

DEP SPECIFICATION

LOADING FACILITIES FOR BULK ROAD VEHICLES

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DESIGN AND ENGINEERING PRACTICE

DEM1



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1. INTRODUCTION

1.1 SCOPE

This DEP clarifies the design issues and describes the hardware required within the design of loading facilities for bulk road vehicles for common white and black oil products.

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)).

The Contractor shall confirm the applicability of this DEP to the design of loading facilities for bulk loading of other hydrocarbon and chemical products.

This DEP 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 September 2011; 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 shall 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.

The word **may** indicates a permitted option.

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 EI-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 EI-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 ₂ S).

Term	Definition
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 H₂S; 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.); chemicals, e.g. ketones, alcohols, ethers, MTBE.
denatured ethanol	ethanol that has been rendered unfit for human consumption (often by adding unleaded gasoline).
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

Term	Definition
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
overflow 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
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
Very Toxic (Substances)	Refer to DEP 01.00.01.30-Gen. for additional details concerning the definitions of "very toxic - acute", "very toxic - chronic", and "very toxic-environment".
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

Term	Definition
ADR	Accord Dangereux Routier
AFFF	Aqueous Film Forming Foam
AGO	Automotive Gas Oil
ALARP	As Low As Reasonably Practicable
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 Shutdown
Exx	Ethanol mixed with gasoline (xx indicates the percentage of Ethanol)
FAME	Fatty Acid Methyl Esters
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
ppm	parts per million
pS/m	Pico Siemens per meter
PVC	Poly Vinyl Chloride
SAP	Shell Standard Enterprise Resource Planning System
SDA	Static Dissipator Additive
STEL	Short Term Exposure Limit

Term	Definition
SWA	Steel Wire Armoured
TMS	Transportation Management System
VFD	Variable Frequency Drive
VOC	Volatile Organic Compound
VRU	Vapour Recovery Unit
XLPE	Cross Linked Polyethylene

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section or clause 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 September 2011. The following are the main, non-editorial changes.

Section/Clause	Change
All	Restructured and clarified requirements, enforced use of shall / should / may for normative statements
All	Removed requirements for tanker vehicles as inappropriate for this DEP.
All	SHALL [PS] requirement restructured.

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be submitted to the Administrator using one of the following options:

Shell DEPs Online (Users with access to Shell DEPs Online)	Enter the Shell DEPs Online system at https://www.shelldeps.com Select a DEP and then go to the details screen for that DEP. Click on the "Give feedback" link, fill in the online form and submit.
DEP Feedback System (Users with access to Shell Wide Web)	Enter comments directly in the DEP Feedback System which is accessible from the Technical Standards Portal http://swwww.shell.com/standards . Select "Submit DEP Feedback", fill in the online form and submit.
DEP Standard Form (other users)	Use DEP Standard Form 00.00.05.80-Gen. to record feedback and email the form to the Administrator at standards@shell.com .

Feedback that has been registered in the DEP Feedback System by using one of the above options will be reviewed by the DEP Custodian for potential improvements to the DEP.

1.7 DUAL UNITS

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.

1.8 NON NORMATIVE TEXT (COMMENTARY)

Text shown in italic style in this DEP indicates text that is non-normative and is provided as explanation or background information only.

Non-normative text is normally indented slightly to the right of the relevant DEP clause.

2. BASIC DESIGN OF A LOADING TERMINAL

2.1 GENERAL

1. The total costs of a loading terminal are:
 - a. capital charges for the actual loading facilities;
(e.g., gantry, structures, pumps, lines, automation system, VRU, etc.).
 - b. projected manpower costs for the administration and surveillance of the loading activities;
 - c. projected maintenance costs of the loading facilities.
2. The above costs should be balanced against the efficiency of serving the vehicles.

This includes:

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

2.1.1 Biofuels

1. When introducing neat biofuels, or fuels containing biofuels, into a Terminal, the following shall be checked at the design stage:
 - a. product contamination;
 - b. materials compatibility with piping, pump seals and vapour recovery units;
 - c. reduction of conductivity with certain mixtures of FAME;
 - d. product classification;
 - e. type of fire fighting systems and foam required; and
 - f. spill containment facilities to deal with ethanol mixtures.
2. Slops containing fuel additives like Ethanol, FAME, MTBE, ETBE shall not be fed back to the refinery.
 - a. Usually conventional slops are fed back to refinery for reprocessing however slops containing additives should be treated differently (e.g., incineration).
3. The terminal shall implement a Slops Management System for oxygenised products.
4. Systems containing FAME shall be designed:
 - a. To prevent the contamination of Jet Fuels with FAME (or with diesel containing FAME).
This is 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.
 - b. To prevent the temperature to drop below 6 °C above the FAME's cloud point.
This is to avoid formation of solids that can cause blockages of fuel lines and filters.

