ENGINEERING STANDARD

FOR

PROCESS DESIGN OF

LOADING AND UNLOADING FACILITIES

FOR

ROAD TANKERS

ORIGINAL EDITION

DEC. 1997

This standard specification is reviewed and updated by the relevant technical committee on July 2004. The approved modifications are included in the present issue of IPS.

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0. INTRODUCTION

"Process Design of Offsite Facilities for OGP Processes" are broad and contain various subjects of paramount importance. Therefore, a group of Process Engineering Standards are prepared to cover this subject. This group includes the following Standards:

STANDARD CODE	STANDARD TITLE
IPS-E-PR-360	"Process Design of Liquid and Gas Transfer and Storage"
IPS-E-PR-370	"Process Design of Loading & Unloading Facilities for Road Tankers"
IPS-E-PR-380	"Process Design of Solids Handling Systems"

This Engineering Standard Specification covers:

"PROCESS DESIGN OF LOADING & UNLOADING FACILITIES FOR ROAD TANKERS"

The loading and unloading facilities in the OPG industries vary with the size and complexity of the plant and the location and requirements of the consumers. Because of seasonal and other variations and product distribution, loading facilities shall be quite flexible and its capacity may far exceed normal plant production.

1. SCOPE

This Engineering Standard Specification covers minimum requirements for process design and engineering of loading and unloading facilities for road Tankers in OGP Industries.

It should be noted that the scope of this Standard is limited to liquid applications and road tankers only. Furthermore in this manual the unloading part is limited to probable discharges of the products remaining in the tankers that arrive for loading.

This manual forms part of a series that may be developed ultimately to embrace all facilities connected with bulk loading and unloading of road vehicles, rail tank wagon and on-shore facilities for loading/discharging of water bore craft.

Note:

This standard specification is reviewed and updated by the relevant technical committee on July 2004. The approved modifications by T.C. were sent to IPS users as amendment No. 1 by circular No. 237 on July 2004. These modifications are included in the present issue of IPS.

2. REFERENCES

Throughout this Standard the following dated and undated standards/codes are referred to. These referenced documents shall, to the extent specified herein, form a part of this standard. For dated references, the edition cited applies. The applicability of changes in dated references that occur after the cited date shall be mutually agreed upon by the Company and the Vendor. For undated references, the latest edition of the referenced documents (including any supplements and amendments) applies.

API (AMERICAN PETROLEUM INSTITUTE)

Bul. 1003, Oct., 1975	"Precautions Against Electrostatic Ignition During Loading of Tank Motor Vehicles"
RP 550, 1986	"Manual on Installation of Refinery Instruments and Control Systems"
API Std., Chapter 6.2, 1st. Ed., Oct. 1983, Reaffirmed March 1990	"Manual of Petroleum Measurement Standards", "Loading Rack and Tank Truck Metering Systems"

BSI (BRITISH STANDARDS INSTITUTION)

BS SP 3492, 1987	"British Standard Specification for Road and Rail Tanker Hoses and Hose Assemblies for Petroleum Products, Including Aviation Fuels"
BS 5173, Sec. 101.1, 1985	"Method of Test for Rubber and Plastic Hoses and Assemblies"

IPS (IRANIAN PETROLEUM STANDARDS)

IPS-E-GN-100	“Engineering Standard for Units”
IPS-E-PR-170	"Engineering Standard for Process Flow Diagram"
IPS-E-PR-230	"Engineering Standard for Piping & Instrumentation Diagrams (P&IDs)"

3. DEFINITIONS AND TERMINOLOGY

3.1 Filling Installations

Facilities for truck loading from entering time up to leaving.

3.2 Gantry

A framework on a loading island, under or besides which one or two loading bays with some articulated loading arms/hoses are arranged.

3.3 Loading Arm/Hose

A piping or hose arrangement for filling in a truck.

3.4 Loading Bay

An inlet for trucks to stay under product loading.

3.5 Loading Facilities

Facilities consist of pumping and filling installations.

3.6 Loading Island

A raised area over which loading arms/hoses and related facilities are installed.

3.7 Spout

An outlet for loading through an arm or a hose, identical with "loading point".

4. SYMBOLS AND ABBREVIATIONS

DN	Diameter Nominal, in (mm).
d_w	Number of working days per week.
HVP	High Vapor Pressure.
LNG	Liquefied Natural Gas.
LPG	Liquefied Petroleum Gas.
LVP	Low Vapor Pressure.
n_d	Number of truck per spout per day.
N_d	Total number of trucks per day.
n_l	Number of simultaneous loading.

N_s	Number of spouts.
OGP	Oil, Gas and Petrochemical.
RVP	Reid Vapor Pressure.
q_1	Loading capacity per spout, in (m^3/h).
Q_a	Average product rate, in (m^3/d).
q_p	Product pumping rate, in (m^3/h).
t_1	Loading time per truck (filling only), in (min).
T_1	Total loading time per truck, in (min).
T_p	Preparation time of a truck, in (min).
V_a	Average truck capacity, in (m^3).
V_T	Specific truck capacity, in (m^3).

5. UNITS

This Standard is based on International System of Units (SI) as per IPS-E-GN-100, except where otherwise specified.

6. TRUCK LOADING AND UNLOADING

6.1 Loading

6.1.1 General

This Standard Specification is limited to provision of, process design of new facilities for loading of bulk road vehicles at normal installations for different products. For this reason, the designs shown include features which will not be necessary in all situations; and when new facilities are planned it is recommended that the simplest facilities that will efficiently perform the filling operation should be constructed. These requirements can also be used for the modernization and/or extension of existing loading facilities for road tankers.

Specifying the yearly average loading capacity, the size of tanker and loading assembly may be fixed and pump capacity will be calculated.

It should be noted that in case there is freedom in tanker size and/or loading assembly then economical evaluation shall be considered for such selections.

6.1.2 Loading facilities in the context of the overall distribution system

The importance of bulk vehicle loading facilities as part of the total distribution complex must be fully realized when plans are made for the construction of new facilities, or the modernization and extension of existing arrangements. It is therefore necessary to examine the operation of the distribution system in order to optimize both its efficiency and the size of the loading facilities. The latter are an integral part of the distribution system and should not be studied in isolation; changes in the system and/or operating procedures can have a considerable effect upon vehicle loading requirements. In this context the objective must be to optimize the number of loading bays, and product loading spouts per bay, in relation to the overall distribution system, capital investment and operating expenditure.

Firstly, the cost of own and Contractor’s vehicles should be assessed for the time spent (vehicle standing charges) while:

- queuing for a loading bay;
- waiting for a loading arm while in the bay;

- being loaded in the bay.

Secondly, for existing installations the traffic flow must be studied to establish the present arrival patterns of vehicles at the loading facilities and hence the peak loading periods. The types of delivery such as urban, country, and over long distances, will influence arrival patterns.

Application of simple methods planning techniques to these operations will show whether efficiency can be improved by changes in:

- working hours;
- shift patterns;
- staggered starting times;
- night loading;
- dispatching and delivery systems;

The objective being to improve utilization of existing facilities and of the existing road transport fleet.

For new installations the above information may not be available. In such cases an operational system must be established in which the various factors mentioned are carefully considered in relation to practice in the local industry, and in consultation with the designers.

6.1.3 Environmental conservation

6.1.3.1 It is the policy of OGP industries to conduct their activities in such a way that proper regard is paid to the conservation of the environment. This not only means compliance with the requirements of the relevant legislation, but also constructive measures for the protection of the environment, particularly in respect of avoidance/containment of spillages.

6.1.3.2 Vapor recovery system

The recovery of product vapors such as gasoline is of interest for economic, safety and environmental reasons. In most locations where bulk lorries are loaded, the total gasoline vapor emissions have not been considered a significant factor affecting the quality of the local environment. Nevertheless, at the design stage, system should be reviewed to see if it becomes necessary to install a vapor collection system return line for poisonous, hazardous and high vapor pressure products. [RVP > 0.34 bar (abs)]

However, it is essential to minimize the generation, and hence the emission of vapors during loading by eliminating the free fall of volatile products and reducing jetting and splashing.

In areas where action has been required by National authorities to minimize vapor emissions at loading facilities, bulk vehicles may have to be filled with a closed vapor system; this entails the following modifications to loading arrangements:

a) Top loading

As the majority of loading facilities in service are top loading, the best solution would be to replace (or modify) the existing loading arms so that when volatile products are loaded, the manhole is sealed and vapors are diverted into a vapor return system. The latter may be either integral with the loading arm or a vapor manifold on the vehicle connected to all the tank compartments which would be similar to the system described in (b) below.

b) Bottom loading

Bulk vehicles equipped for bottom loading require a pipe connection from the vapor emission vent of each compartment into a vapor recovery manifold, which should terminate in a position which is easily accessible from ground level for use at both the loading bay or retail outlets as required. The coupling connections for liquid and vapor must be different types.

6.1.3.3 Reduction of vapor emissions

Apart from installing a full vapor recovery system, considerable reduction in vapor emissions can be achieved by avoiding free fall and splashing of volatile products in top and bottom filling operations, as follows:

- Top filling:

The loading arms should be designed to reach the end compartments of a vehicle tank in such a manner that the down pipe can penetrate vertically to the bottom of the compartment.

- Bottom filling:

It may be necessary to fit deflectors in the vehicle tank at the point of entry of the product into the compartment.

Such measures have the following advantages:

a) minimizing the hazard of static electricity, see 6.1.4.2;

b) minimizing the amount of vapor formation;

c) reducing product losses;

d) reducing the fire risk: the concentration of vapor emanating from the compartments will be dissipated faster to below the explosive limit.

