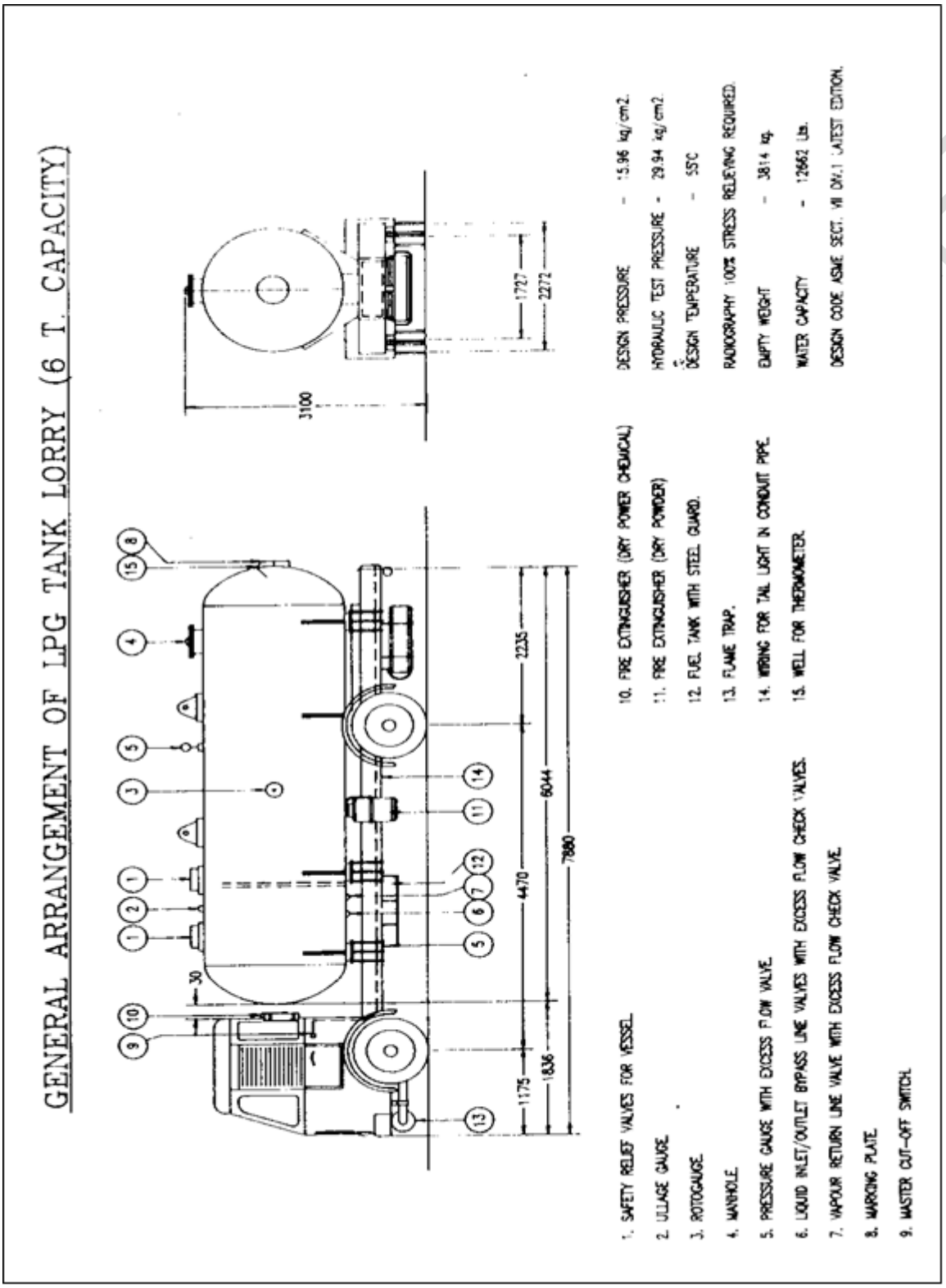
Quantity at 20˚C = Volume at 20 ˚C X Density at 20 ˚C

NOTE VRF is ascertained by ASTM-IP Table - 54).

