

DEP SPECIFICATION

LAYOUT OF ONSHORE FACILITIES

DEP 80.00.10.11-Gen.

February 2011

(DEP Circular 68/11 has been incorporated)

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DESIGN AND ENGINEERING PRACTICE

DEM1



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1. INTRODUCTION

1.1 SCOPE

This new DEP specifies requirements and gives recommendations for site master plans, plant layouts and equipment arrangements for on-shore facilities.

It includes:

- a) Layout strategy (2)
- b) Layout development process (3)
- c) General layout considerations and guidelines (4)
- d) Specific layout considerations and guidelines for site master plan (5)
- e) Specific layout considerations and guidelines for plant layout (6)
- f) Specific layout considerations and guidelines for equipment arrangement (7)

Sections 2, 3 and 4 are applicable for site master plans, plant layouts and general equipment layout arrangements.

This DEP is structured such that sections 5, 6 and 7 may be used in isolation from each other.

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.

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 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 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.

1.3.2 Specific definitions

Term	Definition
Asset	A discrete element of a business that has a monetary value. Assets include physical plant and equipment. Examples are a refinery or chemical plant, production platform, retail network or project.
Building Risk	The explosion risk to an individual in the building, if occupied by the person 40 hours/week (100% occupancy).
BC-IR	Building Contribution to the Individual risk. The 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. The BC-IR for the most exposed person is the BC-IR for the person that spends the most number of hours per week in the building.
Occupied Building	A 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, zone shops, 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, or 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.
Risk contour	A risk contour is an 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
Safety Distances	The distance at which all hazards inherent in a plant or unit are either eliminated or controlled so that their associated risks are reduced to a level which is ALARP to adjacent plants or units.
Plant	The overall collection of units which together make up an operating entity
Unit	A unit consists of several pieces of equipment which can operate independently

Plant Layout Overall spatial arrangement of the individual units and general facilities within the plant boundary

Equipment arrangement Overall spatial arrangement of equipment within the unit boundaries

1.4 ABBREVIATIONS

ALARP As Low As Reasonably Practicable

SIMOPS SIMultaneous OPERATIONs
May include simultaneous operation & maintenance activities as well as simultaneous operation & constructions activities

FAR Field Auxiliary Room

FEED Front End Engineering Design

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

NPSH Net Positive Suction Head

BRM Blast Resistant Module as per DEP 34.17.10.33-Gen.

PRT Process risk tool

1.5 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 (8).

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://www.shell.com/standards> and on the main page of the DEPs DVD-ROM.

1.7 DUAL UNITS

Amended per

Circular 68/11

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.

2. LAYOUT STRATEGY

The project shall develop and implement an overall layout strategy that addresses how and when the following elements will be delivered during the distinct stages of the project development cycle:

- site master plan
- plant layout
- equipment arrangement

The layout strategy shall ensure that the above elements are optimized to achieve:

- Minimum cost by utilizing compact layouts with minimum hydrocarbon inventory and minimum required separation distances;
- Minimum lost production resulting from assets destroyed or damaged during a fire/explosion event;
- Safety risk levels for “on site” workforce are tolerable and ALARP;
- Safety and environmental risk levels for surrounding facilities and communities are tolerable and ALARP;

The layout strategy shall ensure that the resulting layouts are consistent with the defined Project HSE plan. Output from the deliverables of the defined Project HSE plan SHALL [PS] be incorporated into the layout development at each stage of the project.

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

3. LAYOUT DEVELOPMENT PROCESS

3.1 INTRODUCTION

The development of a layout is a multi-disciplinary task and requires co-ordination between various disciplines involved in the design.

3.2 DELIVERABLES PER PROJECT PHASE

The specific layout development activities, as defined in the layout strategy, shall be carried out at the various distinct stages during a project development cycle as described in this section.

3.2.1 Identify/Assess phase

When required, specific deliverables with sufficient detail shall be developed to check the feasibility of possible concepts.

A layout strategy shall be developed during this phase.

3.2.2 Select phase

Specific deliverables defined in the overall layout strategy shall be developed with sufficient detail to support the required costs estimate and concept selection by evaluating available options.

