

DEP SPECIFICATION

SAFE VAPOUR CONTROL FOR WASTEWATER COLLECTION AND TREATMENT SYSTEMS

DEP 30.73.10.30-Gen.

February 2017

ECCN EAR99

DESIGN AND ENGINEERING PRACTICE

DEM1



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1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the selection, application, and design of safe vapour control for wastewater collection and treatment systems.

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

The scope for this DEP includes new construction wastewater collection (sumps and sewers) and treatment units where there is potential for hydrocarbon (VOC) accumulation in a confined vapour space. Examples include primary oil-water-solids separation, equalization and diversion tanks, slop oil tanks, oily solids tanks and dewatering tanks and equipment and equipment that both drain and treat. Facilities performing only drainage functions fall outside the scope of this DEP.

The DEP also applies to cases where existing wastewater collection and treatment systems are being reconstructed with covers and vapour controls. For example, such controls may be required due to new regulatory or industrial hygiene requirements.

This DEP applies to onshore treatment facilities and associated collection systems (i.e. process sewers). Facilities that only drain non-contaminated rainwater are not subject to this DEP.

This DEP is intended to provide the user with a specification that will improve standards for good design and engineering practice for vapour control systems. Guidelines relating to safety and the typical requirements during various project development phases are included so that these aspects can be accommodated during the design stage.

The importance of a well-designed, constructed, managed and maintained vapour control system for wastewater collection and treatment systems where VOC can accumulate cannot be overstressed, in terms of safety and environmental care. Shortcomings in a vapour control system can have significant impact on process safety and the environment.

This DEP is not required if it can be documented that volatile organic compounds (VOC) have no potential to enter a unit having a vapour space.

Examples where this DEP may not be applicable could include treated wastewater tanks prior to discharge, non-flammable chemicals used in the treatment process, segregated rain water systems serving non-process areas, etc.

This DEP is a revision of the same number dated February 2015; see (1.5) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorized by Shell GSI, the distribution of this DEP is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them. Any authorized access to DEPs does not for that reason constitute an authorization to any documents, data or information to which the DEPs may refer.

This DEP is intended for use in facilities related to onshore oil and gas production, gas handling, oil refining, and chemical processing. 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 authorized to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation or a preferred solution.

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

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

1.3.2 Specific definitions

Term	Definition
Activated Carbon	Trade name for a carbonaceous adsorbent having a porous structure and a large internal surface area (typically 4×10^5 to 1.6×10^6 m ² /kg) commonly used for adsorptive removal of select compounds, mainly organics, from both gas and liquid streams
Deflagration	Combustion wave that propagates at subsonic velocities (based on the temperature and pressure of the flame front). Flames initiated in a horizontal constant-diameter pipe naturally propagate at subsonic velocities.
Detonation	Propagation of a combustion wave at sonic or supersonic velocity (based on the temperature and pressure of the flame front). A detonation is stable when it has a velocity equal to the speed of sound in the burnt gas, and may be unstable with a higher velocity and pressure.
Detonation Arrester	Passive, in-line, flow-through, flame-arresting device designed and certified to stop passage of both deflagrations and detonations. It comprises of an arrester element and housing. Both mono-directional (i.e., able to stop flame passage from one direction only) and bi-directional (i.e., able to stop flame passage from either direction) designs are available
Explosion	Propagating pressure that expands from the point of ignition at a velocity of about 300 m/s (984 ft/s) and is usually followed by a flame front. A dust explosion is actually a series of explosions consisting of a primary explosion followed by multiple secondary explosions. The secondary explosions are usually far more devastating than the initial explosion.
Flame Arrester	Passive, flow-through, end-of-line or near-end-of-line, flame-arresting device designed and certified to stop the passage of a low-pressure deflagration. It comprises an arrester element and housing, and has specific limitations regarding the piping arrangement and distance between the arrester and ignition source (i.e., to ensure that conditions do not exceed those for which the arrester has been certified).
Lower Flammability Limit (LFL)	Lowest concentration of a combustible compound in air that will support its combustion. It is sometimes referred to as lower explosive limit (LEL). The LFL is usually expressed as % in air and changes as a result of inerting, pressure, and temperature of the mixture.
Maximum Safe Oxygen Concentration (MSOC)	The limiting concentration of oxygen below which combustion is not possible, independent of the concentration of fuel. It is expressed in units of volume percent of oxygen.
Safety Integrity Level (SIL)	A classification system for instrumented protective functions demonstrating the degree of risk reduction associated with application of the function. SIL takes into account probability of failure and availability to rank the level of risk reduction.

