

DEP SPECIFICATION

LAYOUT OF ONSHORE FACILITIES

DEP 80.00.10.11-Gen.

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DESIGN AND ENGINEERING PRACTICE

DEM1



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1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for layout of onshore facilities and specifically covers the following deliverables:

- a. Site master plans
- b. Plot plans
- c. Mechanical general arrangement drawings

This DEP is applicable both for new sites as well as for revamps or expansions of existing sites.

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 February 2011; see (1.5) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised 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 authorised 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 onshore facilities related to oil and gas production, gas handling, oil refining, chemical processing, gasification, distribution and supply/marketing. 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.

1.3.2 Specific definitions

Term	Definition
Building Risk	Explosion risk to an individual in the building, if occupied on the basis of 40 hours/week.
BC-IR (Building Contribution To The Individual Risk)	Annual frequency that an identifiable individual might be killed from an explosion whilst occupying a specific building. It is calculated by multiplying the building risk with the fraction of 40 hrs/week the individual is occupying the specific building.
Facility	Process and utility plants, tanks, buildings, marine structures, pipe racks and roads located within a site boundary.
Inside Battery Limit	The rectangular area of a unit or plant which envelops the equipment of the unit or plant.
Layout	One or more of the following deliverables: site master plan, plot plans and mechanical general arrangement drawings.
Mechanical General Arrangement Drawings	Overall spatial arrangement of equipment within the available unit boundaries.
Occupied Building	Building that personnel occupy while doing a major part of their work, such as control rooms, laboratories, office buildings, maintenance work areas, outside operator buildings, etc.; or a building with a primary purpose that necessitates people to occupy it, such as field labs, lunch rooms, locker facilities used to change clothes, showers, restrooms or toilets (lightweight plastic porta-toilets are excluded from this definition), etc. Other buildings that have a primary purpose to house or store equipment or materials are considered an "occupied building" if an individual spends on average 10 hours or more a week inside the building, 10 or more people are in the building at any given time, or a group spends an average of 200 hours or more a week inside the building. Observation shelters provided for weather protection for the marine, road, or rail loading operator may, in consultation with the Principal, be excluded from the definition of an occupied building. By nature, such buildings are small and require a large amount of window area to satisfy operational safety requirements with the loading operations.
Plot Plan	Overall spatial arrangement of one or more unit(s) and related general facilities within a plot boundary, showing the arrangement of equipment within units.
Process Safety Critical Equipment	Equipment that enables controlled process shutdown and/or potentially controls further incident escalation in the event of an incident.
Risk Contour	Iso-risk line on the map at which a hypothetical individual staying there unprotected and for 24 hours per day 365 days per year would be killed due to exposure to hazards induced by an activity

Term	Definition
Minimum Separation Distances	Separation distances that ensure that the risk of escalation from a fire and/or explosion event on an adjacent area is tolerable. These distances include allowance for safe SIMOPs during normal operations, construction and maintenance activities. Increased separation, above the minimum distances specified, may be required to allow for sufficient access and working space to support construction and maintenance activities. Additional separation shall be determined from and demonstrated to meet project specific requirements. Separation distances are taken as those between inside battery limits of adjacent units or plants, or between inside battery limits of the unit or plant and the edge of the item under consideration (e.g., road, building, fence, pipe rack).
Shepherd	Shell best practice tool for process safety cumulative risk calculation.
Site	Plot of land with defined boundaries.
Site Master Plan	Overall spatial arrangement of all process and utility plants, tankage areas, buildings and connecting infrastructure (e.g., roads, pipe racks). The site master plan shows the individual plot boundaries within the overall site boundary.

1.3.3 Abbreviations

Term	Definition
ALARP	As low as reasonably practicable
BRM	Blast resistant module per DEP 34.17.10.33-Gen.
FAR	Field auxiliary room
HSE	Health, safety and environment
HFE	Human factors engineering (or ergonomics); refers to the application of human physical and cognitive sciences in conjunction with engineering sciences to achieve optimal human and system performance.
ISBL	InSide Battery Limit
SIMOPS	SIMultaneous OPerationS May include simultaneous operation and maintenance activities as well as simultaneous operation and constructions activities.