3.2.3 Define phase

This phase may be implemented in two sub phases: Pre-FEED and FEED.

Pre-FEED phase

Deliverables of the previous phase shall be further developed with sufficient detail to support the required costs estimate.

FEED phase

Specific deliverables defined in the overall layout strategy shall be developed with sufficient detail to support the required costs estimate.

3.2.4 Execute phase

During this phase, deliverables of previous phase shall be further developed and updated based on the available equipment data from process and relevant vendors.

A site master plan, plant lay-outs and equipment arrangements shall be developed to support construction.

3.3 REVIEWS PER PROJECT PHASE

Deliverables as specified in (3.2) shall be included in the defined project specific Technical Assurance Plan and reviewed/approved accordingly.

The reviews, e.g. by layout drawings and/or 3D-CAD model reviews shall use a structured and auditable assessment methodology, which ensures that the requirements of other disciplines have been incorporated in the design and to eliminate possible clashes and to ensure the design is fully ALARP. For 3D-CAD model reviews, reference is made to DEP 30.10.05.11-Gen.

4. GENERAL LAYOUT CONSIDERATIONS AND GUIDELINES

4.1 INTRODUCTION

The following shall be taken into account in the development of the site master plan, plant layout and equipment arrangement:

- a) Cost;
- b) HSE;
- c) Security;
- d) Operability and maintainability;
- e) Constructability
- f) Human factors engineering

The general layout development process is to first develop the conceptual layout based on the layout strategy in chapter (2) (being a compact layout) as well as the information in chapter (4.2) and the individual chapters (5 for site master planning, 6 for plant layout and 7 for equipment arrangement).

As the HSE deliverables are completed against the defined Project HSE Plan, they shall be reviewed to determine the impacts to the conceptual layout. The layout shall be updated as needed. Where the defined project HSE plan has called for a quantitative analysis, the criteria in (4.2) **SHALL [PS]** be used.

4.2 HSE CONSIDERATIONS

Separation distances for initial layouts can be found in (5.2). When detailed quantitative assessments are made the following criteria should be applied.

Safety distances within the facility fence **SHALL [PS]** conform to the project's risk tolerability criteria requirements.

4.2.1 In-side the facility fence

4.2.1.1 Toxics

The Principal shall be consulted for separation of toxic containing plants, units and equipment and operations/buildings.

4.2.1.2 Escalation

The minimum distance between assets **SHALL [PS]** be based on the more stringent of:

- The acceptable lost production level
- 10^{-4} per year exceedance blast overpressures of explosions.

In general, a 10^{-4} per year exceedance of 0.3 bar (4.4 psi) explosion overpressure should be used for process plants as a design value. Other facilities like tanks are more vulnerable.

4.2.1.3 Buildings

Amended per

Circular 43/12

Siting of occupied (portable, temporary and permanent) buildings and buildings containing process safety critical equipment (i.e. loss of this equipment functionality after an explosion would not allow controlled process shutdown and/or potentially lead to further incident escalation) **SHALL [PS]** use the following criteria:

- a) Siting of building to be based on a risk assessment using a model approved by the Principal.
- b) Explosions

- New buildings are to be sited outside the 10^{-5} Building Risk contour. The generic building construction type used to generate the Building Risk contour shall be chosen to best represent the proposed building construction type.
- Where new buildings are required to be sited inside the 10^{-5} Building Risk contour they are to be designed to be blast resistant using the 10^{-4} blast load (calculated pressure and impulse) corresponding to the 10^{-4} exceedence frequency with low damage using DEP 34.17.10.30-Gen.
- The design of new buildings, when sited between the 10^{-5} and 10^{-6} Building Risk contour, have to be verified against the generic design information for the chosen building type used to generate the Building Risk contours, using DEP 34.17.10.30-Gen.
- New buildings sited outside of the 10^{-6} Building Risk contour may be conventional construction and designed using DEP 34.17.00.32-Gen.
- New assets shall not cause any building to exceed the BC-IR of 10^{-5} /yr. If for an existing building the BC-IR is already above this tolerance level, the new assets should not contribute more than 10^{-6} /yr.