6.1.3.4 Spillage control

The main items to be considered at the loading facilities are provision of:

- emergency shut-off valve to prevent or reduce spillage due to overfilling, hose failure, etc.;
- emergency push-button switch to stop the pumps, activate an alarm, and close all flow control and block valves on the island;
- adequate drainage and interception arrangements.

6.1.4 Health and safety

6.1.4.1 General

Loading facilities are labor intensive (because of numbers of driving personnel) and vulnerable because of emission of vapors. It is the most likely source of accidents in a depot and hence particular attention needs to be paid to working conditions.

6.1.4.2 Static electricity

To minimize the hazard of static electricity it is essential firstly, to ensure that the vehicle tank and loading equipment are at the same potential. This should be arranged by providing a bonding interlock system connecting the vehicle tanks to the loading rack and product flow-control valves.

Secondly, maximum safe flow rates in the loading system should be considered (see Clause 6.1.7.3).

6.1.5 Loading systems

6.1.5.1 General

Ideally, the loading system should be able to fill all compartments of the vehicle without needing to move the vehicle.The spacing between loading systems at the loading island should allow the loading arms or hoses to be operated independently, without interference between each other, or meter heads, and with minimum obstruction of access for the operator.

Appendix A Figs. A.1 through A.7, presents typical lay-outs for filling installations and typical gantry arrangements. In Appendix B Figs. B.1, B.2, B.3 and B.4 typical flow schemes for top and bottom loading systems and corresponding drainage are given. Symbols used for these schemes are generally according to IPS-E-PR-170 and IPS-E-PR-230, but some additional compound symbols or schematic ones are given in the above figures and Figs. B.5, B.6 and B.7 for convenience. These symbols are valid only for illustration purposes, if they have some deviations with those accepted standard symbols as indicated in IPS-E-PR-170 and IPS-E-PR-230.

6.1.5.2 Choice of loading system-top or bottom

The first criteria for selection of loading system is the volatility characteristics of the product. If RVP (Reid Vapor Pressure) of the product at 38°C is higher than 0.55 bar (abs) in summer or 0.83 bar (abs) in winter then bottom loading shall be used.

The second aspect is the requirements to restrict emissions from a specific product which dictates to use bottom loading.

Besides above mentioned limitations, the relative merits of top and bottom loading system are summarized in Table 1.

TABLE 1 - THE RELATIVE MERITS OF TOP AND BOTTOM LOADING

Safety Features	BOTTOM LOADING	TOP LOADING
Worksite	Ground level	On platform. Can be made safe by provision of guard rails and access ramps to vehicles, but at extra cost.
Vapor emissions (no vapor recovery)	Closed manhole covers gives rise to small pressure build-up to operate the vents resulting in marginally less vapor emission.	Open manhole covers therefore slightly greater vapor emission.
Control of product flow assuming meter preset does not work	Reliance on overspill protection equipment.	Positive visual control by loader assuming 'hold-open' valve is correctly used. Two-arm loading requires overspill protection when the conditions are the same as for bottom loading.
Product handling equipment	Arms, and particularly hoses filled with product are heavier to handle. Generally, hose diameters should be limited to DN 80 (3 inches).	Care is needed to ensure that the down-pipe of loading arms, is correctly positioned in each compartment. DN 100 and DN 150 (2 and 6 inches) diameter counter-balanced arms are easily handled.
Electrostatic precautions	Flow rates restricted to 75% of that for equivalent top loading system.	

(to be continued)

TABLE 1 - (continued)

	BOTTOM LOADING	TOP LOADING
Environmental Conservation		
Vapor recovery (loading bay)	Vehicles must be fitted with a vapor recovery manifold connecting each compartment; of sufficient capacity to cope with simultaneous loading of 2, 3 or 4 compartments.	Each product loading arm must be fitted with a vapor sealing head so that vapors are diverted into a vapor recovery system; either (a) on loading arm, or (b) manifold provided for gasoline deliveries to retail outlets. Care must be taken to position collar seal in fill opening. Liquid level sensing equipment must be fitted on loading arms or in each vehicle tank compartment.
Vapor recovery (service stations)	Vehicles already equipped with vapor return manifold for use when loading.	Vehicles must be fitted with vapor return manifold.
Performance		
Preparation for loading (normal)	Removal of caps and connecting couplings is contained within small operating envelope. (No significant difference between systems.)	Greater area of operation because of positioning of manhole covers. (No significant difference between systems.)
Preparation for loading (vapor return)	Additional coupling connection to vapor manifold. (No significant difference between systems.)	Care must be taken to position arm/vapor head in fill opening. (No significant difference between systems.)
Loading arrangement	Simultaneous loading of 2 or more compartments more easily arranged.	
Product flow rates	25% slower per compartment than equivalent top handling system because of electrostatic hazard in certain filling operations.	
Costs		
Capital costs	1. Approximately 17% more loading space is required than that of an equivalent top-loading gantry. Additional cost for greater roof area. 2. i) All vehicle compartments must be fitted with loading dry-break couplings. ii) To minimize over-filling risk, vehicles must be fitted with liquid level sensing equipment. iii) Deflectors must be fitted to foot valves to minimize jetting and turbulence. iv) Additional product handling equipment on islands. Depending upon by group's requirements, this may be about 30-50% more.	Additional structure and safety equipment for working platform.

(to be continued)

TABLE 1 - (continued)

	BOTTOM LOADING	TOP LOADING
Maintenance Costs	The additional equipment above will require to be maintained/replaced. Out-of-service time of vehicles for maintenance may be increased.	Maintenance of working platform and safety features.
Constraints		
Vehicle accommodation	Can more easily accept range of vehicle capacities and heights (present and future).	Less flexible than bottom loading arrangement.
Compatibility with competitors and Contractors vehicles	All vehicles likely to use loading bays must be fitted with suitable equipment. Industry agreement to adopt similar practices should be encouraged.	More flexible.
Compartment outlets full or empty	Possible need to persuade authorities to change law to permit outlet pipes filled with product, otherwise drainage must be arranged with consequent measurement and operational problems.	No problem.
Sophistication	Less flexible operation. Increased maintenance. Need for greater control of maintenance.	More flexible operation.

6.1.6 Control system

6.1.6.1 Control of product flow:

a) Filling by volume

Measurement of product volume governs the amount of product filled into each compartment and this is normally arranged by flow through a positive displacement meter. Slowing down and stopping the flow is usually controlled by a preset quantity control device which represents the first line of control. In the event of any emergency, e.g., malfunction of the mechanism, or incorrect setting of the preset, etc. the possibility of a spillover occurs, and a second line of control is necessary. Methods of achieving this are as follows:

a.1) Top filling

The fitting of a 'deadman control' in the form of a 'hold-open' valve also enables the operator-when filling through an open manhole-to watch the level of the product and to stop the flow immediately in any emergency. The valve operating lever (or control rod) must be located so that the filler can see the product in the compartments at high level, while avoiding the vapor plume emitted from the manhole. However, the temptation to tie the hold-open valves in the open position, has resulted in spillovers.

This factor, together with the necessity for operators to stand on vehicles while fillings, has led to the increasing use of liquid-level control equipment as a positive secondary means of stopping product flow in an emergency.

Where two or more compartments are required to be filled at the same time, liquid level control equipment is strongly recommended as a secondary means of stopping the flow of product.

a.2) Bottom filling

With all loading operations at ground level, and vehicle manhole covers remaining closed, the use of an overfill protection system based upon liquid-level detection equipment becomes essential.

The liquid-level control equipment should be linked into an interlock system which covers bonding of the vehicle, and access to the products by means of controls on the loading arms. This enhances safety and provides the basis for an automatic control system.

b) Filling by mass

Where the weighbridge is positioned at the loading bay, the filling can be controlled by a preset mechanism operating in two stages before cutting off at the total loaded mass. Only one compartment can be loaded at a time with this method. The requirement of secondary protection against overfilling is met:

- For bottom loading; as for (a.2) above.

- For top loading: use of a 'hold-open' type valve on loading arm with operator standing on gantry platform (NOT VEHICLE) in a position to observe compartment being loaded. For single (or large compartments) it may be desirable to fit liquid-level control equipment if the driver/loader has other things to do on the loading platform.

6.1.6.2 Automation

6.1.6.2.1 General

An interlock system whereby product will not flow unless and until:

- the vehicle is properly earthed or bonded;

- the loading arm is in its correct position.

Measurement of product flow into vehicle compartments should be through a positive displacement meter. This enables systems to be developed which capture the data for the product and quantity loaded into a specific vehicle which is required to identify itself before product will flow.

6.1.6.2.2 Provision for automation

The basic equipment which must be available on the loading islands comprises:

- an earth interlock system;

- a positive displacement meter with preset unit and/or 2-stage product flow-control valve, at each product loading point;

- a meter pulse unit transmitting per unit volume;

- means for taking temperature into account, for example:

  • temperature compensating meters;

  • thermometer pocket in product lines for measuring temperature by resistance thermometers or temperature recorders.

Cables for transmission of data on product and flow quantities must be run in separate wiring conduits and not in the same conduit carrying power, lighting and control valve cables.

6.1.7 Process design parameters

6.1.7.1 General

The individual factors that contribute to the total cost of loading vehicles are:

- the cost of the loading facilities (capital charges for bays, structures, pumps, lines, meters, weighbridges, etc.);

- the cost of vehicle time while occupying the loading bay and while queuing for a loading bay, or waiting for a loading arm while in the bay (vehicle standing charges);

- vehicle capacities and dimensions;

- shift patterns, including staggered starts and night loading. In this context the method of operation can be single or double shift patterns, or 24-hour service, or a combination of these.

