DEP SPECIFICATION

LOADING FACILITIES FOR BULK ROAD VEHICLES

DEP 31.06.11.11-Gen.

February 2011
(DEP Circular 83/11 has been incorporated)

DESIGN AND ENGINEERING PRACTICE

DEM1

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1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the design of loading facilities for bulk road vehicles for common white and black oil products. Today, these fuels may contain considerable amounts of bio components (specifically blends of gasoline with ethanol, and blends of Automotive Gas Oil (AGO) with FAME (Fatty Acid Methyl Esters)).

This DEP may also be applied to other hydrocarbon and chemical products such as bitumen and solvents, however, the Principal should be consulted for such applications. This DEP clarifies the design issues and describes the hardware required but it does not cover detailed design or engineering.

This DEP contains mandatory requirements to mitigate process safety risks in accordance with Design Engineering Manual DEM 1 – Application of Technical Standards.

This is a revision of the DEP of the same number dated January 2010; see (1.5) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

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This DEP is intended for use in facilities related to oil refineries, chemical plants, gas plants, exploration and production facilities and supply/distribution installations. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process should be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements could be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable with regards to the safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned, the objective being to obtain agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates the project and ultimately pays for it. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The capitalised term **SHALL [PS]** indicates a process safety requirement.

The word **should** indicates a recommendation.

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1.3.2 Specific definitions

Term	Definition
air eliminator	A device installed in a petroleum piping system to separate free vapour to a specified level from a flowing product stream, and discharge the separated vapour either automatically or by manual venting
bay	(1) area at each side of a top-loading gantry at which road vehicles can be filled at both sides. (2) area alongside the island of a bottom-loading facility.
bio component	biofuel component (in liquid form) derived from organic materials. Ethanol and FAME (Fatty Acid Methyl Ester) are examples of bio components
biodiesel	diesel fuel derived from vegetable oil or animal fat consisting of long-chain alkyl (methyl, propyl or ethyl) esters
biofuel	a blend of main fuel grade (typically gasoline or diesel fuel) with a bio component.
bonding	the connecting together of metal parts to ensure electrical continuity
bottom-loading envelope	the positioning of road vehicle adapter connections as recommended by API RP 1004
bulk road vehicle	a tank or other container mounted on a road-going chassis that is towed or self-propelled and capable of carrying petroleum products in bulk NOTE: For road transport vehicle specifications, reference should be made to national standards.
Class I, II, or III petroleum products	the method by which petroleum products and biofuels are classified for storage and handling by their flash point temperature, in accordance with IP-Part 2, as follows: Class I products have a flash point below 21°C (70°F); Class II products have a flash point between 21°C (70°F) and 55°C (131°F) inclusive; Class III products have a flash point above 55°C (131°F) - refer to IP-Part 2.
common black oil products	class III oil products such as heavy fuel oils and residual fuel oils NOTE: This excludes bitumen and contaminated products (e.g. products with free water, particle matter, H_2S).
common white oil products	gasolines, kerosenes, gasoils and distillates of oil products with a viscosity (unheated) of less than 20 mm^2/s (20 cSt) and a Final Boiling Point (FBP) of less than 385°C (725°F) (e.g. white spirits, toluene). NOTES This excludes: 1. contaminated products, e.g. with free water, particulate matter H_2S; 2. products with true vapour pressures above 0.86 bar (12.5 psi), e.g. LPG, pentanes; 3. very toxic substances (see DEP 01.00.01.30-Gen); 4. chemicals, e.g. ketones, alcohols, ethers, MTBE.
denatured ethanol	ethanol that has been rendered unfit for human consumption (often by adding unleaded gasoline).