2.2 PEAK DEMAND

1. The loading facility shall be designed to meet the forecast loading demand during peak periods.
2. The loading demand at peak periods should be based on:
 - a. statistical analysis of historical figures;
 - b. the effects of planned improvements in methods and loading equipment and any changes likely to occur in:
 - i. working hours;
 - ii. shift patterns;
 - iii. vehicle sizes and types;
 - iv. variations in demand growth of different products;
 - v. requirements for additional or fewer grades etc.
 - c. choice of design concept basis – the ‘morning peak concept or wait time (See 2.5.1).

2.3 LOADING FLOW RATES

2.3.1 Determination of loading flow rate

1. Piping shall be designed to allow for maximum loading rates at the loading gantry.

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

 - a reduction in vehicle idle time, i.e., standing charges;
 - a reduction in the bay occupancy time, which could reduce the total number of required loading bays.
2. Flow rates shall be selected based on the hazard of static electricity (see 2.3.2) and the proposed vehicles that will use the facility then accordingly the size of pumps, piping and measuring equipment are selected.

There are High Speed Loading vehicles / tankers that allow for higher loading rates and are designed to meet certain specific requirements.
3. If a vehicle/tanker is to be classed as suitable for high speed loading in the design, then all compartments on that vehicle SHALL [PS] be high speed loading compartments.
4. An economic analysis shall be provided that addresses the following options before selection of the pumps, piping and measuring equipment:
 - a. multiple pumps;
 - b. larger bore piping (see 3.4.1);
 - c. larger bore loading arms (see 3.4.1);
 - d. multiple loading arms.

2.3.2 Maximum flow rates

1. Loading velocities shall be determined using the flowchart in Figure 1 either:
 - a. if a flammable atmosphere can be present (e.g., when loading flammable products);
 - b. when switch loading is applied.

The logic in Figure 1 is devised to reduce the hazards from static electricity

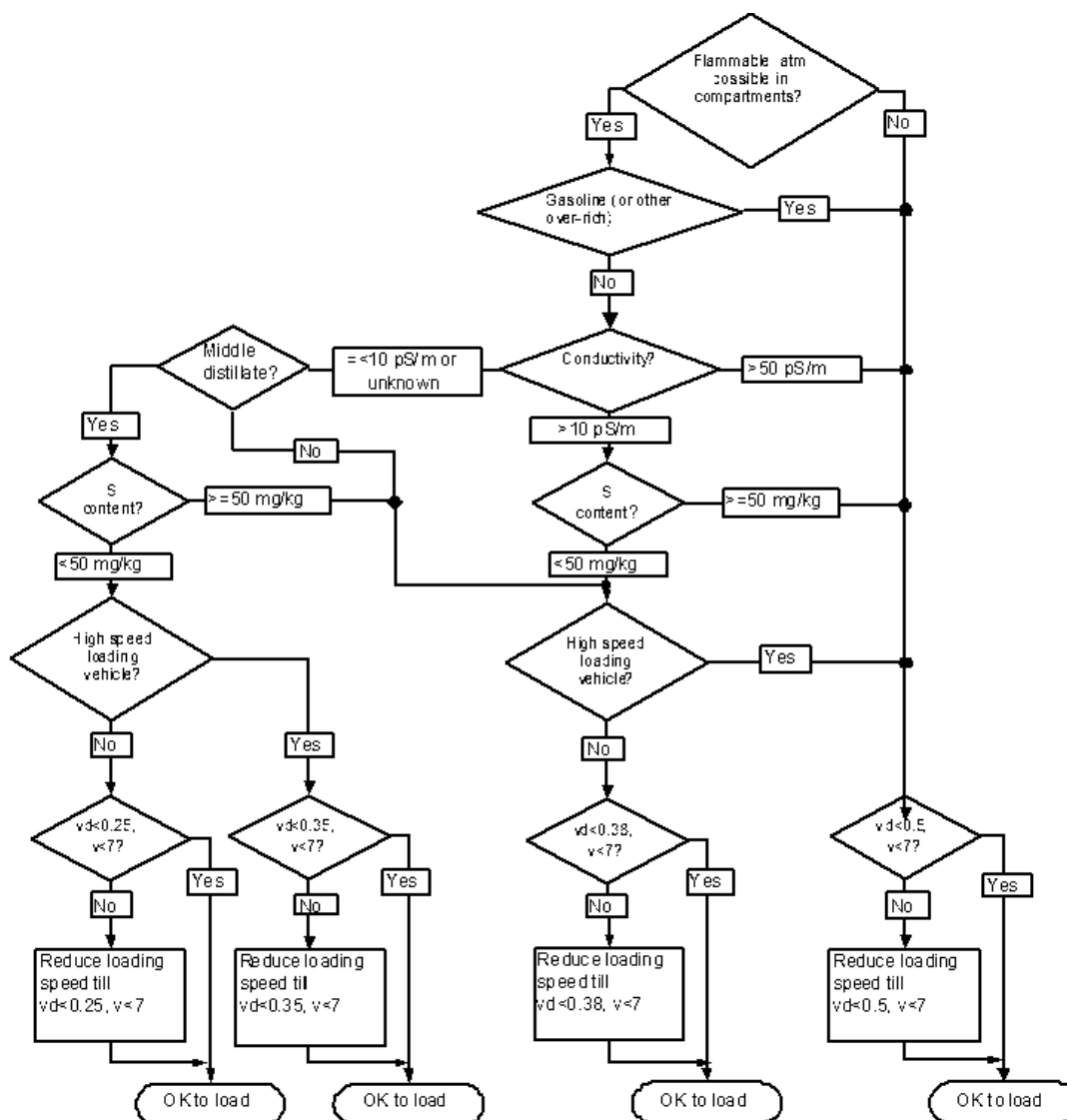
2. In order to use Figure 1 the design shall determine the following key input to determine the safe loading speed:
 - a. determine whether a flammable atmosphere could occur;
 - b. classify the product conductivity (≤ 50 pS/m, > 50 pS/m or unknown)
(≤ 50 micromhos/cm, > 50 micromhos/cm or unknown);
 - c. classify the product sulphur content (≤ 50 mg/kg, > 50 mg/kg) (≤ 50 ppmw, > 50 ppmw);
 - d. determine whether the design basis 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.