All other new buildings may be designed as conventional buildings using DEP 34.17.00.32-Gen.

Where an economic analysis justifies a blast resistant design to reduce the potential unit downtime caused by building damage from an explosion, the building should be designed following DEP 34.17.10.30-Gen.

4.2.1.4 Above-ground LPG storage vessels

Above-ground LPG Storage vessels SHALL [PS] be located and spaced so that, in the event of a fire the maximum allowable heat radiation flux levels will be in accordance with Table 4.1.

Amended per

Circular 68/11

Table 4.1 Radiation flux limits for above-ground LPG pressure storage vessels

Target	Maximum radiation flux levels kW/m ²	Maximum radiation flux levels Btu/hr/ft ²
<i>Equipment inside boundary</i>		
The outer surface of adjacent pressure storage vessels: (1)		
Protected (2)	44	14,000
Unprotected (3)	8	2500
The outer surface of adjacent storage tanks containing flammable products (including refrigerated storage) and process facilities: (1) (4)		
Protected (2)	32	10,100
Unprotected (3)	8	2500
The above-ground connections, including PRVs, of mounded LPG storage vessels	8	2500
Filling/discharge points	8	2500
Control room, maintenance workshops, laboratories, warehouses, etc.	8	2500

Target	Maximum radiation flux levels kW/m ²	Maximum radiation flux levels Btu/hr/ft ²
Administrative buildings	5	1600
Equipment outside boundary		
Remote area (5)	13	4100
Urban area (6)	5	1600
Critical area (7)	1.5	480

- NOTES:
- 1 When siting pressure storage vessels relative to refrigerated product tanks, the radiation flux level on the pressure vessel shell shall be limited to 8 kW/m² (2500 Btu/hr/ft²).
 - 2 Such facilities/areas are protected by means of water sprays, insulation, radiation screens or similar systems.
 - 3 Protection is provided by spacing alone.
 - 4 Special consideration shall be given to the location of floating roof tanks containing volatile products, since effective water cooling of their roof structure is impracticable.
 - 5 An area only infrequently occupied by small numbers of persons, e.g. moorland, farmland, desert, but where immediate escape should be possible. Plant designs based on radiation flux levels of 13 kW/m² (4100 Btu/hr/ft²) shall allow for possible future changes in land use outside the plant.
 - 6 An area which is neither a remote area nor a critical area.
 - 7 This is either an unshielded area of critical importance where personnel not equipped with protective clothing may be required at all times, including during emergencies, or a place difficult or dangerous to evacuate at short notice (e.g. plant entrance, hospital, sports stadium).

4.2.2 Outside the facility fence

Safety distances outside the fence line SHALL [PS] conform to the Project's Risk Tolerability Criteria requirements and any local regulations specifying the risk contour limits and other risk criteria (e.g. F/N curves).

In countries where local regulations specifying risk contour limits do not exist, the following should be used as good practice for new projects:

- Within the 10⁻⁵ risk contour there should be no third party activities unless the activities are controlled and the Emergency Response are linked to the facilities Emergency Response. When this cannot be achieved, it should be attempted to have the 10⁻⁵ contours within the facility fence.
- Within the 10⁻⁶ risk contour there should preferably be no permanent housing. Although residential developments would be permitted in some countries around the world at these distances from the facilities, in general this should be discouraged.

4.3 SPECIFIC GUIDANCE

4.3.1 Segregation between assets

The required segregation shall either be obtained by providing adequate separation distance or by providing a physical barrier (however, the barrier should not introduce confinement or obstruct access). In determining the minimum separation distance or the integrity requirement of a physical barrier, consequence modelling of potential hazardous material releases shall be used to determine the risk to people, the environment and assets. Local legal or code requirements shall take precedence wherever they are more stringent.

The distance between different assets shall minimally be such that maintenance can be carried out safely in one asset with adjacent assets in operation.

When positioning new assets, safety distances SHALL [PS] be applied that address potential exposure to existing assets and buildings.

4.3.2 **Natural ventilation**

Natural ventilation shall be used, where practicable, 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 the cases that it cannot be avoided (e.g. sumps), the atmosphere should be continuously monitored for an explosive mixture.