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Term	Definition
ethanol	Ethyl alcohol made primarily from corn, various other grains and non grain feedstock. Ethanol comes in hydrous and anhydrous form. Anhydrous is the most pure type and is preferred for blending.
FAME – fatty acid methyl ester	FAME is an acronym for Fatty Acid Methyl Ester, the most common type of biodiesel produced from natural oil. The natural oils react with methanol and form the FAME. The type of FAME depends on the type of natural oil used (rapeseed, soy, tallow etc).
flame arrestor	device used in gas vent lines to prevent the passage of flames into enclosed spaces
foot valve	valve fitted at the outlet of a road vehicle tank compartment and sometimes referred to as an emergency valve or bottom outlet valve
gantry	structure associated with a product supply system and provided with all equipment necessary for loading, and providing safe access to, road vehicles
hose loader assembly	system consisting of pipe, swivel and hose connection for bottom loading
loading area	area comprising all filling islands and bays but excluding vehicle waiting areas.
loading arm	system of pipes and swivels, balanced for easy movement, through which product is transferred from the supply pipe into a road vehicle tank
loading island	area on which the equipment necessary to load a vehicle is mounted, e.g. meters, control valve, loading arms, hose loaders, control equipment etc. NOTE: Islands can be designed for multi-product or single product loading
loading terminal or facilities	combination of one or more loading bays or gantries, including additional facilities such as parking areas, waiting lanes, dispatch office, social amenities, and the product and utilities supply piping, from the point at which the piping enters the loading area
meter pre-set control	device or system which controls the quantity of incoming product loaded into a compartment of a road vehicle, sometimes called primary level control. This may be manual or electronic
neat biofuels	is the term used for pure biofuels (before any mixing with main grade fuels, such as gasoline or diesel, has taken place)
neat ethanol	is the term used for pure alcohol
occupancy ratio	proportion of any particular period for which the loading bay is in use for the loading of bulk road vehicles
overfill protection	system installed in addition to the meter pre-set control and designed to cut off flow if the product rises above a predetermined level in the compartment of the bulk road vehicle being filled. The equipment comprises sensors in the form of thermistors, opto electronic or float-controlled reed switches, solenoid or air-operated flow-control valves, etc.
static electricity	electric charge on a non-conductor or poor conductor, often caused by mechanical friction (e.g. product flow in a pipe)
ullage	depth of free space left in a tank above the liquid
vapour	one or more of the components of petroleum when in the vapour phase

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Term	Definition
vent	device for the release of hydrocarbon vapour or air from pipes, tanks, or fittings, and for the entry of air
vent lines	piping system for the transfer of hydrocarbon vapour or air to or from pipes, tanks, or pipe fittings, e.g. air eliminators
working platform	area of the gantry structure from which the person loading the vehicle from the top operates the meters, loading arms etc., and from which access is gained to the top of the tank of the bulk road vehicles

1.3.3 Abbreviations

ADR	Accord Dangereux Routier
AFFF	Aqueous Film Forming Foam
AGO	Automotive Gas Oil
AR	Alcohol Resistant
BOL	Bill of Lading
Bxx	FAME mixed with diesel or AGO (xx indicates the percentage of FAME)
COPS	Cross Over Protection System
CROSS	Customisable Routing and Scheduling System (for Road Transport)
EPA	Environmental Protection Agency
ERP	Enterprise Resource Planning
ESD	Emergency Shut Down
Exx	Ethanol mixed with gasoline (xx indicates the percentage of Ethanol)
FAME	Fatty Acid Methyl Ester
IGO	Industrial Gas Oil
JDE	Enterprise Resource Planning System
MTBE	Methyl Tertiary Butyl Ether
NRV	Non-Return Valve
OEL	Occupational Exposure Limit
PD	Positive Displacement
pS/m	Pico Siemens per meter
ppm	parts per million
PVC	Poly Vinyl Chloride
SAP	Shell Standard Enterprise Resource Planning System
SDA	Static Dissipator Additive
STEL	Short Term Exposure Limit
SWA	Steel Wire Armoured
TMS	Transportation Management System
VFD	Variable Frequency Drive
VOC	Volatile Organic Compound
VRU	Vapour Recovery Unit
XLPE	Cross Linked Polyethylene

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1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section number is shown in brackets. Other documents referenced by this DEP are listed in (10).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated January 2010. The following are the main, non-editorial changes.