Having established the likely future pattern of vehicle arrivals during peak hours, the extent and cost of alternative loading methods and loading rates can be determined and costed, and the economic balance obtained between the cost of vehicle queuing delays and the cost of providing extra loading facilities which will reduce or eliminate them.

6.1.7.2 Peak demand

Any loading facility should be designed to meet the forecast loading demand during peak periods. To calculate the facilities required, it is necessary to determine the quantity to be loaded in the peak hour for each product, at the same time establishing the quantities required for each multi-product vehicle loading combination; and to forecast the future peak demands on which the size (number of loading bays) will be based.

After establishing the total number of loading bays, the effect of major sensitivities should be studied, in particular the reduction of loading bays by one (or more) on the waiting time for all vehicles, and vice versa, in order to ensure that an economic optimum for the whole system is chosen.

6.1.7.3 Product flow rates

Flow rates are generally restricted by safety precautions (i.e., prevention of excessive static electricity generation), also the economic size of pumps, pipework and measuring equipment.

As regards safety precautions, concerning static electricity on flow rates, the rate of flow should not normally exceed the figures as given in Table 2 below.

TABLE 2 - FLOW RATE LIMITATION FOR STATIC ELECTRICITY

PRODUCT	MAXIMUM LOADING RATE, m^3/h		
	DN 80 (3 inches)	DN 100 (4 inches)	DN 150 (6 inches)
Top loading	108	144	216
Bottom loading	78	105	

6.1.7.4 Simultaneous loading using two or more arms/hoses

Considerable benefit can be achieved by loading a vehicle using two or more loading arms or hoses simultaneously. The additional cost of meters or loading arms, etc. is usually well compensated by the savings from reduced vehicle time in the bay, and in a reduction in the number of loading bays required.

In the case of top loading, the simultaneous use of two or more arms will result in the need for additional equipment to prevent overfilling which may not be necessary for single arm operation. The cost and other consequences arising from such equipment must be taken into account in the economic comparison.

6.1.7.5 Calculation of number of spouts and pumping capacity

a) General

The determination of the optimum number of spouts for loading facilities is important because it directly affects capital costs of the facilities on the one hand, and operating costs of vehicle fleet on the other hand.

Loading rates and the number of spouts required for each product varies with:

1) truck size,

2) number of loading hours per day;

3) number of loading days per week;

4) time required for positioning, look-up and depositioning of truck; and

5) size of loading assemblies.

b) Formulation

For formulation and an example see Appendix C in this Standard Specification.

6.1.7.6 Heating for loading arms

When heated pipelines are used, the pipework up to and including the final valve on the loading arm should be heated. Since heating is often required only in cold weather or during start up, it is economical to consider using thermostatically controlled flame/explosion-proof electric heating.

6.1.8 Equipment

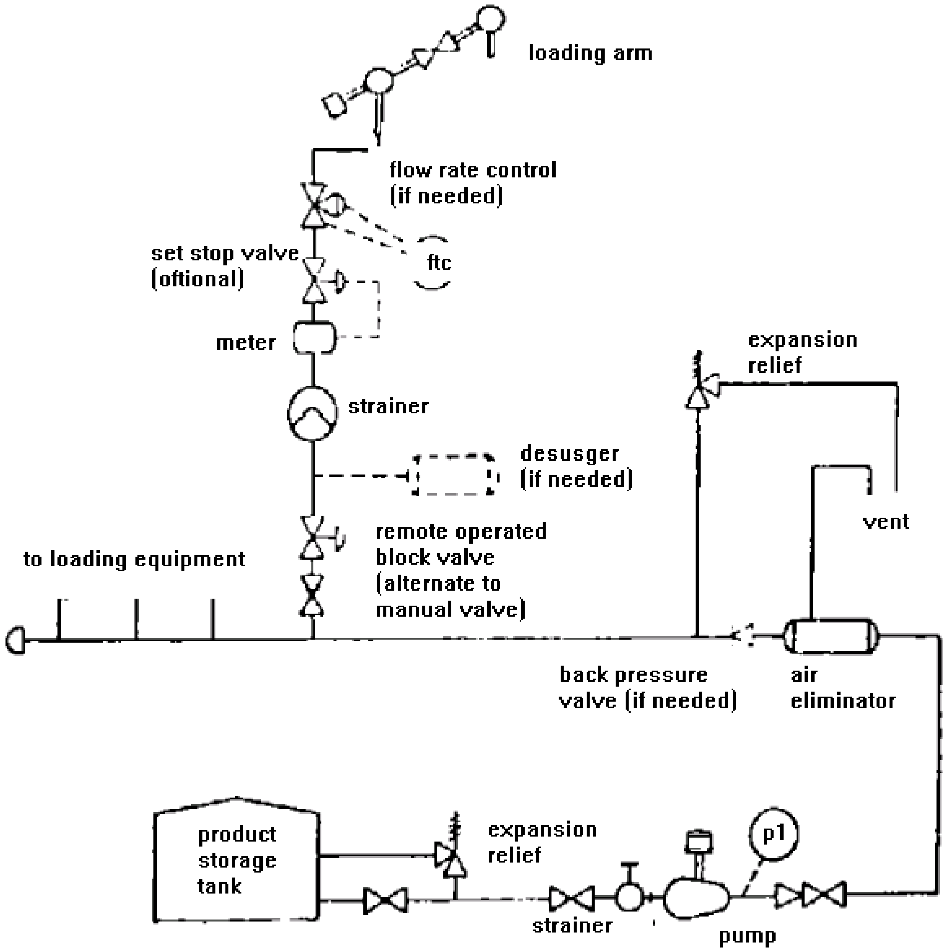
6.1.8.1 General

Typical equipment required for a truck loading operation is shown in Fig. 1.

Air eliminators are used to disengage air and other vapors which would affect the accuracy of metering. Disengaging of vapor is done at about 2 bar (ga) and if there is not at least this amount of static head difference between the air eliminator and the loading spout discharge, a back pressure valve must be provided. This may be a swing-type check valve.

Desurgers are installed in some installations to decrease hydraulic shock resulting from quick shut-off. Strainers are provided to keep dirt and other foreign particles out of the meters, which are normally of the positive-displacement recording type. Set stop valves are used to stop product flow automatically at a predetermined quantity set on the set-stop counter of the meter. These valves can be used in remote-controlled systems and can also serve as a remotely operated block valve to prevent unauthorized withdrawal of product.

Rate-of-flow controllers are self-contained flow-indicating control valves used to prevent overspeeding and wear of meters.The flow indicator is usually a pitot venturi, and a straight meter run of at least six pipe diameters is recommended when the controller is downstream of a strainer, globe valve, or short-radius elbow. The loading arm is a mass or springbalanced assembly of pipe and swing joints which will reach various points on trucks of a range of heights. A controlled closing loading valve is included in the assembly. This decreases the flow rate rapidly to a small percentage of capacity, after which shut-off is slow to prevent shock.



TYPICAL SCHEMATIC DIAGRAM OF USUAL EQUIPMENT NEEDED FOR TANK-TRUCK LOADING

Fig. 1

Note:

The symbols shown in this figure have only illustration value.

6.1.8.2 Pumps

6.1.8.2.1 Pumps and loading devices shall be sized to provide rates of flow appropriate to the capacity of the facility. Extreme care shall be taken to ensure that the rates of flow are such that the operator can follow the course of loading and unloading at all times and have adequate time to shut down the facility before the tank or tanks are emptied completely or before they are filled beyond their maximum filling height.

6.1.8.2.2 Transfer systems shall be designed such that dangerous surge pressures cannot be generated when the flow in either direction is stopped.

6.1.8.2.3 Provision may be made for forced or natural circulation of cold liquid through the loading facility when it is not in service to minimize relief problems and thermal recycling.

6.1.8.2.4 The pumps should have flat head capacity characteristics to provide a reasonably constant discharge pressure under varying delivery and discharge conditions. Usual pump differentials are 2.5 to 3 bars without major changes in static head.

6.1.8.3 Instruments

6.1.8.3.1 Flow indicators

Sight flow indicators are not required for large installations, but they may be desirable in some instances in which small quantities of liquid transfer are involved. However, care must be taken to ensure that such equipment is adequately designed for the pressure to which it may be subjected. Either the flapper type or rotor type is satisfactory. The flapper type must be properly installed with respect to direction of flow because it also serves as a check valve.

6.1.8.3.2 Pressure gages

Pressure gages shall be located in a sufficient number of places in the liquid and vapor lines to allow the operator to have a constant check on operating pressure, differentials, and so forth to ensure safe operation.

6.1.8.3.3 Emergency shut-off valves

Emergency shut-off valves shall incorporate all of the following means of closing:

1) Automatic shut-off through thermal (fire) actuation. (When fusible elements are used they shall have a melting point not exceeding 120°C.

2) Manual shut-off from a remote location.

3) Manual shut-off at the installed location.

Installation practices for emergency shut-off valves shall include the following considerations:

a) Emergency shut-off valves shall be installed in the transfer line where hose or swivel piping is connected to the fixed piping of the system. Where the flow is only in one direction, a back-flow check valve may be used in place of an emergency shut-off valve if it is installed in the fixed piping downstream of the hose or swivel piping.

b) Emergency shut-off valves shall be installed so that the temperature sensitive element in the thermally actuated shut-off system is not more than 1.5 meters in an unobstructed direct line from the nearest end of the hose or swivel-type piping connected to the line in which the valve is installed.

c) The emergency shut-off valves or back-flow check valves shall be installed in the plant piping so that any break resulting from a pull will occur on the hose or swivel piping side of the connection while retaining intact the valves and piping on the plant side of the connection. This may be accomplished by the use of concrete bulkheads or equivalent anchorage or by the use of a weakness or shear fitting.