3. Diameter d in Figure 1 should be the diameter of the smallest section of pipe upstream of the tank being filled.
 - a. The diameter d may be increased from that of the smallest diameter pipe to that of a larger diameter upstream of the tank being filled if the length of the smallest diameter section of pipe is less than 10 m (33 ft) and the diameter of this larger diameter pipe is no greater than 1.5 times that of the smaller diameter pipe.

This commonly allows the use of nominal DN 80 (NPS 3) in DN 100 (NPS 4) bottom loading systems, where $vd > 0.5$ m²/s (5.4 ft²/s), provided the pipe length is limited to around 2 m (6 ft) where flow conditioning straighteners are used.

Figure 1 Flowchart for determining the maximum safe loading velocity for road tankers



Note: v - 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 m²/s

2.3.2.1 Flow limits

1. If contaminated non-conductive liquids are loaded, the loading velocity should be limited to 1 m/s (3 ft/s).
2. For liquids with a conductivity of more than 50 pS/m (50 micromhos/cm) the loading velocity should be limited to 7 m/s (23 ft/s).

This limit is not based on static electricity.

3. 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 a non-high-speed-loading vehicle, loading speed SHALL [PS] give $vd \leq 0.25$ m²/s (≤ 2.7 ft²/s); (max. 1200 L/min (11 ft³/min) with standard 10 cm (4 in) pipework).
4. 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) a high-speed loading vehicle, loading speed SHALL [PS] give $vd \leq 0.35$ m²/s (≤ 3.8 ft²/s) (max. 1650 L/min (58 ft³/min) with standard 10 cm (4 in) pipework).
5. With a possible flammable atmosphere and conductivity between 10 and 50 pS/m (10 and 50 micromhos/cm) and middle distillate with a sulphur content ≤ 50 mg/kg (≤ 50 ppmw) loading speed SHALL [PS] give $vd \leq 0.38$ m²/s (≤ 4.1 ft²/s) (max. 1800 L/min (64 ft³/min) with standard 10 cm (4 in) pipework).
6. With a possible flammable atmosphere and 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 $vd \leq 0.38$ m²/s (≤ 4.1 ft²/s) (max. 1800 L/min (64 ft³/min) with standard 10 cm (4 in) pipework).
7. With no flammable atmosphere loading speed SHALL [PS] give $vd \leq 0.5$ m²/s (≤ 5.4 ft²/s) (max. 2400 L/min (85 ft³/min) with standard 10 cm (4 in) pipework).
8. With loading gasoline or other liquid that produces an over-rich atmosphere loading speed SHALL [PS] give $vd \leq 0.5$ m²/s (≤ 5.4 ft²/s) (max. 2400 L/min (85 ft³/min) with standard 10 cm (4 in) pipework).
9. With a possible flammable atmosphere and conductivity > 50 pS/m (> 50 micromhos/cm) loading speed SHALL [PS] give $vd \leq 0.5$ m²/s (≤ 5.4 ft²/s) (max. 2400 L/min (85 ft³/min) with standard 10 cm (4 in) pipework).
10. With a possible flammable atmosphere and conductivity between 10 pS/m and 50 pS/m and sulphur content > 50 mg/kg (> 50 ppmw) or non-middle distillate product loading speed SHALL [PS] give $vd \leq 0.5$ m²/s (≤ 5.4 ft²/s) (max. 2400 L/min (85 ft³/min) with standard 10 cm (4 in) pipework).
11. With a possible flammable atmosphere and 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 $vd \leq 0.5$ m²/s (≤ 5.4 ft²/s) (max. 2400 L/min (85 ft³/min) with standard 10 cm (4 in) pipework).

2.4 SIMULTANEOUS LOADING USING TWO OR MORE ARMS/HOSES

1. A design that mandates the simultaneous use of two or more arms for top loading should only be used if:
 - a. the additional equipment to prevent overfilling is provided (see 4.5.1);
 - b. the product is not lighter than diesel fuel.