Annex A
(informative)
LPG Storage Vessel



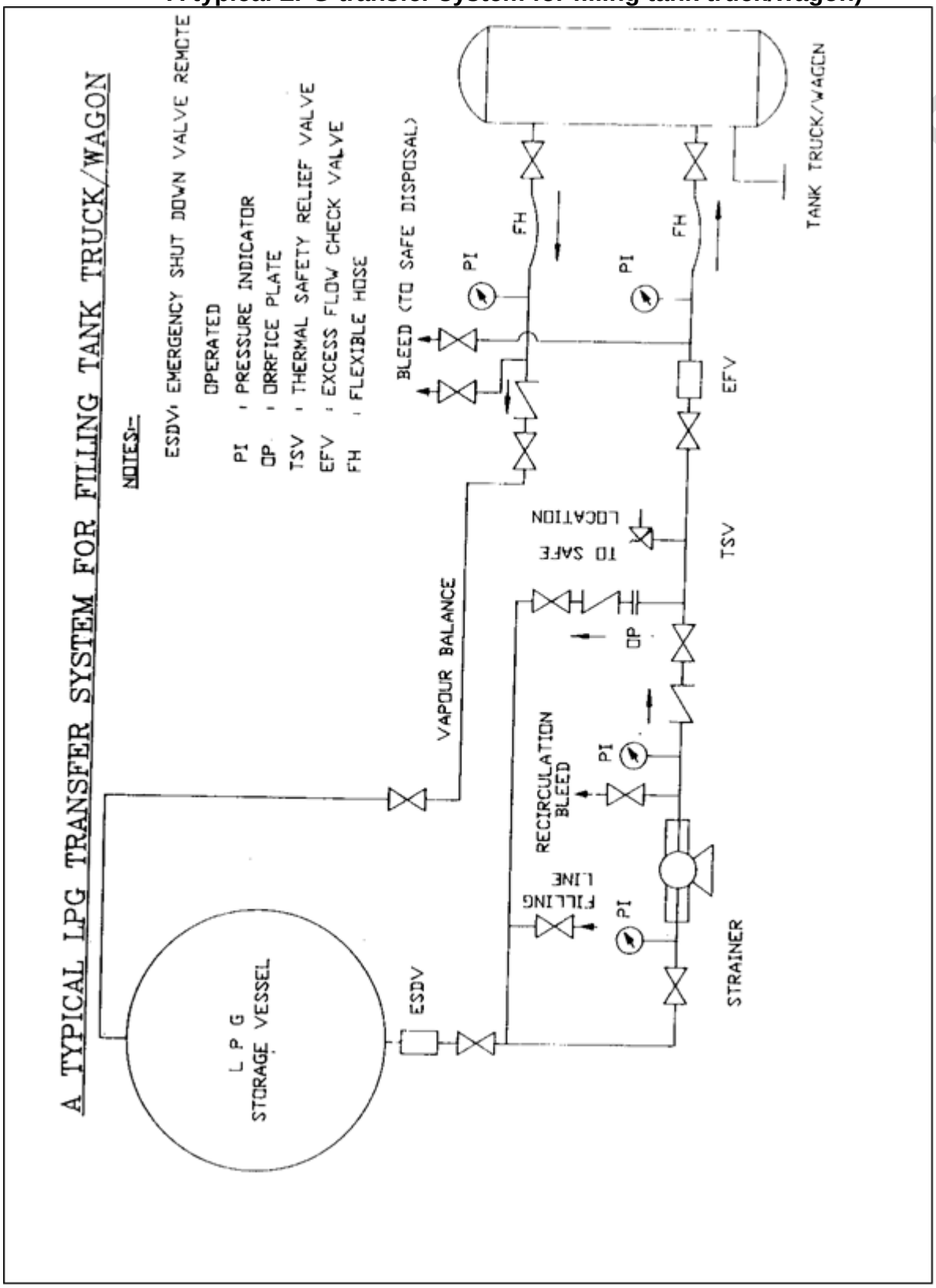
Annex B
(informative)
General Arrangement of LPG tank lorry



Annex C:

(informative)

A typical LPG transfer system for filling tank truck/wagon)



Annex D:
(informative)
Safe filling of LPG vessel

LPG has relatively high coefficient of expansion. If sufficient vapour space is not left in the vessel, pressure inside the vessel would shoot up rapidly once the vessel becomes liquid full. Hence care is exercised in limiting the filling of storage vessel to the filling density of LPG. The filling density is defined so as to leave a guaranteed free space of five percent at the reference temperature of 55°C. As per static and mobile pressure vessels (unfired) Rules - 1981, the design pressure of a vessel shall not be less than the vapour pressure of the gas in the vessel at 55 °C.