Old section	New section	Change
General	General	Split of document in 2 parts. In DEP Spec which contains all mandatory requirements and in DEP Inf, its companion tha contains additional supporting information.
General	Gerneral	Process safety requirements have been indicated by the use of the capitalised term "SHALL [PS]"

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be sent to the Administrator at standards@shell.com, using the DEP Feedback Form. The DEP Feedback Form can be found on the main page of "DEPs on the Web", available through the Global Technical Standards web portal http://sww.shell.com/standards and on the main page of the DEPs DVD-ROM.

1.7 DUAL UNITS

Amended per Circular 83/11
Dual units have been incorporated throughout this DEP.

This DEP contains both the International System (SI) units, as well as the corresponding US Customary (USC) units, which are given following the SI units in brackets. When agreed by the Principal, the indicated USC values/units may be used.

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2. BASIC DESIGN OF A LOADING TERMINAL

2.1 GENERAL

In the design of a loading terminal, the total cost of loading vehicles should be minimised. The costs of the loading terminal include:

- capital charges for the loading facilities (e.g. gantry, structures, pumps, lines, automation system, VRU etc.).
- manpower costs for the administration and surveillance of the loading activities.
- maintenance costs of the loading facilities.

The above costs should be balanced against:

- the cost of vehicle time while “in the yard”, queuing for a loading bay, occupying the loading bay and exiting the terminal.

Wherever possible, for products lighter than diesel fuel, Bottom Loading configurations shall be used for all new gantry development works including refurbishment to achieve maximum possible loading efficiency and truck utilisation, reduce group HSSE risks by improving occupational health and minimise VOC emissions to the environment.

Top loading shall only be used when bottom-loading alternatives are not available and only after carrying out an HSE risk assessment of the operations. Approved fall protections systems shall be installed and used as designed.

2.1.1 Biofuels

When introducing neat biofuels, or fuels containing biofuels, into a Terminal, there are several issues that shall be checked at the design stage, such as: product contamination; materials compatibility with piping, pump seals and vapour recovery units; reduction of conductivity with certain mixtures of FAME; product classification; type of fire fighting systems and foam required; and spill containment facilities to deal with ethanol mixtures.

Usually conventional slops are fed back to refinery for reprocessing. Slops containing Ethanol, FAME, MTBE, ETBE etc. shall not be fed back to the refinery and should be treated differently than conventional slops (eg. incineration). The terminal shall implement a proper Slops Management System for oxigenized products.

At terminals, any contamination of Jet Fuels with FAME (or with diesel containing FAME) shall be avoided to ensure that the average level of FAME in a batch of jet fuel is below the maximum level as specified in DEFSTAN91-91 for Jet A-1.

FAME shall be handled using procedures that do not allow the temperature to drop below 6°C above the FAME’s cloud point to avoid formation of solids that can cause blockages of fuel lines and filters. In areas of cold climate, depots should consider whether heating of transfer lines is necessary to maintain the temperature at the correct level.

2.2 PEAK DEMAND

Any loading facility should be designed to meet the forecast loading demand during peak periods. A statistical analysis of historical figures should be the starting point, but the effects of planned improvements in methods and loading equipment and any changes likely to occur in working hours, shift patterns, vehicle sizes and types, variations in demand growth of different products, requirements for additional or fewer grades etc., shall be taken into account.

2.3 LOADING FLOW RATES

2.3.1 Determination of loading flow rate

Flow rates are restricted by the economic size of pumps, piping and measuring equipment or by the hazard of static electricity, (see 2.3.2).