4.3.3 **Hazardous area classification**

Hazardous area classification standards give industry accepted separation distances between ignition sources and credible sources of flammable release. However, the distances provided by the Codes do not cater for the effects of any larger, but less likely catastrophic failures. These should be reviewed as part of an overall layout study.

Reference is made to DEP 80.00.10.10-Gen.

4.3.4 **Active and passive fire protection**

There are 2 types of fire protection:

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

Fire protection shall be considered in order to assure the future functional integrity of potentially fire exposed equipment. The designs shall in principle be inherently safe whereby the application of protection is only an additional aid.

Reference is made to DEP 80.47.10.30-Gen.

4.3.5 **Escape and evacuation**

Safe means of escape and evacuation SHALL [PS] be provided under all foreseeable emergency conditions.

The following considerations shall be taken into account:

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

4.3.6 **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.

4.4 **OPERABILITY AND MAINTAINABILITY**

The layout, location and orientation of the assets shall allow operation and maintenance to be carried out in an effective, efficient, cost effective and safe manner. Attention shall be given to adequate access and space in design.

The approach should be driven by a focus on critical tasks and should include a review of human factors issues (4.8).

A maintainability study should be carried out early in the design to address:

- Lifting and mechanical handling requirements (dimensions/weights)
- Access/space requirements to allow the lifting, mechanical handling and component transport

- Extend and design of pavement
- Laydown and dropdown areas (extent and load requirements)

Lifting and mechanical handling shall be assessed so that safe and efficient removal of equipment can be accomplished.

Where required, access for mobile transporting equipment (e.g. flat bed trucks) shall be provided.

The type, size, and reach of mobile lifting equipment (e.g. cranes) and transporting equipment that will be or are readily available should be defined as an input to the maintainability study. The maintainability and layout study should be based on this input.

In determining the number and type of this equipment, the anticipated simultaneous usage and frequency for the equipment for other operations shall be taken into account.

Minimum workspace area, work envelope as well as turning radius for lifting and mechanical handling equipment should be determined based on specifications of the selected equipment.

Assets that are expected to share a common turnaround schedule should be grouped together.

Curb stones, drainage ditches, pipe ways at ground etc should not obstruct the entry of mobile equipment from roads.

4.5 CONSTRUCTABILITY

4.5.1 General

The layout shall be designed for adequate access during construction.

It shall be ensured that adequate facilities (e.g. material off-loading facilities, equipment transport routes, materials and equipment lay-down and storage areas and support facilities such as temporary offices and accommodation) and space is provided to safely construct the facilities cost effective and at the desired schedule with full consideration of adjacent facilities that may be in operation.

Required soil and pavement conditions shall be taken into account.

Support areas should be as close as is permitted by safety requirements to the construction site to minimize transportation time for personnel and equipment. Consideration must be given to any adjacent operating units as well as the commissioning and start up of the unit under construction.

For more details on the location of temporary occupied facilities, see (4.2).

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

The risk to construction workers associated with construction in a live plant is considerably higher than typical individual construction or operations risks. This shall be evaluated by the project to determine if the risks are tolerable, or if not, what additional measures need to be taken.

4.5.2 Modularization

The layout of a site or plant and the equipment arrangement are different for stick-built and modularised construction philosophy. Therefore the construction philosophy needs to be considered from an early phase in the project.

Factors that favour a modularised philosophy include issues associated with access difficulties, severe weather and limited labour.

Project Guide17b – Onshore Module Constructability should be used for guidance on selection of construction method.

4.6 COST

Site master plan, plant layouts and equipment arrangements should be developed considering costs.

The plants/units and equipment should be arranged in accordance with the sequence of the process flow.

Similar types of equipment should be grouped together.

Pipe routing should be optimised.

The length of the interconnecting piping and the number of supporting structures should be minimized.

4.7 EXPANSION

Requirements with respect to future modifications and/or expansions shall be defined prior to the start of the development of the site master plan, plant layout or equipment arrangement. Impacts of the envisaged modifications and/or expansion on piperacks etc shall be taken into account.