6.1.8.3.4 Metering equipment used in loading and unloading

When liquid meters are used in determining the volume of liquid being transferred from one container to another, or to or from a pipeline, such and accessory equipment shall be installed in accordance with the procedures stipulated by the API "Manual of Petroleum Measurement Standards" and Recommended Practice 550.

6.1.8.4 Hoses and arms

6.1.8.4.1 Hoses and arms for transfer shall be suitable for the temperature and pressure conditions encountered. Hoses shall be provided for the service and shall be designed for a bursting pressure of not less than five times the working pressure. The hose working pressure shall be considered as the greater of the maximum pump discharge pressure or the relief valve setting.

6.1.8.4.2 Provisions shall be made for adequately supporting the loading hose and arm. When determining counter masses, ice formation on uninsulated hoses or arms shall be considered.

6.1.8.4.3 Details on hoses for road and rail tankers for some petroleum products are presented in Appendix D.

6.1.8.4.4 Flexible pipe connections shall be capable of withstanding a test pressure of one and one-half times the design pressure for that part of the system.

6.1.8.5 Vehicles

Typical bulk road vehicle dimensions for different truck capacities is presented in Appendix E, Figs. E.1, E.2, and E.3 for reference.

6.2 Truck Unloading

6.2.1 General

Many Points which have been referred to under the subject of loading, are applied here as well. Furthermore, in the following Section specific reference is made to discharging of some quantities of products possibly remaining in the tankers before loading again.

6.2.2 Discharging unloaded products

Vehicles may sometimes return for loading with a quantity of product remaining on board. Attempts should be made to minimize this, and if it occurs, to check the quantity and grade and then to ’load on to’. Where this cannot be done, the product must be offloaded, and tanks, pipelines and pumps provided as required. Offloading facilities should be located at a separate bay to avoid congestion at the loading bays; a typical arrangement is illustrated in Fig. B.3 of Appendix B.

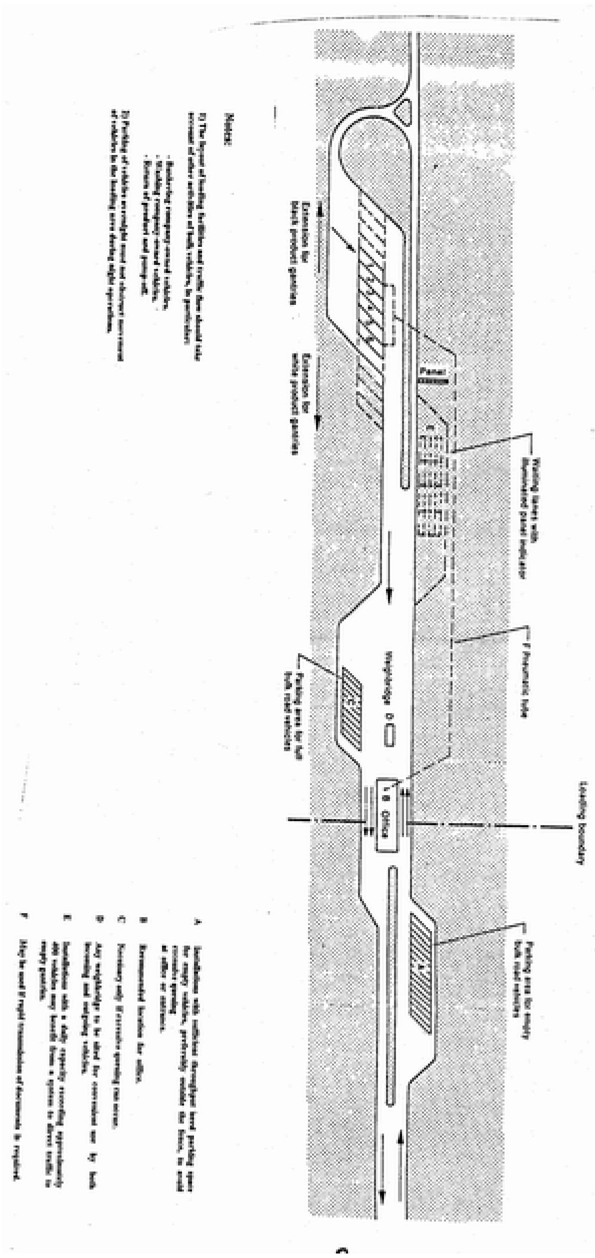
Such facilities can also be used if vehicle flushing and draining is required, or for special grade changing procedures.

Since quantities to be offloaded should be small, offloading rates do not need to be as fast as loading rates, and rates of about 50 to 80 m^3/h are usual. With suitable manifolding, the pump used occasionally to pump out product from the offloading tanks may be used to speed offloading from the vehicle; otherwise gravity discharge into an underground tank is acceptable.

APPENDICES

APPENDIX A

TYPICAL LAYOUTS AND GANTRY ARRANGEMENTS

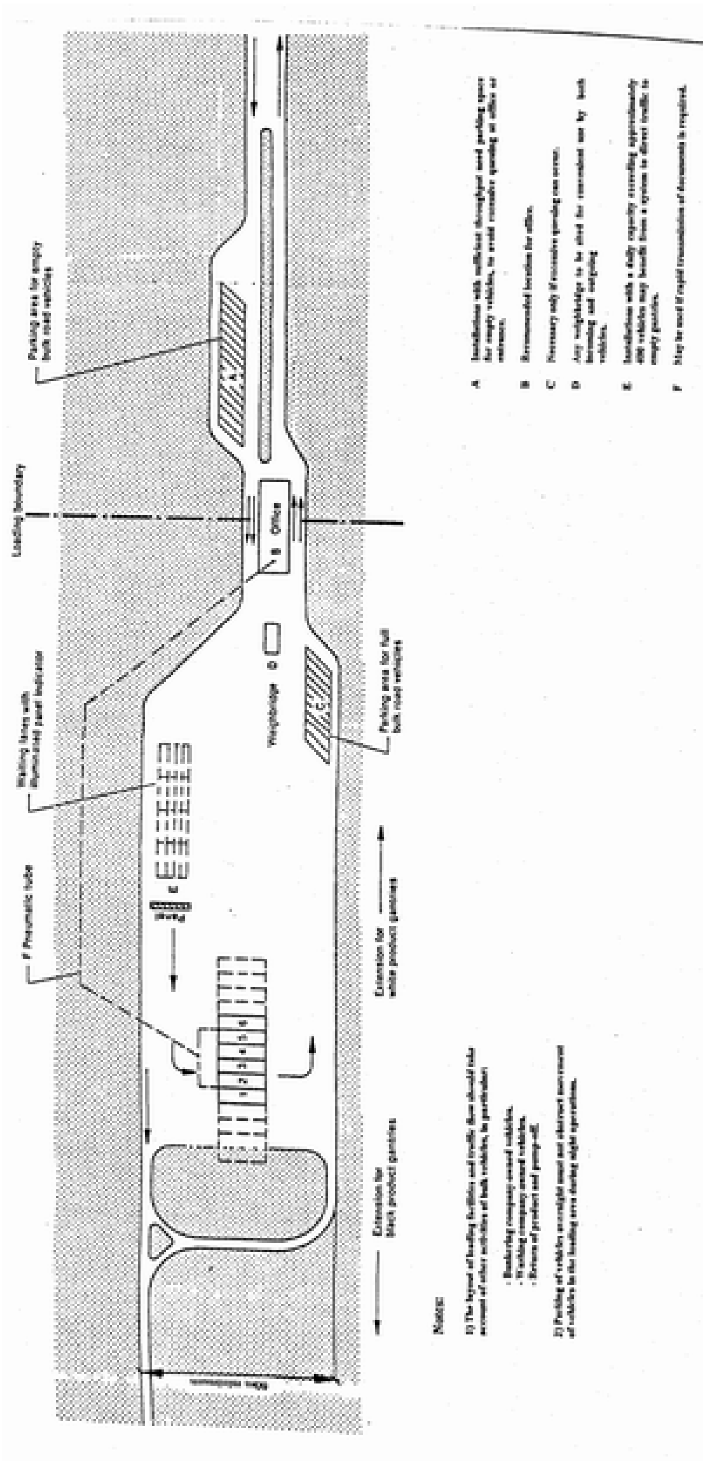


TYPICAL BULK ROAD VEHICLE FILLING INSTALLATION WITH STRAIGHT GANTRIES AND WAITING AREA

Fig. A.1

(to be continued)

APPENDIX A (continued)