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High loading flow rates reduce the time spent by a vehicle at a loading gantry, resulting in the following:

(i) a reduction in vehicle idle time, i.e. standing charges;

(ii) a reduction in the bay occupancy time, which could reduce the total number of required loading bays.

On the other hand, the additional costs of pumps, larger bore piping, loading arms, flow meters and other equipment, together with increased energy consumption, shall also be taken into account.

For bottom loading, a 4-inch system should be employed (see 3.4.1).

2.3.2 Maximum flow rates of uncontaminated liquids due to static electricity hazards

If a flammable atmosphere may be present (e.g. when loading flammable products and/or when switch loading is applied), the loading velocities SHALL [PS] be determined using the flowchart in (2.3.3).

Before loading, if a flammable atmosphere may be present, the following are the key issues to be taken into account when using the flowchart in (2.3.3) to determine the safe loading speed.

1) Determine whether a flammable atmosphere could occur

2) Classify the product conductivity (≤ 50 pS/m, > 50 pS/m or unknown) (≤ 50 micromhos/cm, > 50 micromhos/cm or unknown)

3) Classify the product sulphur content (≤ 50 mg/kg, > 50 mg/kg) (≤ 50 ppmw, > 50 ppmw)

4) Detemine whether the vehicle / tanker is suitable for high speed loading

There are High Speed Loading vehicles / tankers that allow for higher loading rates and are designed to meet certain specific requirements. If a vehicle/tanker is to be classed as suitable for high speed loading, then all compartments on that vehicle SHALL [PS] be high speed loading compartments.

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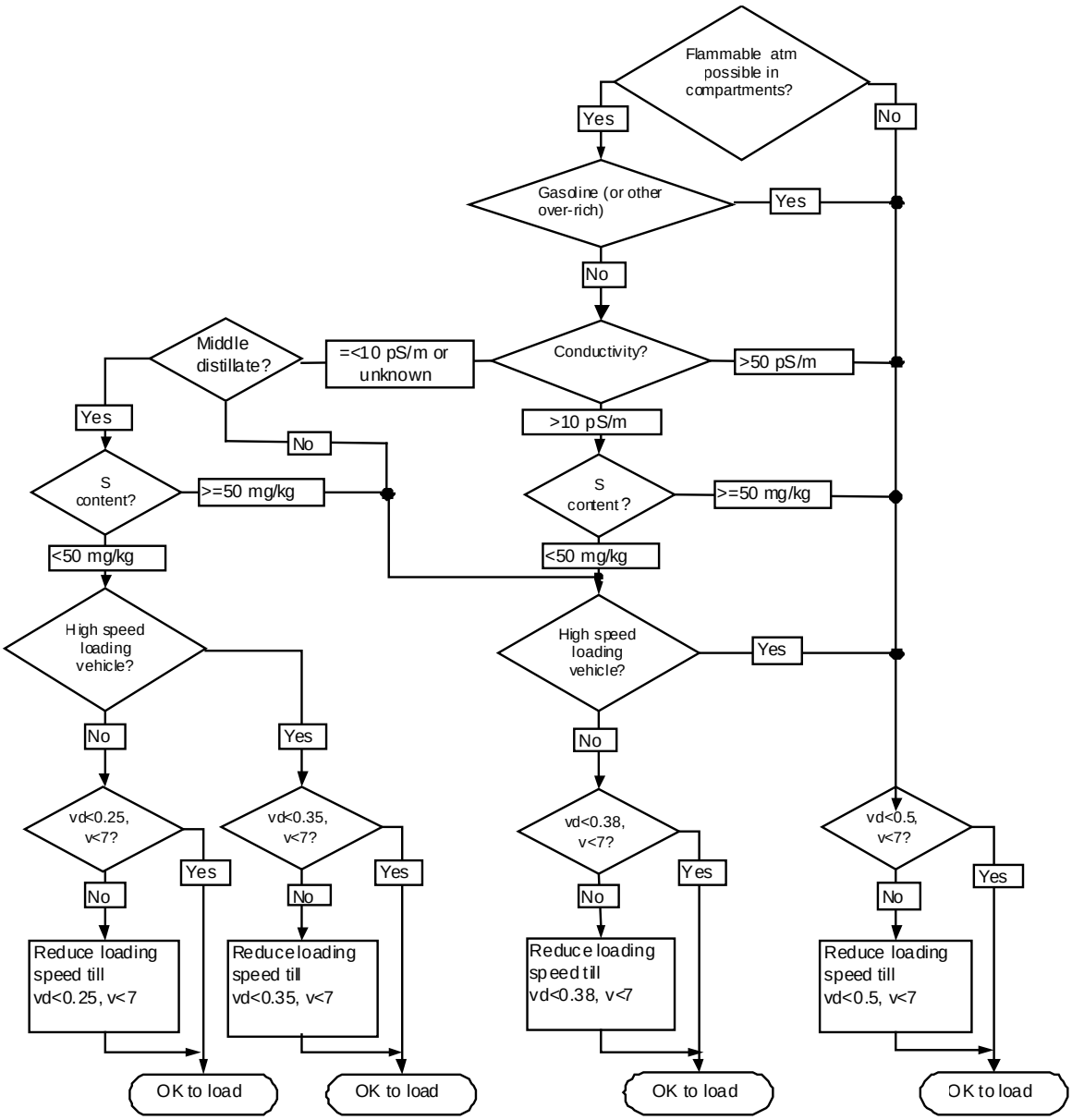
2.3.3 Flowchart for determining the maximum safe loading velocity for road tankers