The location of the vacant plot space should be carefully chosen so that construction (erection and testing) of the future modifications and/or expansions causes minimum disruption to on-going operations and maintenance activities. Preferably the space should be located on the periphery of the facility, plant or unit.

During initial layout it is advisable to typically oversize (30 %) the capacity of instrument, electrical, pipe racks/tracks and trenches to avoid expanding of these facilities during the detailed design phase when more detailed information becomes available and plot area may not be available anymore.

4.8 HUMAN FACTORS ENGINEERING

The layout shall be adequately designed with respect to HFE requirements and shall support high levels of human performance on identified critical tasks with respect to occupational health and safety, effectiveness and efficiency during construction, operation and maintenance. Reference is made to DEP 30.00.60.10-Gen. - Human Factors Engineering in Projects.

During the design, construction and installation phases sufficient attention should be given towards the human-machine interface especially for critical tasks (e.g. high frequency, vulnerability to human error, high/difficult level of manual intervention, manual handling of chemicals etc).

A proper Human Factors Engineering assessment should be carried out in order to arrive at an optimum layout and adequate level of human working environment. Analysis should address the routine, non-routine and emergency activities.

The design of workplaces should be based upon a clear understanding of tasks demands and operator strengths and limitations (physical and cognitive), and should use anthropometric data relevant to the intended workforce.

Attention shall be paid to maximise the logical and consistent layout of equipment.

Personnel should not pull or lift loads exceeding 25 kg (55 lb) (16 kg [35 lb] for women), and only if loads are able to be lifted close to the body and at waist height. If equipment (parts) weigh more and cannot be lifted by a mobile crane, a lifting aid shall be provided. This can either be a fixed (lifting beam) or portable device. The lifting beam should run to an open area from which the equipment (parts) can be transported away. Roof clearance for use of a mobile crane and/or lifting aids should be available.

The limit for equipment to be lifted by 2 persons will be in the order of 40 kg (88 lb) provided that the workspace design allows proper posture, and the size of the equipment will not restrict safe access and handling.

5. SITE MASTER PLAN

5.1 INTRODUCTION

The objective of this chapter is to give specifications and requirements on the development of a site master plan.

The site master plan of a facility should give the overall spatial arrangement of all process plants, utility plants and general facilities. It shall be developed as per the guidelines in this DEP and the requirements laid down in the layout strategy (2), the layout development process (3) and the layout considerations (4).