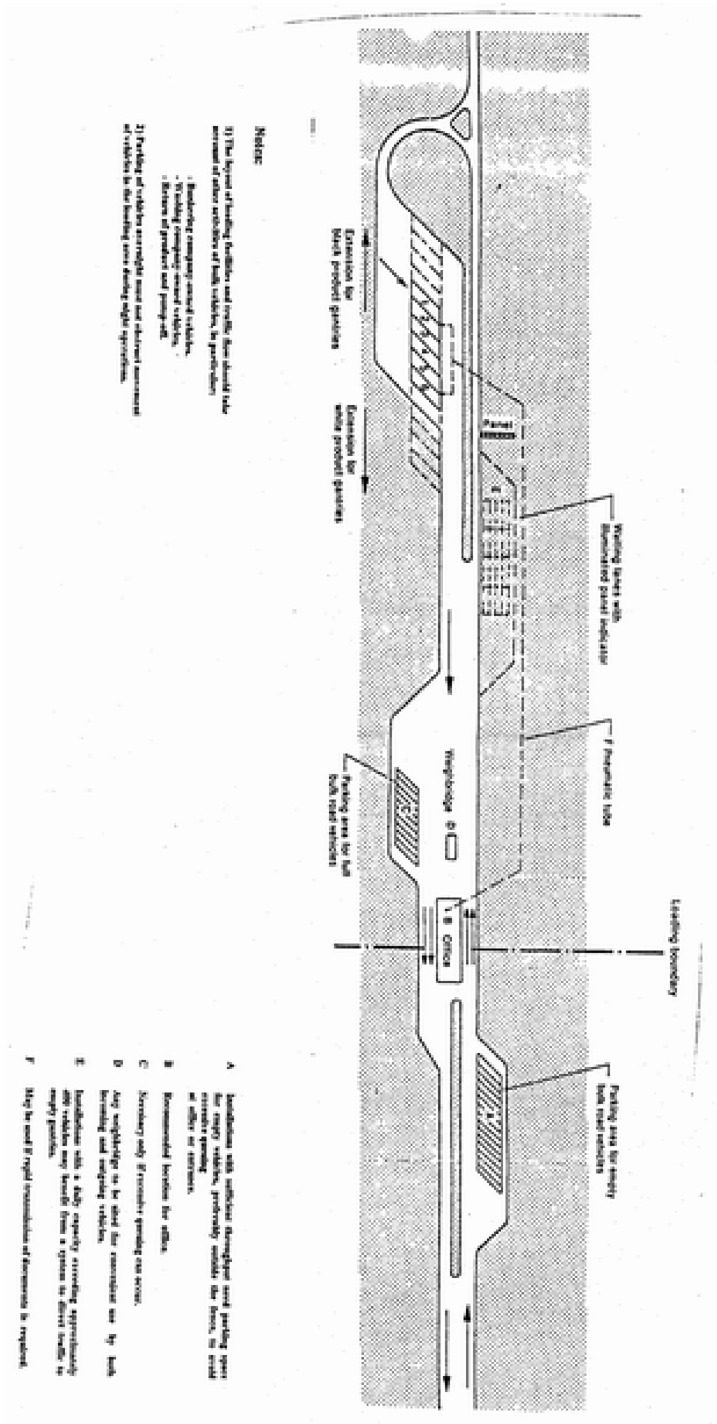


TYPICAL BULK ROAD VEHICLE FILLING INSTALLATION WITH STRAIGHT GANTRIES

Fig. A.2

(to be continued)

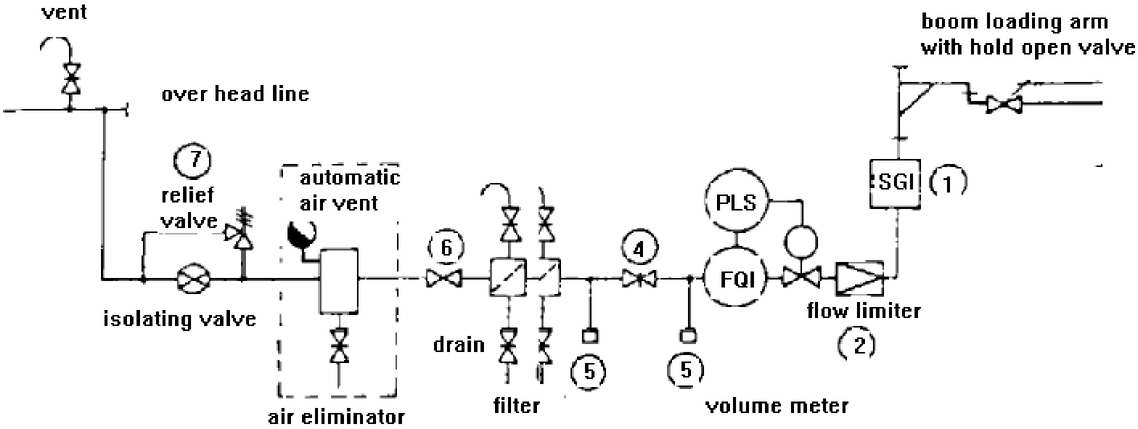
APPENDIX A (continued)



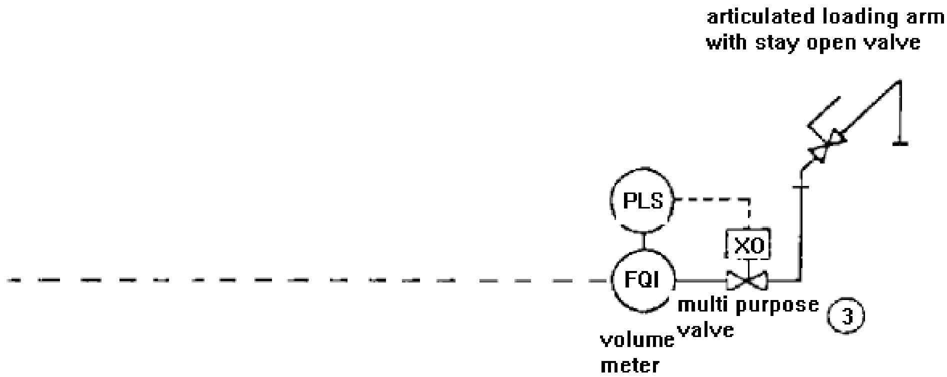
TYPICAL BULK ROAD VEHICLE FILLING INSTALLATION WITH ANGLED GANTRIES

Fig. A.3

APPENDIX B
TYPICAL LOADING SYSTEMS FLOW SCHEMES



LOADING OF BULK ROAD VEHICLES BY METER-MECHANICALLY CONTROLLED



LOADING OF BULK ROAD VEHICLES BY METER-AUTOMATICALLY CONTROLLED

Notes:

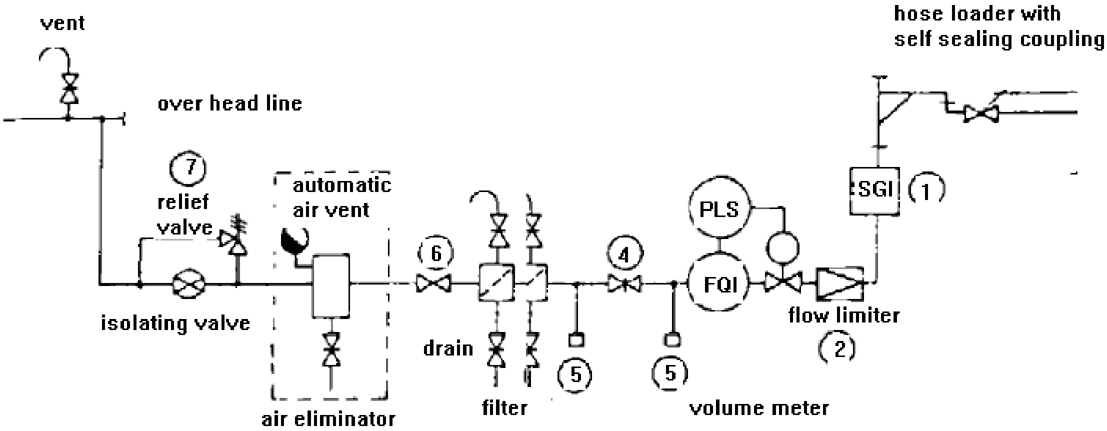
1) Sight glass should be incorporated only where required by local regulations.
2) Flow limiter protects the meter if one pump is used for more than one meter.
3) Multi-purpose solenoid-operated flow-control valve:
- **protects the meter if one pump is used for more than one meter;**
- **operated by meter quantity preset control;**
- **shuts off product flow if actuated by overfill prevention system;**
- **interlocked with bonding of vehicle to loading equipment.**

4) Gate valve, block and bleed.
5) Meter test proving point, self-sealing coupling.
6) Valve assists filter draining/cleaning.
7) Relief valve relieves thermal expansion pressure.
8) For black oils:
- **a) Air-eliminating equipment is not required.**
- **b) Loading line equipment including the loading arm may have to be heated.**
- **c) Boom type arms with hydraulically-operated valves may be required.**

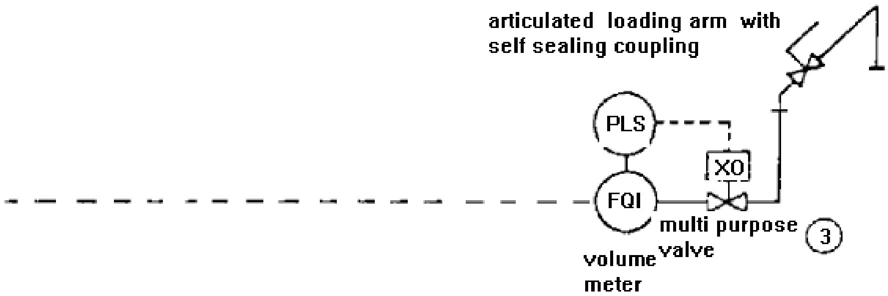
TYPICAL LOADING SYSTEMS
Fig. B.1

(to be continued)

APPENDIX B (continued)