v is the velocity in m/s and d is the internal pipe diameter in metres, and the variable (*vd*) is the velocity times the internal pipe diameter expressed. The variable vd is expressed in m^2/s.

<u>Flow limits</u>

a) With a possible flammable atmosphere, conductivity ≤ 10 pS/m (10 micromhos/cm) or unknown, middle distillate with a sulphur content ≤50 mg/kg (≤50 ppmw) and

I. a non-high-speed-loading vehicle,

loading speed SHALL [PS] give vd ≤ 0.25 m^2/s (≤ 2.7 ft^2/s); (max. 1200 L/min (11 ft^3/min) with standard 10 cm (4 in) pipework).

II. a high-speed loading vehicle,

loading speed SHALL [PS] give vd ≤ 0.35 m^2/s (≤ 3.8 ft^2/s) (max. 1650 L/min (58 ft^3/min) with standard 10 cm (4 in) pipework).

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b) With a possible flammable atmosphere and:

I. conductivity between 10 and 50 pS/m (10 and 50 micromhos/cm) and middle distillate with a sulphur content ≤50 mg/kg (≤50 ppmw); or

II. conductivity ≤10 pS/m (≤10 micromhos/cm) and sulphur content >50 mg/kg (>50 ppmw) or product other than middle distillate

loading speed SHALL [PS] give vd ≤ 0.38 m^2/s (≤ 4.1 ft^2/s) (max. 1800 L/min (64 ft^3/min) with standard 10 cm (4 in) pipework).

c) With:

I. no flammable atmosphere; or

II. loading gasoline or other liquid that produces an over-rich atmosphere; or

III. a possible flammable atmosphere; and

i. conductivity > 50 pS/m (< 50 micromhos/cm) or

ii. conductivity between 10 pS/m and 50 pS/m and sulphur content >50 mg/kg (> 50 ppmw) or non-middle distillate product or

iii. conductivity ≤10 pS/m and sulphur content >50 mg/kg (>50 ppmw) or non middle distillate product and high speed loading vehicle

loading speed SHALL [PS] give vd ≤ 0.5 m^2/s (≤ 5.4 ft^2/s) (max. 2400 L/min (85 ft^3/min) with standard 10 cm (4 in) pipework).