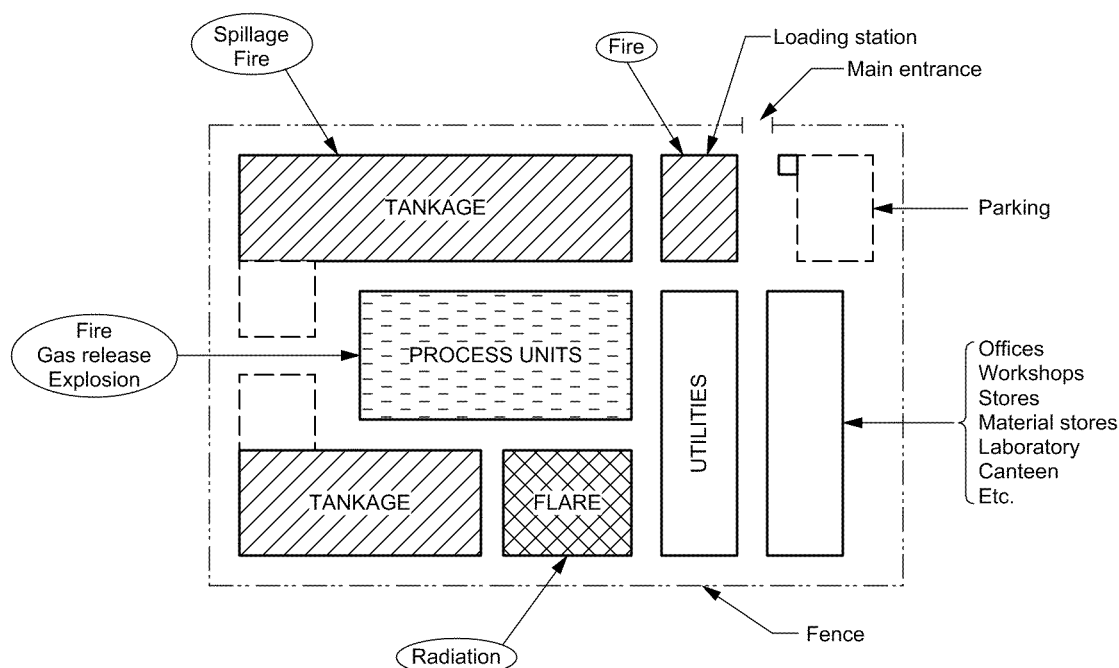


Figure 5.1 Example site master plan

The site master plan shall be developed to provide the most cost effective layout over the plant life without compromising with safety, process, maintenance, operation and construction requirements. Separation distance should only be provided when needed.

When developing the site master plan and the orientation of the facility, the following constraints of the site shall be clearly established:

1. Available plot area
2. Obstructions on site e.g. buried pipelines, (high tension) electrical cables etc
3. Soil conditions
4. Site level
5. Raw material supply and product route
6. Topographical, geological, bathymetric and meteorological constraints
7. Environmental impact
8. Site boundary and service parameters e.g.:
 - Main and public roads

- Rail and water way entry
 - Pipeline routes
 - Permitted storm water and sewage outfalls
 - Process, potable and cooling water supplies
 - Power supply
9. Emissions to air and water resources
 10. Future expansion
 11. Legal requirements e.g. :
 - Planning and building laws
 - Effluent and pollution requirements
 - Traffic regulations
 - Fire and other safety requirements
 12. Lay-down areas
 13. Construction areas/facilities
 14. Distances to other facilities e.g. industrial areas, urban areas, airports etc
 15. Specific site standards
 16. Possible nuisance and inconvenience caused by smell, noise, illumination, visual impact, additional traffic etc during normal operation and emergencies
 17. Security
 18. Helicopter approach with respect to wind rose, heat emission sources e.g. gas turbine stacks, flare radiation etc
 19. Flare radiation

After establishing the constraints, the site master plan is developed broadly as follows based on the process block scheme:

- The facility shall be set-up such that the product flow is logical with respect to process flow and pipe lengths are kept to a minimum. The storage area should be optimally located with respect to flow of consumables.

Generally, this is best accomplished by using a rectangular process area subdivided into process blocks or units separated by access roads and/or pipe racks. The optimum grouping of units depends on how closely they are related from a process viewpoint. The sizes of the blocks depend on the nature of the process, the degree of expansion desired and minimisation of isolation inventory in the event of emergency or maintenance blow-down.

Relations between different units may also exist with respect to operations, mechanical, electrical, structural and safety aspects.

- Utility areas (e.g. power generation, effluent plant etc.) shall be positioned in the most convenient position for interfaces with the process (e.g. fuel gas, utility air) and for access.
- Buildings shall be located in accordance with the requirements as specified in (5.2.7) and such that people movement is optimal.
- The road and rail systems shall be marked in.

The site master plan shall then be considered to see whether this is consistent with safety requirements and that it will assist action in an emergency.

Reference is made to (6) and (7).

5.2 SAFETY DISTANCES

5.2.1 Introduction

A site master plan shall be developed so as to reduce risk to a tolerable and ALARP for the facilities itself as well as surroundings by providing appropriate barriers between potential hazards and vulnerable assets and people.

Appropriate separation distances SHALL [PS] be maintained between process plants and manned buildings like control building, offices, accommodation etc. The area between process facilities and support functions typically provides a convenient location for lower risk facilities such as utilities and tankage.

Safety-critical equipment, e.g. firewater pumps, emergency generators/switch-gear that is used to protect assets and personnel, SHALL [PS] be located (or protected) such that these equipment 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.

Support systems such as offices, workshops, stores are preferably to be located upwind or cross-wind of the prevailing wind direction and in close proximity to the main facility entrance.

Where the defined Project HSE plan has called for a quantitative analysis, the final distances SHALL [PS] be based on:

- risk contours and the criteria as in (4.2).for distances between on-site facilities and critical receptors outside the facility fence
- acceptable lost production levels and associated safety risks for credible scenarios using physical effects modelling and the criteria as in (4.2) for distances between units inside the facility fence

5.2.2 General

The re-commended safety distances as given in table 5.1 and detailed in section 5.2 can be used for initial layouts.