The following information are required to work out the safe filling capacity of a storage vessel.

a) Water capacity of the vessel (WC)

b) Density of liquid LPG

c) Filling density (FD)

d) Ullage factor (U)

$$FD = \frac{WC \times U \times density\ of\ LPG\ at\ 55^{\circ}C}{WC} = U \times density\ of\ LPG\ at\ 55°C$$

a) Safe maximum quantity of LPG that can be filled by weight – FD x WC

b) Safe maximum quantity of LPG at 15 °C that can be filled by volume percent of water capacity

$$\frac{FD \times 100}{Density\ of\ LPG\ at\ 15^{\circ}C}$$

c) Safe maximum quantity of LPG at t °C that can be filled by volume percent of water capacity.

$$\frac{FD \times 100}{density\ of\ LPG\ at\ t^{\circ}C}$$

$$\frac{FD \times 100}{Density\ of\ LPG\ as 15^{\circ}C \times VRF}$$

Where,

FD is the filling density

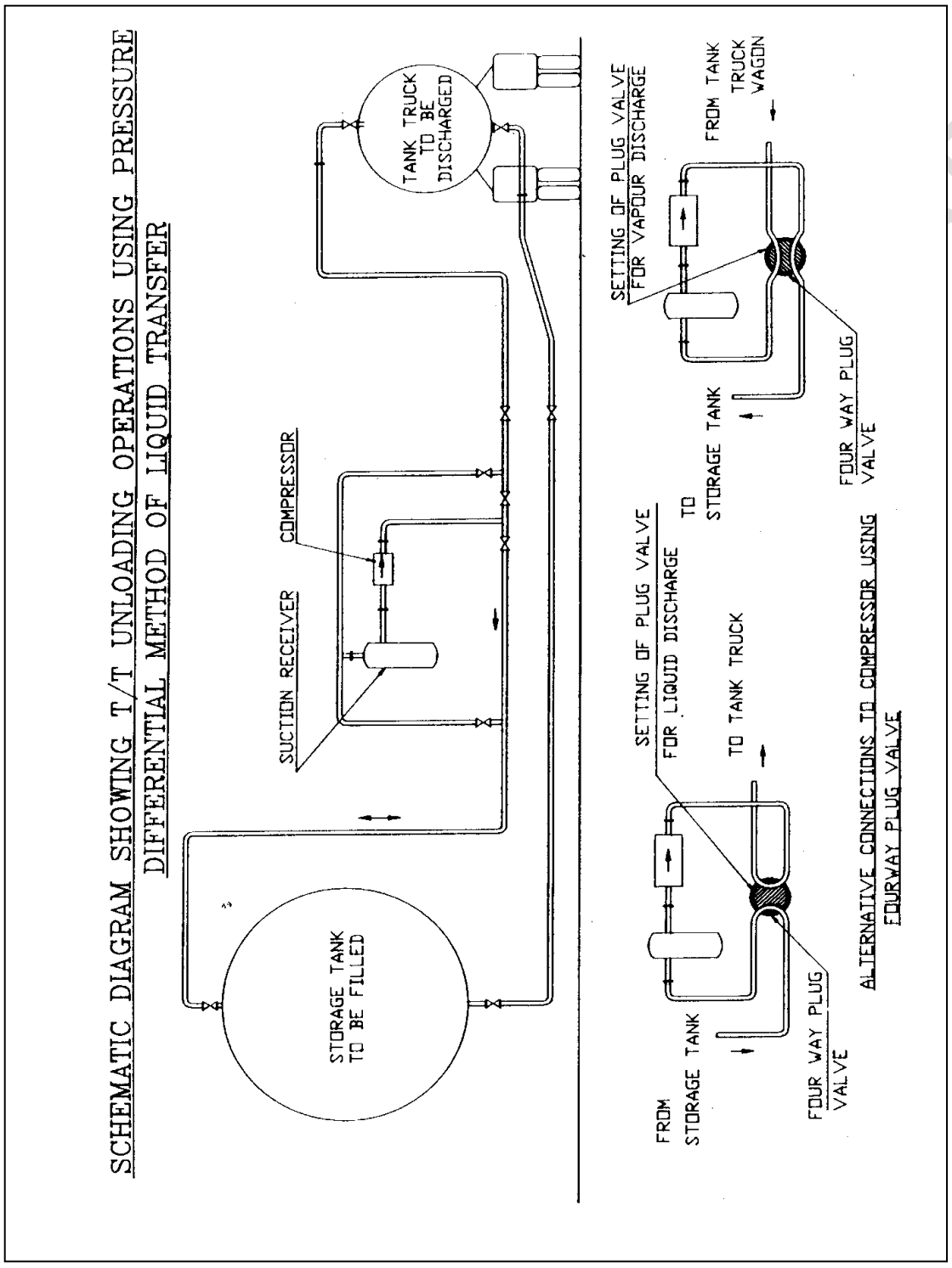
WC is the Water capacity in litres at 15 °C may be taken as total weight of water in kg.