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 (7).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated February 2011. This is a major rewrite of the DEP and the changes are too numerous to list here.

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://sww.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.

2. LAYOUT STRATEGY

The Contractor shall develop and implement a layout strategy and submit to the Principal for review.

Depending on the relevant stage of the Opportunity Realisation Process (ORP) one or more of the following deliverables shall be included:

- a. Site master plan
- b. Plot plans
- c. Mechanical general arrangement drawings

The layout strategy aims to achieve the following:

- a. Safety and environmental risk levels for surrounding facilities and communities are tolerable and ALARP;
- b. Safety risk levels for “on site” workforce are tolerable and ALARP;
- c. Minimum cost by utilizing compact layouts with minimum hydrocarbon inventory and minimum required separation distances;
- d. Minimum lost production resulting from damage to facilities in the event of fire and/or explosion;

The layout strategy, the site master plan, the plot plans and mechanical equipment arrangement drawings shall incorporate and address the requirements of the Project HSSE plan.

Allowance for all future phases, taking unhindered access during construction and sufficient safety distances considering SIMOPS, shall be taken into account.

3. GENERAL LAYOUTING REQUIREMENTS

3.1 INTRODUCTION

Layout requirements applicable to all project phases and deliverables are defined in this Section.

Additional requirements or exceptions for site master plans, plot plans or mechanical general arrangement drawings may be specified in relevant chapter.

3.2 HSSE

3.2.1 Segregation inside the facility fence

The required segregation between all new, or between new and existing process and utility plants, tankage areas, buildings and supporting/connecting infrastructure shall either be obtained by providing adequate separation distance or by providing a physical barrier. However, the barrier shall not introduce confinement or obstruct access.

Adequate separation is provided by the minimum separation distances as defined within this DEP and SHALL [PS] be used for layouting.

Defined minimum separation distances ensure the risk of escalation from a fire and/or explosion event(s) on an adjacent area are tolerable. These distances include allowance for safe SIMOPS during normal operations, construction and maintenance.

Minimum separation distances and siting requirements used for types of plant, equipment, units, tankage, buildings and connecting/supporting infrastructure not included within this DEP should also be demonstrated and accepted by the Principal as stated below.

Increased separation, above the minimum distances specified shall be provided to allow for sufficient access and working space to support construction and maintenance activities.

Additional separation shall be determined from and demonstrated to meet project specific requirements.

Separation distances are distances between inside battery limits of adjacent units or plants, or between inside battery limits of the unit or plant and the edge of the item under consideration (e.g., road, building, fence, piperack).

Reduced minimum separation distances or physical barriers shall only be used when sufficient segregation is demonstrated by using appropriate consequence modelling or risk assessment and accepted by the Principal. Modelling of potential hazardous material releases shall be used to determine the risk to people, the environment and facilities. Determined distances between facilities SHALL [PS] be based on escalation risks taking into account potential facility damage and production loss and shall be balanced against the potential cost savings with reduced land take/cablings/piping, etc.

If a risk assessment is applied, it shall be used in conjunction with the project risk tolerability criteria.

Local legal or code requirements shall take precedence wherever they are more stringent.

3.2.2 Segregation outside the facility fence

Separation distances outside the fence line SHALL [PS] conform to the project risk tolerability criteria requirements. Where local regulations specify risk contour limits and other risk criteria (e.g., societal risk), they shall be followed.

3.2.3 Toxics

The Principal SHALL [PS] be consulted for separation of plants, units, equipment and operations/buildings containing toxic substances.

3.2.4 Safety critical equipment

Safety critical equipment SHALL [PS] be located (or protected or designed to fail safe) such that they are not subject to any damage from the hazards for which they have a role in prevention and/or mitigation. All safety critical equipment shall be easily accessible in case of any unwanted event/hazard.

Indoor safety critical equipment shall meet requirements for buildings per (4.14.1).

The Principal SHALL [PS] be consulted for outdoor safety critical equipment.

3.2.5 Hazardous area classification

Hazardous area classification standards provide industry-accepted separation distances between ignition sources and likely sources of flammable release. However, the distances provided by the Codes do not address the effects of larger (but less likely) failures. These shall be reviewed as part of an overall layout study.

Reference is made to DEP 80.00.10.10-Gen. and DEP 80.00.10.13-Gen.