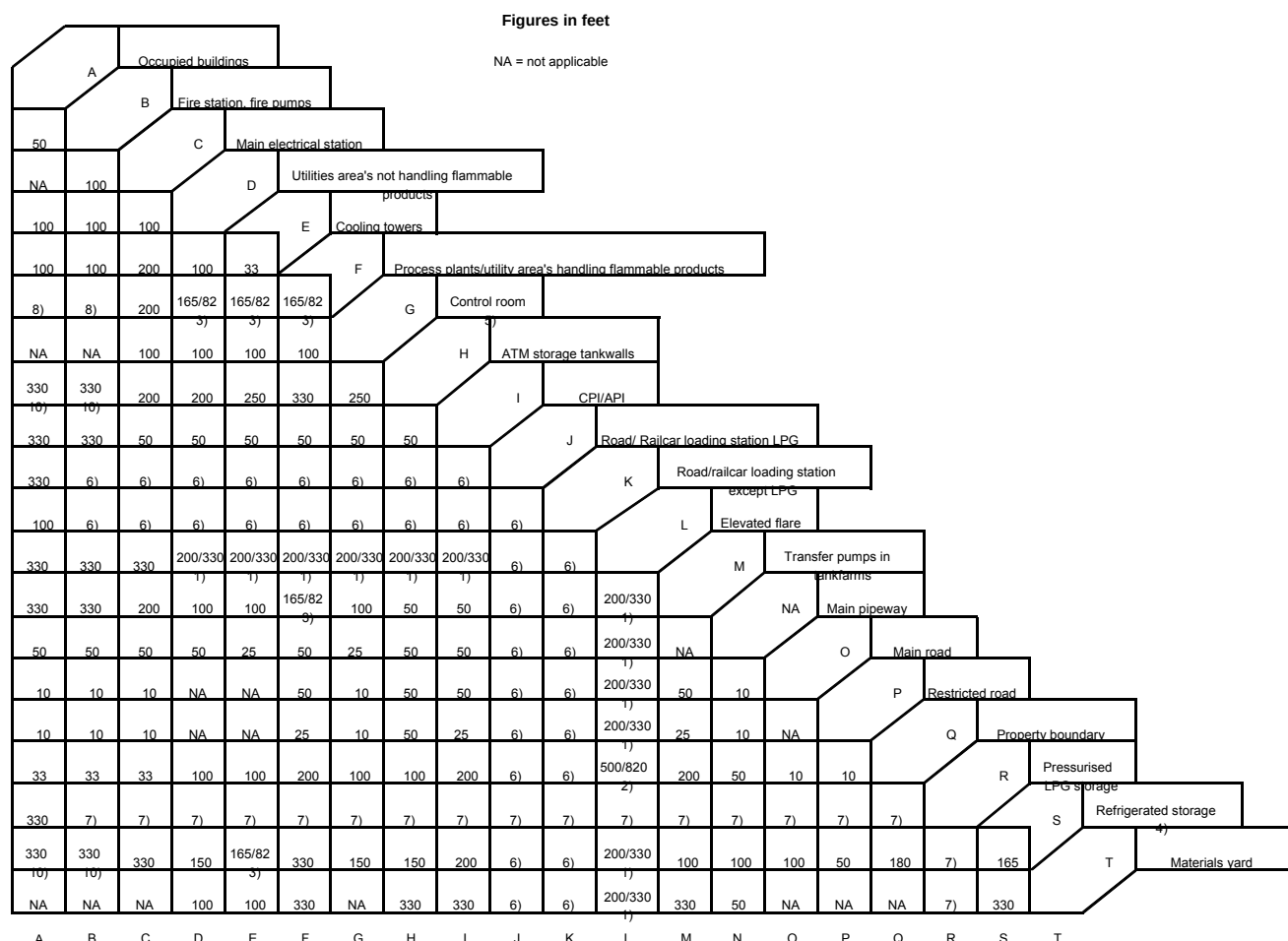
NA = not applicable

A		Occupied buildings			NA = not applicable																									
B		Fire station, fire pumps																												
15	C		Main electrical station																											
NA	30	D		Utilities area's not handling flammable products																										
30	30	30	E		Cooling towers																									
30	30	60	30	10	F		Process plants/utility area's handling flammable products																							
8)	8)	60	50/25 3)	50/25 3)	50/25 3)	G		Control room 5)																						
NA	NA	30	30	30	30	H		ATM storage tankw alls																						
100 10)	100 10)	60	60	75	100	75	I		CP/APi																					
100	100	15	15	15	15	15	15	J		Road/ Railcar loading station LPG																				
100	6)	6)	6)	6)	6)	6)	6)	6)	K		Road/railcar loading station except LPG																			
30	6)	6)	6)	6)	6)	6)	6)	6)	6)	L		Elevated flare																		
100	100	100	60/100 1)	60/100 1)	60/100 1)	60/100 1)	60/100 1)	60/100 1)	6)	6)	M		Transfer pumps in tankfarms																	
100	100	60	30	30	50/25 3)	30	15	15	6)	6)	60/100 1)	NA		Main pipew ay																
15	15	15	15	7.5	15	7.5	15	15	6)	6)	60/100 1)	NA	O		Main road															
3	3	3	NA	NA	15	3	15	15	6)	6)	60/100 1)	15	3	P		Restricted road														
3	3	3	NA	NA	7.5	3	15	7.5	6)	6)	60/100 1)	7.5	3	NA	Q		Property boundary													
10	10	10	30	30	60	30	30	60	6)	6)	150/250 2)	60	15	3	3	R		Pressurised LPG storage												
100	7)	7)	7)	7)	7)	7)	7)	7)	7)	7)	7)	7)	7)	7)	7)	S		Refrigerated storage 4)												
100 10)	100 10)	100	45	50/25 3)	100	45	45	60	6)	6)	60/100 1)	30	30	30	15	55	7)	50	T		Materials yard									
NA	NA	NA	30	30	100	NA	100	100	6)	6)	60/100 1)	100	15	NA	NA	NA	7)	100												
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T											

Table 5.1.a Onshore facilities distances table

Note

- 1 60 m for refineries – 100 m for LNG facilities
- 2 100 m for refineries – 250 m for LNG facilities