VRF is the Volume reduction factor for density of LPG at t °C as per ASTM Table 54.

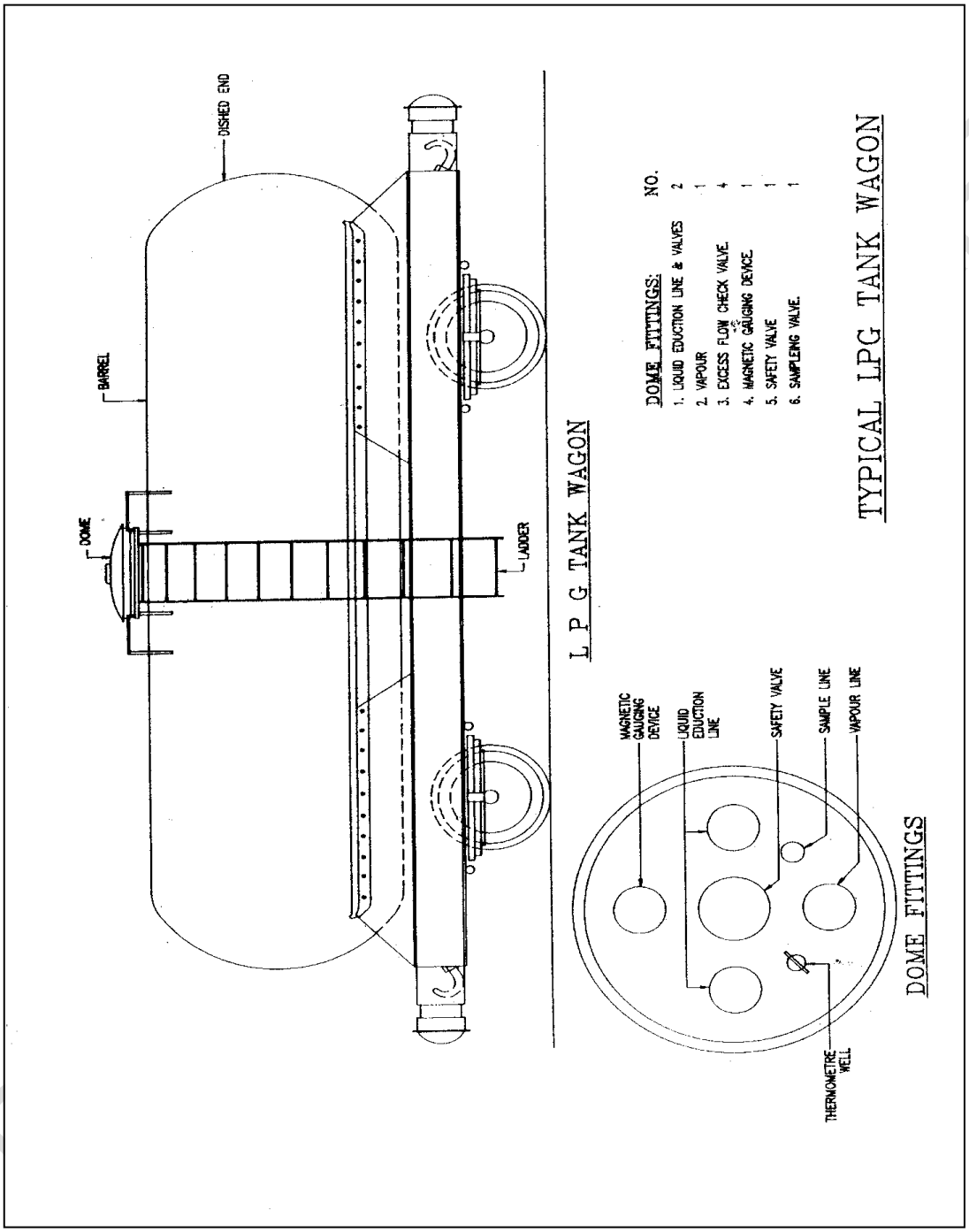
Annex E:

(informative)

Unloading operations using pressure differential method of liquid transfer



Annex F:
(informative)
Typical LPG tank wagon



Annex G

(informative)

Liquefied gas-cargo transfer check list
(Items to be checked before cargo transfer begins)

SHIP:_____DATE:_____

PORT &BERTH:_____TIME:_____

1. Has information on cargo and ship shore connection been supplied ?
2. Is the agreed ship-shore communication system operative?
3. Are fire and other emergency procedures agreed ?
4. Are local regulations being observed?
5. Has safe access been provided and warning notices posted?
6. Are moorings secure and agreement reached on the use of tension winches?
7. Are emergency towing-off wires correctly positioned?
8. Is the ship ready to move under its own power?
9. Are smoking restrictions in force and notices posted?
10 Are naked light restrictions being observed?
11 Are portable electrical equipment cables disconnected?
12 Are all hand torches and portable R/T sets of approved type?
13 Are ship's main transmitting aerials and radar switched off and earthed?
14 Some doors and ports have to be closed are they actually shut?
15 Are all air conditioning intakes correctly trimmed and window type units closed?
16 Is the water main ready for immediate use?
17 Is the water spray system ready for immediate use?
18 Are dry powder and all other fire fighting appliances correctly positioned and ready for immediate use?
19 Is necessary protective clothing available or being worn?
20 Are void spaces properly inerted?
21 Is the required ventilation equipment in operation?
22 Is the cargo system set for the operation?
23 Are all remote control valves in working order?
24 Are cargo tank relief valves correctly set and in good order?

25 Are the required cargo pumps and compressors in good order ?

26 Is reliquefaction or boil-off control equipment in good order ?

27 Is gas detection equipment set for the cargo, calibrated and in good order?

28 Are cargo system gauges and alarms correctly set and in good order?

29 Are scuppers plugged and suitable drip trays in position?

30 Are cargo and bunker hoses in good condition and properly rigged, have certificates being checked?

31 Are unused bunker connections blanked and bunker tank lids closed?

32 Are unused cargo connections (including inert gas line) securely blanked?

33 Are automatic shutdown systems working properly?

34 Does shore know the closing rate of ship's automatic valve at operating temperature does ship have a similar details of shore system?

35 Are all personnel (including supernumeraries and new arrivals) aware that cargo transfer is to begin ?

36 Have all personnel been allocated emergency stations?

37 Are non-essential personnel clear of the cargo area?

38 Are those directly involved aware of the agreed cargo transfer sequence ?

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REMARKS :

We have checked with each other the items on the above check list and have satisfied ourselves that the entries we have made are correct to the best of our knowledge.

CHECKED BY_____ _____

(For Ship) (For Terminal)

Annex H

(informative)
Safety related properties of LPG

Parameter	Commercial propane	Commercial butane
Boiling Point, degrees centigrade at 1 atmosphere	- 45	- 7
Vapour pressure, absolute at 15 ˚C	7.3	2.4
Limits of flammibility% vol.,H/C in Air Upper Lower	 10.0 2.2	 9.0 1.8
Gas to liquid volume ratio at 15 ^{0}C	255	232
Volumes flammable mixture per unit volume of liquid	11591	12889
Ignition temperature, ºC.	450-550	420-540
Co-efficient of expansion fraction / º C	0.003	0.002
Coefficient of compressibility (liquid), fraction/kg.sq.cm	$2x\ 10^{-4}$	$2x\ 10^{-4}$
Gas density, kg/m^3 at 15 ºC at 1 atmosphere	2.0	2.5
Liquid density, kg/m^3 at 15 ºC at 1 atmosphere	510	580

Bibliography

[1] KS 1938-2:2012, Handling, storage and distribution of liquefied petroleum gas in domestic, commercial, and industrial installations — Code of practice — Part 2: Transportation of LPG in bulk by road, rail and sea