3.3 MINIMUM SEPARATION DISTANCES

3.3.1 General

Plants or units SHALL [PS] be located to meet the larger of the following specified minimum separation distances to prevent escalation in the event of fire or explosion:

- a. 50 m (165 ft) between process facilities (either plants or units depending on the acceptable lost production level) containing pressurised liquids,
- b. 25 m (80 ft) between process facilities (either plants or units depending on the acceptable lost production level) containing gasses,
- c. 100 m (265 ft) between process facilities (either plants or units depending on the acceptable lost production level) having a total hydrocarbon containing equipment area in excess of 25000 m² (270000 ft²).

The separation distance 'X' in Figure 3.1 is indicative of how the above distances should be taken into account.

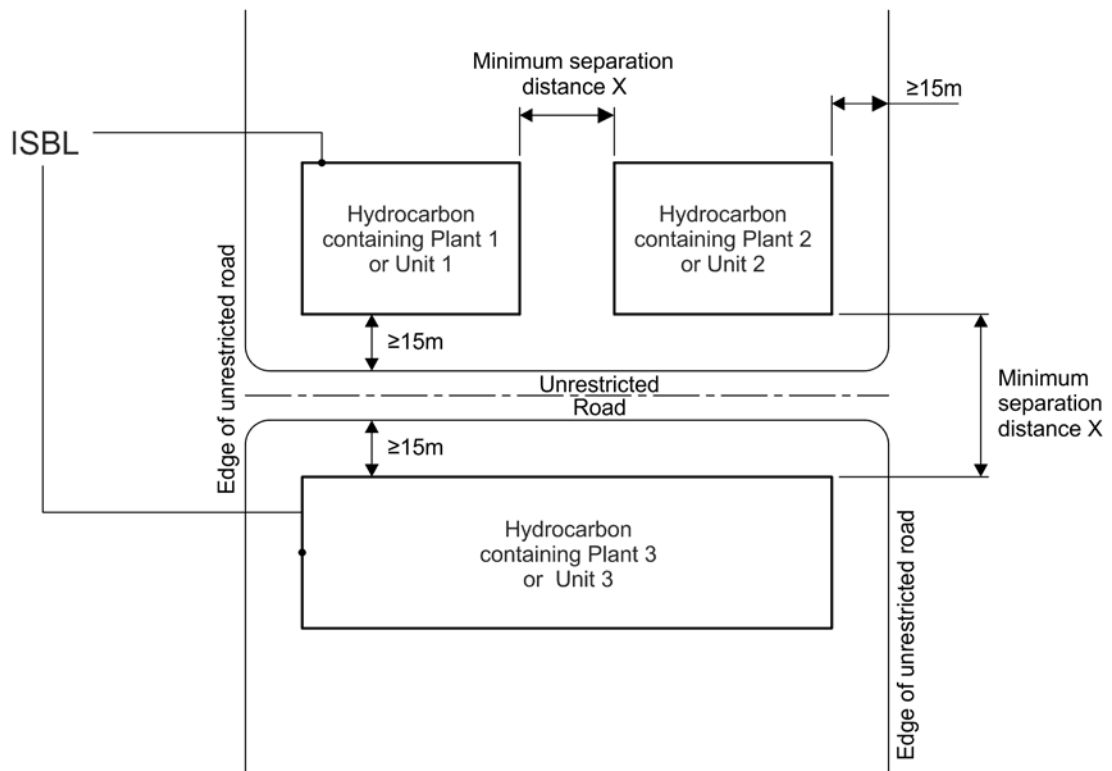


Figure 3.1 Minimum separation distances

3.3.2 Roads

The edge of unrestricted roads (i.e., roads which can be accessed without a permit) shall be located at least 15 m (50 ft) from equipment handling hydrocarbons and be situated outside hazardous areas as defined in DEP 80.00.10.10-Gen.

See DEP 34.13.20.31-Gen. for the extent, type, width, radii, and gradients of roads.