Diameter d should normally be the diameter of the smallest section upstream of the tank being filled, but if the smallest section is less than 10 m (33 ft) long and has a diameter of at least 67 % of the next smallest section, the diameter of the next smallest section may be taken. This commonly allows the use of 3 inch meters (10 in ft) in DN 100 (NPS 4) bottom loading systems, where vd>0.5 m^2/s (5.4 ft^2/s), but pipe length is limited to around 2 m (6 ft) where flow conditioning straighteners are used.

If contaminated non-conductive liquids are loaded, the loading velocity should be limited to 1 m/s (3 ft/s). For liquids with a conductivity of more than 50 pS/m (50 micromhos/cm), no loading velocity restrictions apply for static electricity reasons, but the loading velocity should still be limited to 7 m/s (23 ft/s).

2.4 SIMULTANEOUS LOADING USING TWO OR MORE ARMS/HOSES

For top loading, the simultaneous use of two or more arms will result in the need for additional equipment to prevent overfilling which may otherwise not be necessary (see 4.5.1). The cost and other operational consequences (HSSE) arising from such equipment shall be taken into account in the economic comparison but this is not a recommended configuration for products lighter than diesel fuel.

2.5 CALCULATION OF NUMBER OF LOADING BAYS

2.5.1 General

Depending on local circumstances the design of loading facilities should distinguish between two design concepts as detailed below:

(i) the 'morning peak period' design concept,

(ii) the 'waiting time' design concept.

2.5.2 The 'morning peak period' design concept

The demand in this 'peak period' has a considerable effect on the size of the final arrangement and hence shall be ascertained by consulting local staff. If all waiting vehicles have to be loaded in one hour (resulting in an average waiting time of half an hour for those vehicles which cannot be served at once), the loading facility will be twice as large as one

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where all the vehicles have to be loaded in two hours (resulting in an average waiting time of one hour for those vehicles which cannot be served immediately).

2.5.3 The 'waiting time' design concept

If the arrival of vehicles is irregular, the design procedure should be based on a specified maximum average waiting time per vehicle. Such is the case, for example, in terminals operating 24 hours per day, or in terminals which try to spread the working load as evenly as possible over the working day.

2.5.4 Manual estimation of the number of loading bays required

The first step is the calculation of the 'peak period' demand; this is defined as follows for each method:

- in the 'morning peak period' method, the peak period demand is the offtake by those vehicles which queue outside the gate and which shall be loaded in the first morning period (one or more hours).
- in the 'waiting time' design method, the peak period demand is defined as the offtake during (any) one hour in a period, which has the highest vehicle arrival frequency. This period may be longer than one hour and can occur on more than one occasion in any one day.

2.6 ALLOCATION OF LOADING ARMS TO BAYS

For operational reasons, it is desirable to limit the number of loading arms at one gantry/loading bay to six. Allocation of loading arms should take into consideration the combination of products each tanker will carry so that tankers do not have to move from one bay to another during loading. Also, the product-grouping requirement (see 8.1.5) shall be taken in account.

The accommodation of more than 6 arms may be considered where product loading grouping and speciality products require single load arms. Special consideration then should be paid to access, loading envelope and drainage requirements.

2.7 PUMP CAPACITIES

2.7.1 Single loading arm

If only one product loading arm or hose is allocated for any product, a single pump rated for the maximum design flow rate of the loading system (meters, piping, loading arm/hose) should be provided.

2.7.2 Two loading arms

If two product loading arms/hoses are allocated for any product, a single pump rated for the maximum design flow rate of the loading systems for two arms/hoses, operating together, should be provided.

2.7.3 More than two loading arms per product

If more than two loading arms/hoses are allocated for any product, as a means of optimising pump numbers and sizes, a reduced total pumping capacity may be provided to allow for the time when vehicles occupy a loading bay but product is being loaded slowly or not at all, i.e. at the beginning or end of the filling cycle. By reducing the pumping capacity, the VRU and pipe work capacity may also be reduced.

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