Term	Definition
Upper Flammability Limit (UFL)	Concentration of a combustible compound in air above which combustion will not proceed. Sometimes referred to as upper explosive limit (UEL). The UFL is usually expressed in air and changes as result of inerting, pressure, and temperature of the mixture.

1.3.3 Abbreviations

Term	Definition
ALARP	As Low As Reasonably Practicable
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
CFR	Code Of Federal Register (United States)
DA	Detonation Arrestor
DAF	Dissolved Air Flotation
ESD	Emergency Shut-Down
FA	Flame Arrestor
FRP	Fibre-Reinforced Plastics
FS	Flame Suppression
HAZOP	Hazards and Operability Review
LEL	Lower Explosive Limit
LFL	Lower Flammable Limit (Same As Lel)
MESG	Maximum Experimental Safe Gap
MSOC	Maximum Safe Oxygen Concentration
RTD	Resistance Temperature Detector
SIL	Safety Integrity Level
UFL	Upper Flammable Limit (Same As Uel)
VOC	Volatile Organic Compound

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 (7).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a full revision of the DEP of the same number dated February 2015.
The following are the main, non-editorial changes.

Section/Clause	Change
All	Minor text editorial and update of informative data
2.7 Item 1 and 3.3 Item 2	Slight restructure of SHALL [PS]
3.2.1 and 6.2	Updated/ SHALL [PS] to (2.7)

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.
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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. GENERAL DESIGN REQUIREMENTS

2.1 VAPOUR CHARACTERISATION

1. The actual vapour concentrations and oxygen concentrations that define lower flammability limit (LFL) and upper flammability limit (UFL) shall be determined.
 - a. Contractor shall document on a case-by-case basis and address in the design the variations in vapour compositions that can occur.
 - b. A documented assessment of the composition and concentration (mass and energy balance, analyses, etc.) of flammable compounds in the vapour space shall be provided for design and reviewed with the Principal.
 - c. The system potential for air ingress shall be accounted for in the classification of vapours.
 - d. From this assessment, a flammability envelope shall be developed to indicate the flammability zone of the vapour within the enclosed space and its composition feeding to a vapour control device (i.e., flare, thermal oxidizer, carbon canister, etc.).
2. Prior to selecting a vapour collection system and end control device, source vapours shall be classified according to their flammability during normal operations as follows:
 - a. Normally below LFL;
 - b. Normally above UFL;
 - c. Could pass in and out of the flammability envelope (i.e., flammable or indeterminate);
 - d. Normally oxygen deficient.

3. The design of vapour-collection and control systems shall demonstrate that the following objectives are met:
- a. Reduction of risks to ALARP Levels standards in accordance with the Principal including:
 - Minimize the potential hazards to life, property and the environment in the event of an incident. Prevention of unsafe operating conditions.*
 - i. Identifying and avoiding unsafe operating conditions.
 - ii. Incorporating emissions control for the specific application in compliance with all applicable source performance standards.
 - Atmospheric dispersion any vented emissions is to comply with all applicable occupational exposure limits, ambient air-quality objectives, and point-of-impingement standards.*
 - iii. Ensuring the system meets the structural and mechanical design requirements.
 - The design requirements for structural and mechanical integrity is over the full range of potential pressures, vacuums and temperatures (both static and dynamic) that could be experienced during start-up, operating, upset, and shutdown conditions in the determined weather conditions.*
 - iv. Ensuring compliance with all applicable spacing or off-set requirements, noise control guidelines, codes, regulations and industry standards.
 - v. Managing the risks of freezing, overpressure, vacuum, air ingress and overfill hazards.
 - vi. Managing the formation of flammable mixtures and other additional risks in the vapour space.
 - vii. Minimize fugitive or unintentional emissions and the amount of emissions in the event of an accidental release.
 - viii. Elimination or control of ignition sources and the potential for flashbacks.
 - b. Life time cycle control for the operating range of the system (average operating conditions seldom occur; knowing the range during all phases is key).
 - c. Provide corrosion and fouling resistance that meets the design criteria.