3.4 CONSTRUCTABILITY

Requirements as defined in the project or facility construction strategy (including pre-commissioning and initial start-up) shall be taken into consideration in all layouting activities to include optimal provisions for:

- a. Human factors engineering (3.5.2),
- b. Suitable (in terms of obstructions, slope, and bearing capacity) access or construction equipment, (including cranes, heavy equipment and transporters),
- c. Minimum workspace envelope (including turning radii) for construction equipment, (including cranes, heavy equipment and transporters),
- d. Areas for laydown, storage and temporary facilities (e.g., office, camps, welfare),
- e. Material (off)loading facilities,
- f. Safe SIMOPs,
- g. Traffic and pedestrian management,
- h. Security and exclusion requirements,
- i. Desired construction strategy (stick built/modular), sequence and schedule.

During expansions of an existing site, the construction area shall have a separate entrance, gatehouse and boundary fence to keep free access for construction personnel and delivery of construction materials clear of the existing operating facilities.

A clear distinction shall be established by physical barriers between operating areas and construction areas for both security of operating facilities and to ensure control of hazards, e.g., vehicle traffic through operating facility.

3.5 OPERABILITY AND MAINTAINABILITY

Requirement as defined in the project or facility operating and maintenance philosophy (including start-up and shutdown) shall be taken into consideration in all laying activities to include optimal provisions for:

- a. Human factors engineering (3.5.2)
- b. Suitable (in terms of obstructions, slope, and bearing capacity) access or maintenance equipment, (including cranes, heavy equipment and transporters)
- c. Minimum workspace envelope (including turning radii) for maintenance equipment, (inc. cranes, heavy equipment and transporters)
- d. Areas for laydown, storage and temporary facilities (e.g. office, welfare)
- e. Safe SIMOPs
- f. Traffic and pedestrian management
- g. Security and exclusion requirements

3.5.1 Expansion

Expansion (planned or future) requirements shall be taken into consideration in all laying activities to include optimal provisions for:

- a. Construction per (3.4)
- b. Operability and Maintainability per (3.5)
- c. Tie-in to existing and new infrastructure (piperacks, piping, utilities, drainage, etc.)
- d. On-going operation and maintenance activities of the existing facility

3.5.2 Human factors engineering

The layout shall be adequately designed with respect to HFE requirements specified in DEP 30.00.60.10-Gen.

3.5.3 Emergencies, escape and evacuation

Layout designs shall provide for emergency situations shall be taken into account within. Local regulations shall be checked.

Safe means of escape and evacuation shall be provided for all credible emergency conditions. The following considerations shall be taken into account:

- a. Safe means of escape and evacuation provided to and from all areas, whether or not these are regularly manned;
- b. The effect of toxic releases or the heat flux and smoke from a fire, on the ability of personnel to escape to safe areas;
- c. Flare radiation on escape and evacuation.

The road system shall be designed such that access to all areas is possible in case of an emergency, taking the different wind directions into account.

All access to plant areas shall be by paved walkways or hard standings. The need to walk over rough or unmade ground shall be avoided.

The location of helipad(s) and the facilities relative to river access shall be designed such that access to those is possible in case of an emergency taking the different wind directions into account.

3.5.4 Fire protection

There are two types of fire protection:

- a. Passive fire protection, e.g., distance, fire proofing etc;
- b. Active fire protection, e.g., water based fire protection systems, etc.

Fire protection shall be considered to assure the future functional integrity of potentially fire exposed equipment.

Reference is made to DEP 80.47.10.30-Gen.

3.5.5 Natural ventilation

Where practicable, natural ventilation shall be used, to reduce the likelihood of potential accumulations of explosive hydrocarbon/air mixtures. Equipment should be oriented to minimise disruption of natural ventilation. Designs shall be such that dead pockets where explosive mixtures can remain for extended periods of time are avoided. In cases that this cannot be avoided (e.g., sumps), the atmosphere shall be continuously monitored for an explosive mixture.

3.5.6 Acoustic enclosures

The risk of enclosing noise generating equipment shall be weighed against the possibility of accumulation of flammable or toxic materials within the enclosure.

4. SITE MASTER PLAN

4.1 INTRODUCTION

The site master plan of a facility gives the overall spatial arrangement of all process and utility plants, tankage areas, buildings and connecting infrastructure (e.g. roads, pipe racks). The site master plan shows the individual plot boundaries within the overall site boundary. The site master plan should indicate relevant surrounding local geographic features (e.g., rivers, coastline, slopes).