LOADING OF BULK ROAD VEHICLES BY METER-MECHANICALLY CONTROLLED



LOADING OF BULK ROAD VEHICLES BY METER-AUTOMATICALLY CONTROLLED

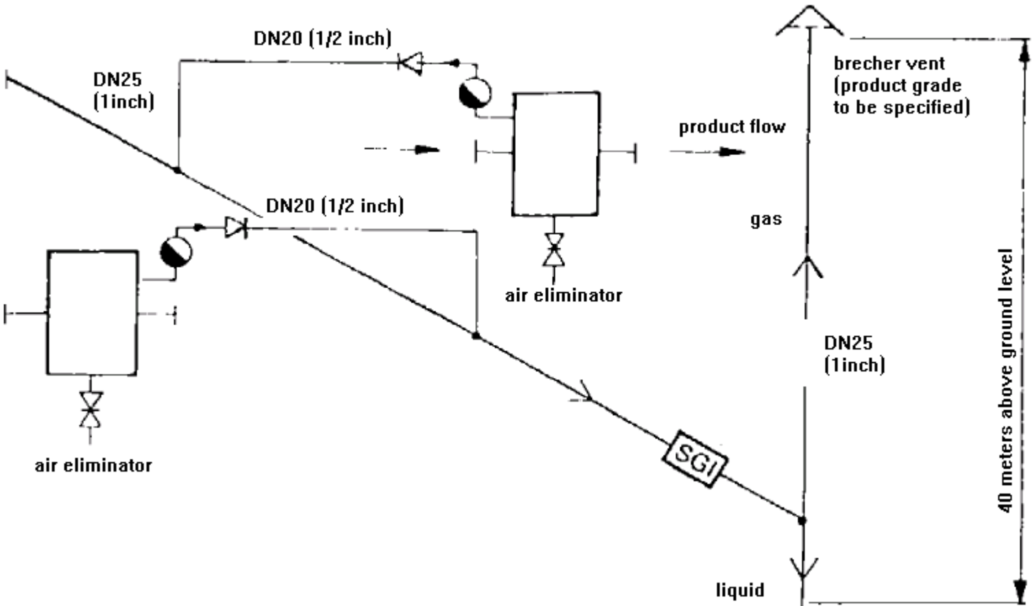
Notes:

1) Sight glass should be incorporated only where required by local regulations.
2) Flow limiter protects the meter if one pump is used for more than one meter.
3) Multi-purpose solenoid-operated flow-control valve:
   - protects the meter if one pump is used for more than one meter;
   - operated by meter quantity preset control;
   - shuts off product flow if actuated by overfill prevention system;
   - interlocked with bonding of vehicle to loading equipment.
4) Gate valve, block and bleed.
5) Meter test proving point, self-sealing coupling.
6) Valve assists filter draining/cleaning.
7) Relief valve relieves thermal expansion pressure.
8) For black oils:
   a) Air-eliminating equipment is not required.
   b) Loading line equipment including the loading arm may have to be heated.
   c) Boom type arms with hydraulically-operated valves may be required.

TYPICAL LOADING SYSTEMS
Fig. B.2

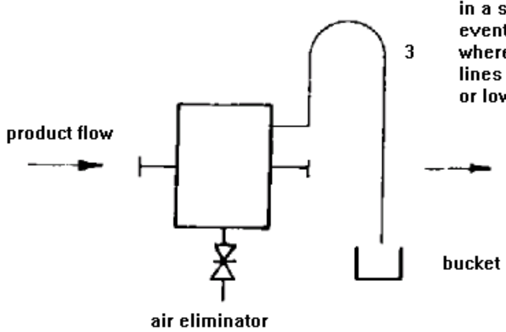
(to be continued)

APPENDIX B (continued)



SCHEME FOR CLOSED OUTLETS

notes:
1 instead of acentral collecting tank small individual tanks may be installed on each gantry stand
2 draining on each filters meters and vehicle tanks also flushings from vehicle tanks should be collected in a small tank trolly for eventual ndisposal by approprate down grading
3 where common collecting lines are used these should be segregated to high or low flash point products etc



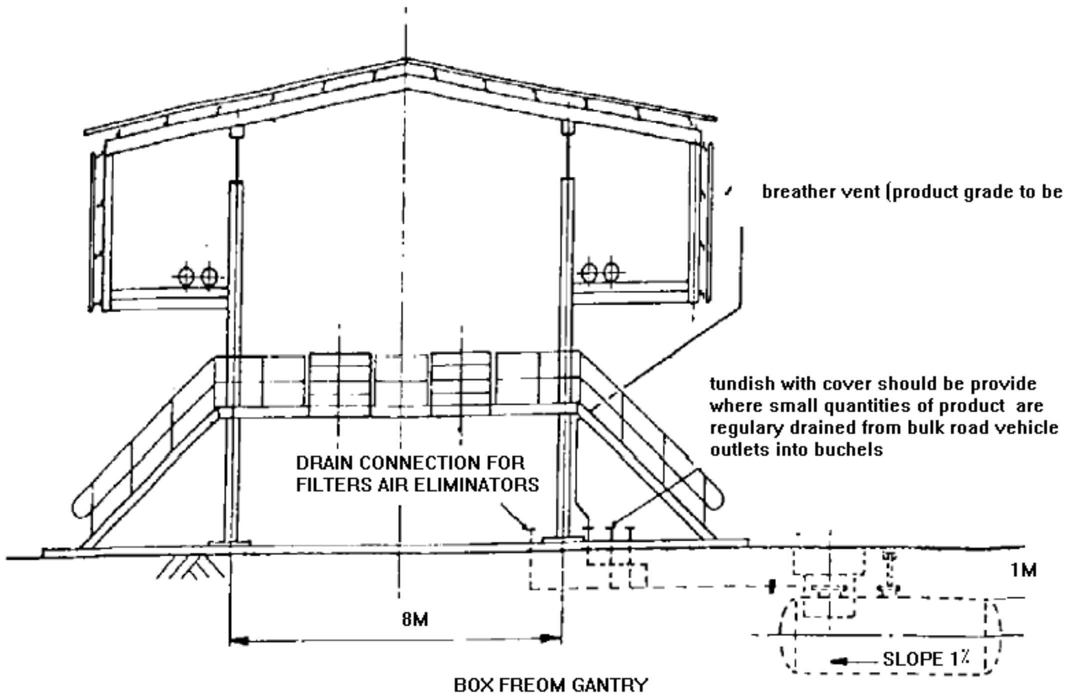
SCHEME FOR OPEN OUTLETS

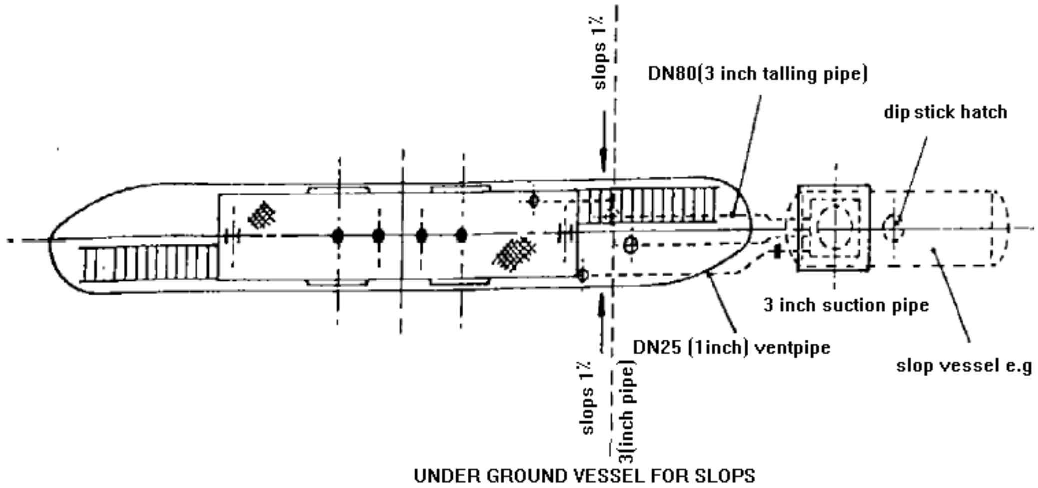
TYPICAL PIPELINE COLLECTION SYSTEMS FOR AIR ELIMINATORS

Fig. B.3

(to be continued)

APPENDIX B (continued)



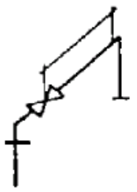


TYPICAL UNDERGROUND VESSEL FOR SLOPS, WITH CLOSED DRAINAGE FLOW SCHEME

Fig. B.4

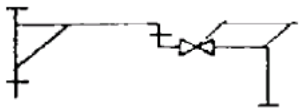
(to be continued)

APPENDIX B (continued)

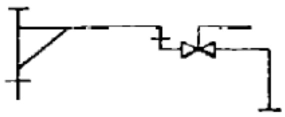


Articulated loading arm with hold-open hand-operated loading arm valve for white and black oil products.

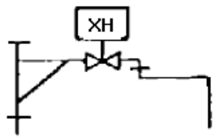
Articulated loading arm with stay-open hand-operated loading arm valve for white and black oil products.



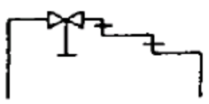
Long range boom type loading arm with deflector and hold-open hand-operated loading arm valve for white products.



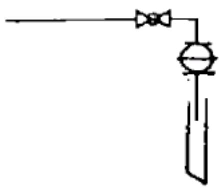
Long range boom type loading arm with deflector and stay-open hand-operated loading arm valve for white products.



Short range boom type loading arm with hold-open hand-operated loading arm valve controlled by a hand-operated hydraulic system for black oil products.



Short range boom type loading arm for bitumen with hand-operated loading valve.



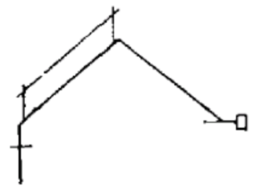
Telescopic loading lance with ball swivel and hand operated loading valve.