2.2 SAFEGUARDING AGAINST FIRE OR EXPLOSION

1. The vapour collection and control system shall be designed with an operating window that is, under any credibly defined operating scenario, outside the flammability envelope of the vapour.
2. The controls to prevent operation within the explosive envelope of the vapour shall not depend on extrinsic control devices (e.g., LFL indicators) alone.
3. Contractor shall provide to the Principal the Contractor design process and personnel for review.

The Contractor is to have a complete knowledge of the operating conditions of the vapour source and collection and control systems; and, be familiar with the operating ranges of the process vapour sources and issues and controls necessary to manage explosive and flammable mixtures.

The Contractor's designer is to be familiar with the concept of the flammability envelope and the means of gas composition control to remain outside of the flammable region.

4. The Contractor shall specify all operating conditions of the vapour collection and control systems on the process datasheet.
5. Contractor shall provide to the Principal all documents for a complete design review of the fire/explosion risk.

The purpose of the design review is to verify that the risk of operation within the flammability envelope is sufficiently mitigated.

2.3 LIQUID REMOVAL FROM VAPOUR STREAMS

1. All free or entrained liquids shall be removed from waste gas streams prior to handling the vapour stream in rotating equipment (e.g., blower), safeguarding devices (e.g., detonation arrester) and end control devices (e.g., oxidizer).
 - a. The liquids shall be removed using a knockout (or disengagement) drum.
 - b. The potential for condensation downstream of the knockout drum should be minimized.
2. Liquid removal facilities shall be provided on the suction of any machinery if required by the Manufacturer/Supplier.
3. Lines shall be sloped to enable the continuous drainage and removal of liquids by the knockout drum.

2.4 CONDENSABLE VAPOURS

1. Any control device that receives vapours that could condense or freeze at ambient conditions shall be designed to preclude condensation downstream of the knockout drum.
2. For the control of vapour condensation, the all of the following requirements shall be included in the design of the system:
 - a. Minimize the distance between the source and the end control device.
 - b. Commingle the waste gas with lighter gas streams to lower the dew point temperature of the mixture to below the end-of-pipe temperature.
 - c. Pre-cool the waste gas to near the end-of-pipe temperatures (e.g., using a quench drum or heat exchanger).
 - d. Provide enough heating or preheating, and insulation to keep the gas above its dew point temperature.
3. The design shall prevent condensation in the headspace of a tank or low pressure vessel.

2.5 WINTERISATION

1. All system components that could be adversely affected by cold weather conditions shall be winterised to ensure reliable system performance.
2. Where heat tracing or preheat systems are employed, the design shall avoid the possibility of contact between gas/vapours and surfaces that are at or above the auto-ignition temperature of the gas/vapours.
3. Electrical heat tracing shall not be installed in an enclosed system where flammable vapours could be present.

2.6 PREVENTION OF BACKFLOW OR BACKMIXING

1. Vapour control systems shall be designed to prevent any potential for backflow or backmixing of air through vents, discharge stacks, and from end-control devices.

Backmixing of air can occur at vents and discharge stacks if the ambient air is denser than the waste gas or from cooling following a warm discharge.

- a. For continuous systems, this may be done by maintaining adequate waste gas flows.
2. Purge gas may be used to prevent air ingress on low or variable flow vapour control systems.
 - a. This shall be accomplished through use of the following techniques:
 - i. Purge reduction seals (e.g., velocity seals and density traps) are used to reduce the amount of purge gas needed.
 - 1). A fixed orifice shall be used and sized for the desired purge gas flow.
 - 2). The purge line shall be equipped with a flow indicator and low flow alarm as a means to verify the purge is in operation.
 - ii. The purge gas is introduced at the beginning of the main vapour collection line and at the beginning of any branch lines that do not have sufficient continuous gas/vapour flow to prevent air ingress.
 - iii. In the case of vessels, compartments or tanks, the purge gas is added on the opposite side and as far away as possible from the gas outlet connection to maximize effectiveness of the vapour space purge.
 - 1). Separate connections of nitrogen inerting gas shall be equipped for start-up and shutdown.
 - iv. The location of each purge gas orifice is marked by a prominent sign.
 - v. A minimum of one check (non-return) valve is placed on each purge gas connection to safeguard against backflow to the purge gas supply.