4.2 MINIMUM SEPARATION DISTANCES AND SITING REQUIREMENTS

Section to be read in conjunction with (3.2.1).

Minimum separation distances and siting requirements specified in Table 4.1 and within (4.3) to (4.15) SHALL [PS] be met.

Table 4.1.A Minimum separation distances (SI units)

Occupied Building (e)	A	NA																			
Fire Station, Fire Pumps (e)	B	15	NA																		
Main Electrical Station	C	NA	30	NA																	
Utilities Area not handling flammable products	D	30	30	30	NA																
Cooling Towers	E	30	30	60	30	10															
Process Plants/Utility Areas handling flammable products	F	(h)	(h)	60	50/25 (c)	50/25 (c)	50/25 (c)														
Control Room (e)	G	NA	NA	30	30	30	30	NA													
Atmospheric Storage Tanks (j)	H	(i)	(i)	60	60	75	(i)	(i)	(i)												
Oily Water Interceptors (CPI/API)	I	100	100	15	15	15	15	15	15	NA											
Road/Railcar loading station for LPG	J	60	(f)	(f)	(f)	(f)	(f)	(f)	(f)	(f)	NA										
Road/Railcar loading station except LPG	K	30	(f)	(f)	(f)	(f)	(f)	(f)	(f)	(f)	(f)	NA									
Elevated Flare	L	100	100	100	60/100 (a)	60/100 (a)	60/100 (a)	60/100 (a)	60/100 (a)	60/100 (a)	60/100 (a)	60/100 (a)	NA								
Transfer Pumps in tank farms	M	100	100	60	30	30	50/25 (c)	30	15	15	(f)	(f)	60/100 (a)	NA							
Main Pipeway	N	15	15	15	15	7.5	15	7.5	15	15	(f)	(f)	60/100 (a)	NA	NA						
Main Road	O	3	3	3	3	3	15	3	15	15	(f)	(f)	60/100 (a)	15	3	NA					
Restricted Road	P	3	3	3	3	3	7.5	3	15	7.5	(f)	(f)	60/100 (a)	7.5	3	NA	NA				
Property Boundary	Q	10	10	10	30	30	60	30	30	60	(f)	(f)	150/250 (b)	60	15	3	3	NA			
Pressurized LPG Storage	R	(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)		
Refrigerated Storage (d)	S	100	100	100	45	45	100	45	45	60	(f)	(f)	60/100 (a)	30	30	30	15	55	(g)	50	
Materials Yard	T	NA	NA	NA	30	30	100	NA	100	100	(f)	(f)	60/100 (a)	100	15	NA	NA	NA	(g)	100	NA
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	
	Occupied Buildings (e)	Fire Station, Fire Pumps (e)	Main Electrical Station	Utilities Area not handling flammable products	Cooling Towers	Process Plants/Utility Areas handling flammable products	Control Room (e)	Atmospheric Storage Tanks (j)	Oily Water Interceptors (CPI/API)	Road/ Railcar loading station for LPG	Road/Railcar loading station except LPG	Elevated Flare	Transfer Pumps in tank farms	Main Pipeway	Main Road	Restricted Road	Property Boundary	Pressurized LPG Storage	Refrigerated Storage (d)	Materials Yard	

Figures in Meters
NA = Not Applicable

- NOTES:
- a. 60 m for refineries; 100 m for LNG facilities.
 - b. 150 m for refineries; 250 m for LNG facilities.
 - c. 50 m for pressurized liquids; 25 m for gases; 100 m between process facilities (either plants or units depending on the acceptable lost production level) having a total hydrocarbon containing equipment area in excess of 25000 m²; see (3.3.1).
 - d. Figures for full containment concrete tanks.
 - e. See (4.14.1) and (4.14.2).

- f. See (4.10).
- g. See (4.12).
- h. 150 m from process units and 200 m from LNG trains.
- i. See (4.11).
- j. Distances are measured from the external wall of the tank.

Table 4.1.B Minimum separation distance (USC units)

[illegible]

Figures in Feet
NA = Not Applicable

- NOTES: a. 200 ft for refineries; 330 ft for LNG facilities.
b. 500 ft for refineries; 820 ft for LNG facilities.