SYMBOLS FOR BULK ROAD VEHICLE LOADING ARMS (TOP LOADING)

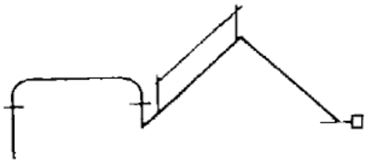
Fig. B.5

(to be continued)

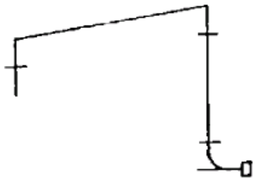
APPENDIX B (continued)



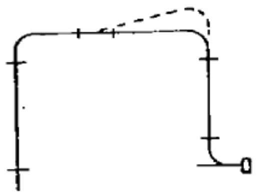
Articulated loading arm with self-sealing coupling.



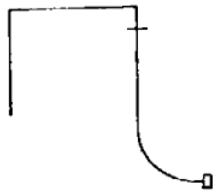
Boom type articulated loading arm with self-sealing coupling.



Spring balance type hose loader with self-sealing coupling.



Hinged joint type hose loader with self-sealing coupling.



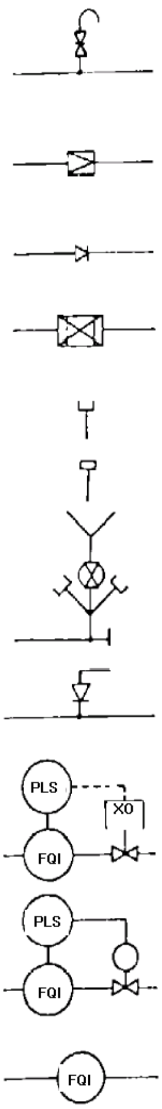
Hose loader with self-sealing coupling.

SYMBOLS FOR BULK ROAD VEHICLE LOADING ARMS AND HOSES (BOTTOM LOADING)

Fig. B.6

(to be continued)

APPENDIX B (continued)



Controlled vent

Flow limiter.

Check valve.

Flame arrester

Hose coupling (female half).

Hose coupling (male half).

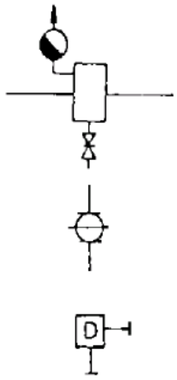
Slops tundish with hose couplings.

Vacuum-breaker valve.

Positive displacement meter fitted with solenoid-operated multi-purpose valve and limit switch.

Positive displacement meter fitted with preset valve and limit switch.

Positive displacement meter with local indicator.



Air-eliminator with automatic air vent and drain valve.

Ball swivel.

Detonation protector.

SYMBOLS FOR BULK ROAD VEHICLE LOADING INSTALLATION FLOW SCHEMES

Fig. B.7

APPENDIX C
FORMULATION AND CALCULATION OF PUMP CAPACITY AND NUMBER OF SPOUTS EXAMPLE TO ITEM 6.1.7.5 b

C.1 Formulation

Having Q_a select V_T, q1 then tp (based on truck size) then,

$$t_1 = \frac{60V_T}{q_1} \qquad \text{(Eq. 1)}$$

$$T_1 = t_1 + t_p \qquad \text{(Eq. 2)}$$

$$n_d = \frac{60\ t_d}{t_1 + t_p} \qquad \text{(Eq. 3)}$$

$$N_s = \frac{7\ Q_a}{n_d\ .\ V_T\ .\ d_w} \qquad \text{(Eq. 4)}$$

$$n_1 \geq \frac{t_1}{T_1}\ .\ N_s \qquad \text{(Eq. 5)}$$

T1

$$q_p = n_1 + q_1 \qquad \text{(Eq. 6)}$$

$$N_d = n_d \times N_s \qquad \text{(Eq. 7)}$$

Note:

Above calculations are based on loading of single product, full and even utilization of spouts. This means, the trucks are always available during the working hours. Otherwise distribution of truck arrivals and availability should be considered and correcting factor for both number of spouts and pumping capacity applied. It is reminded that cost of additional investment and operating cost of loading facilities should be balanced against cost of trucks waiting time.

C.2 Example

Assuming:

Q_a = 1000 m³/d;

d_w = 5 and 4 hours working time per day;

V_T = 13.2 m³, q_l = 70 m³/h t_p = 10 min;

Then:

$$t_1\ \frac{13.2 \times 60}{70} = 12 \text{ min}$$

$$T_1 = 12 + 10 = 22 \text{ min}$$

$$n_d = \frac{4 \times 60}{22} = 10.9 \text{ take } 10$$

(to be continued)

Appendix C (continued)

$N_s = \frac{1000 \times 7}{10 \times 13.2 \times 5}$ **= 10.6 take 11**

$n_1 \geq \frac{12}{22}$ **× 11 = 6**

$Q_p = 6 \times 70 = 420\ m^3/h$

Total No. of trucks loaded/day:

$N_d = n_d \times N_s = 10 \times 11 = 110$

APPENDIX D
HOSE SPECIFICATIONS

D.1 Hoses for Road and Rail Tankers for Petroleum Products

D.1.1 Scope

This part specifies requirements for rubber and plastic hoses and assemblies for carrying gasoline, kerosene, fuel and lubricating oils, including aviation fuels with an aromatic hydrocarbon content of not more than 50% at temperature up to 80°C. All types are suitable for use with a vacuum not exceeding 0.5 bar.

D.1.2 Types and classes

D.1.2.1 Types

Hoses are designated as follows.

Type A Rough bore externally armored hose principally for gravity discharge with a maximum working pressure of 3 bar.

Type AX Rough bore composite hose principally for gravity discharge with a maximum working pressure of 3 bar.

Type B Rough bore externally armored hose with a maximum working pressure of 7 bar.

Type BX Rough bore composite hose with a maximum working pressure of 7 bar.

Type C Smooth bore hose with smooth or corrugated exterior principally for gravity discharge with a maximum working pressure of 3 bar.

Type D Smooth bore hose with smooth or corrugated exterior with a maximum working pressure of 7 bar.

Type E Smooth bore reeling hose with a maximum working pressure of 7 bar.

Type F Smooth bore reeling hose of controlled dilation for metered delivery with a maximum working pressure of 7 bar.

D.1.2.2 Classes

Types A, AX, B and BX are divided into the following two classes:

class 1 for aviation and other uses;

class 2 for non-aviation use.

D.1.2.3 Dimensions and tolerances

D.1.2.3.1 Bore

The bore of the hose shall comply with the nominal dimensions and tolerances given in Table D.1 when measured in accordance with BS 5173: Section 101.1.

(to be continued)

APPENDIX D (continued)

TABLE D.1 - NOMINAL BORES AND TOLERANCES

TYPES A, AX, B BX, C AND D	TYPES E AND F	PERMISSIBLE DEVIATIONS
mm	mm	mm
---	25	± 1.25
32	32	± 1.25
38	38	± 1.5
51	51	± 1.5
63	---	± 1.5
76	---	± 2.0
102	---	± 2.0

D.1.2.4 Pressure requirements

The maximum working pressure, proof pressure and minimum burst pressure of hoses shall be as given in Table D.2.

TABLE D.2 - PRESSURE RATINGS

PRESSURE	TYPES A, AX AND C	TYPES B, BX, D, E AND F
	bar	bar
Maximum		
Working	3	7
Proof	4.5	10.5
Minimum burst	12	28

D.1.2.5 Performance requirements

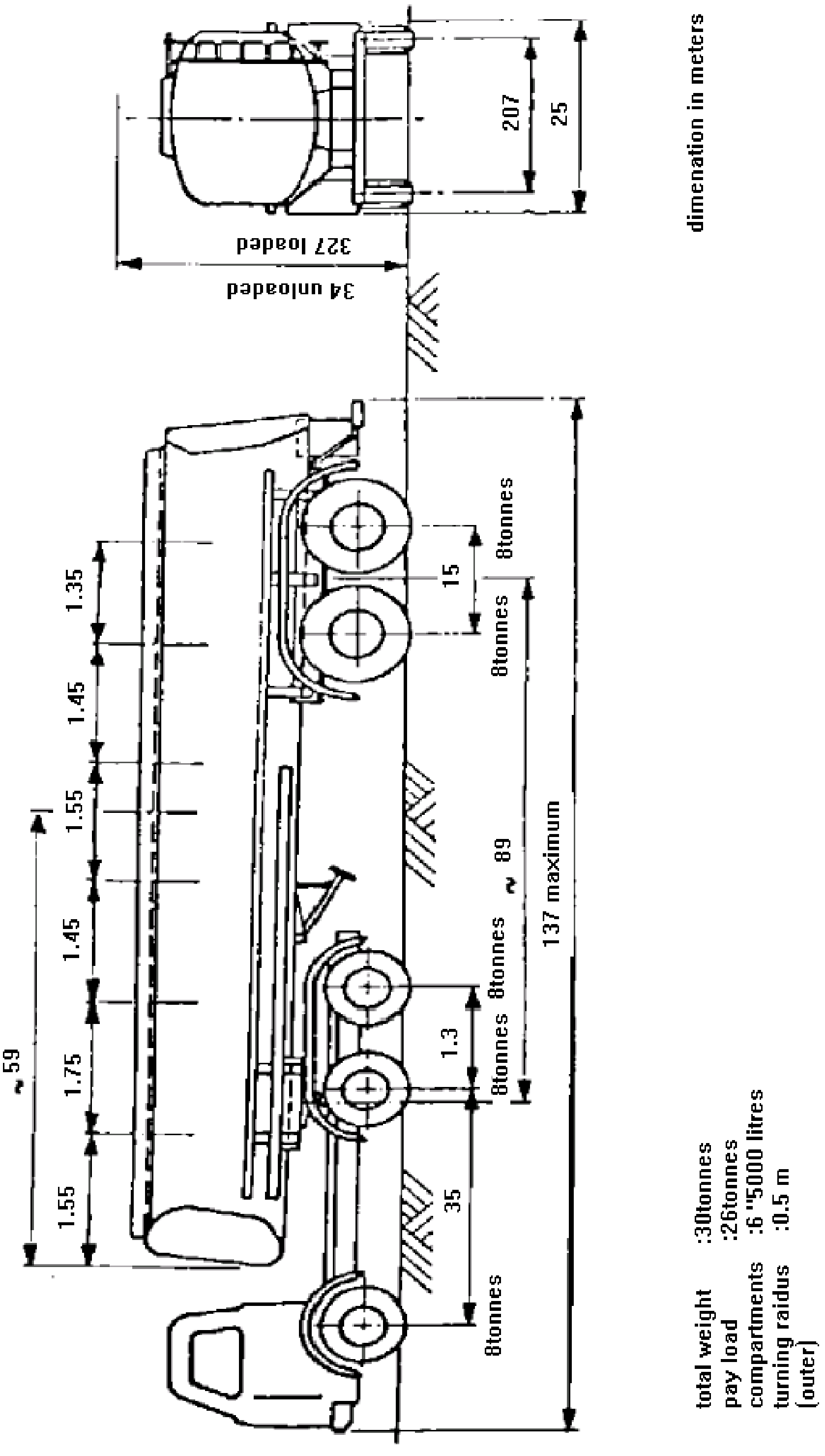
Besides pressure requirements, the hose shall have resistance to vacuum of up to 0.5 bar. It shall also have sufficient resistance to materials to be handled.

Note:

For further details see BS 3492.

APPENDIX E

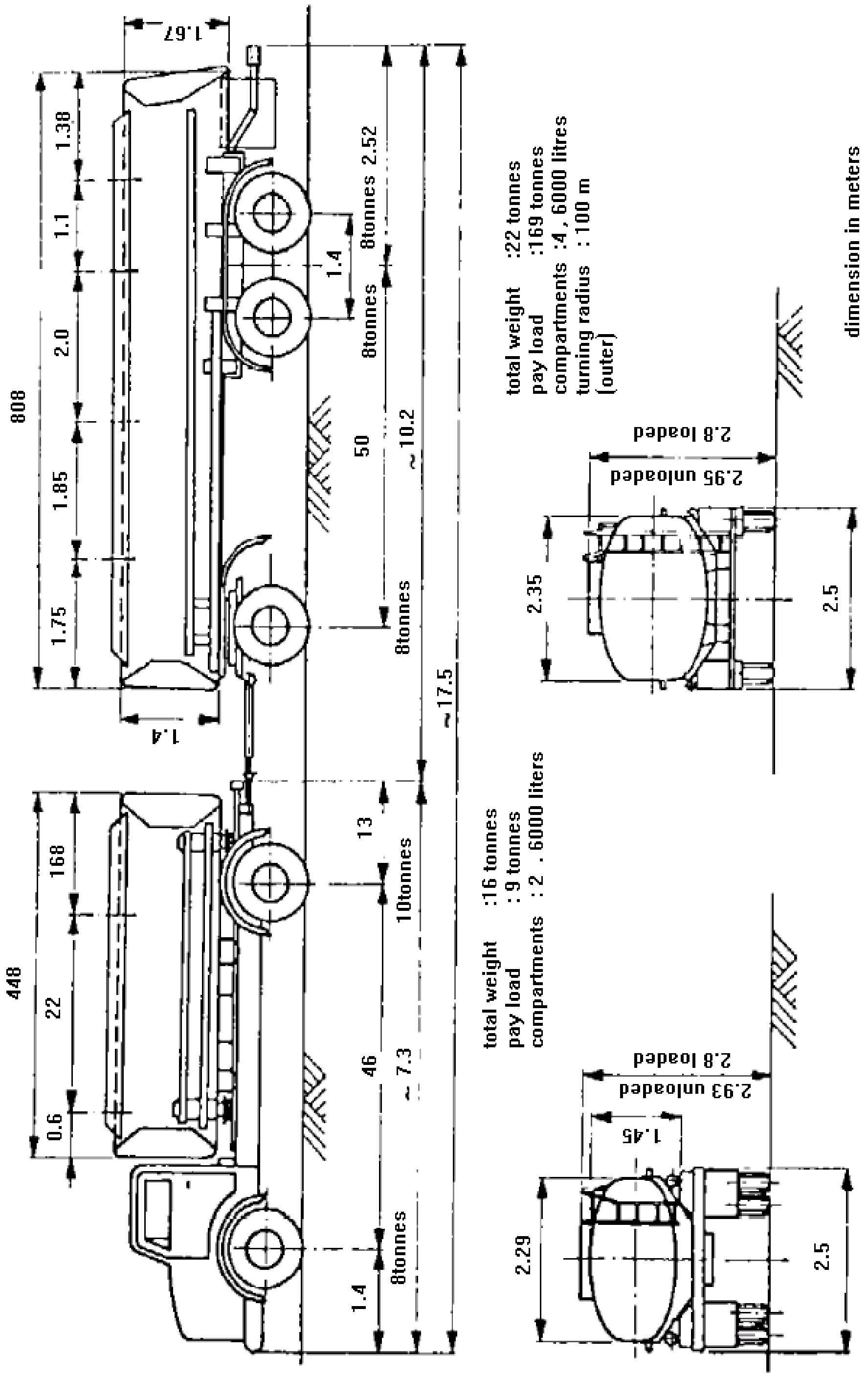
TYPICAL TRUCK DIMENSIONS



TYPICAL 38 - TONNE BULK ROAD VEHICLE
Fig. E.1

(to be continued)

APPENDIX E (continued)

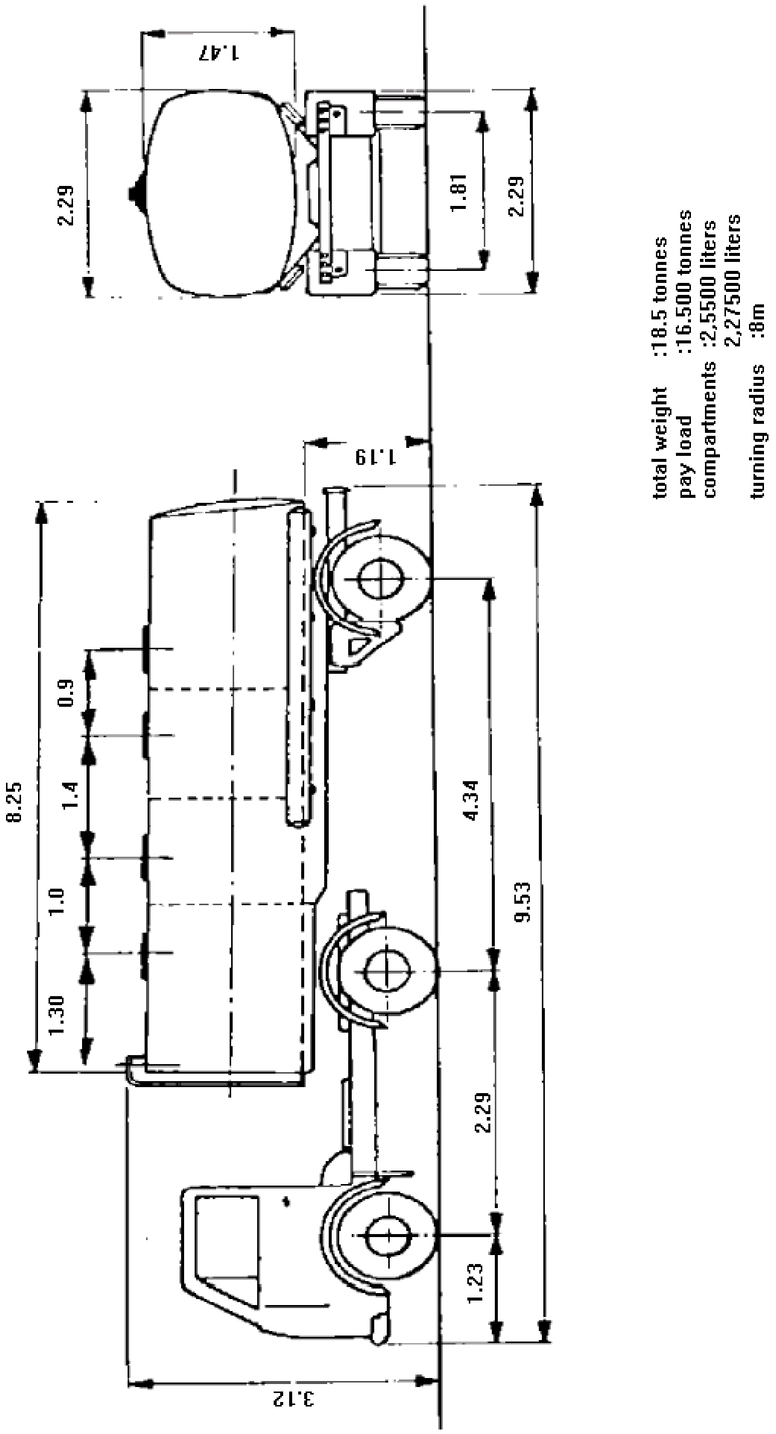


TYPICAL BULK ROAD VEHICLE WITH TRAILER

Fig. E.2

(to be continued)

APPENDIX E (continued)



TYPICAL BULK ROAD VEHICLE-16.5 CUBIC METERS CAPACITY

Fig. E.3