- 3 50 m for pressurised liquids – 25 m for gases
- 4 Figures for double containment concrete tanks, check Principal for steel tanks, single cylindrical containment tanks and spherical tanks
- 5 For reinforced building
- 6 See (5.2.8)
- 7 See (5.2.10)
- 8 In general 150 meter from process trains and 200 meter from LNG
- 9 60 m from process equipment in isolated areas (i.e. not part of a congested process area) that present a significant risk such as pumps, pressure vessels, relief valves to atmosphere, flares, process vents, and low pressure storage (including their associated loading and unloading racks) that could, during an unexpected operational upset, release flammable or toxic products.
- 10 60 m from atmospheric storage tanks having a tank sidewall greater than 5 m in height and containing naphtha, gasoline, benzene, methyl ethyl ketone, MTBE, acetone, pentane and natural gas liquids (condensates). 30 m from atmospheric storage tanks contain other (less volatile) flammables.



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Table 5.1.b Onshore facilities distances table

- | | |
|------|---|
| Note | <ol style="list-style-type: none"> 1 200 ft for refineries – 330 ft for LNG facilities 2 330 ft for refineries – 820 ft for LNG facilities 3 165 ft for pressurised liquids – 82 ft for gases 4 Figures for double containment concrete tanks, check Principal for steel tanks, single cylindrical containment tanks and spherical tanks 5 For reinforced building 6 See (5.2.8) 7 See (5.2.10) 8 In general 500 ft from process trains and 660 ft from LNG 9 200 ft from process equipment in isolated areas (i.e. not part of a congested process area) that present a significant risk such as pumps, pressure vessels, relief valves to atmosphere, flares, process vents, and low pressure storage (including their associated loading and unloading racks) that could, during an unexpected operational upset, release flammable or toxic products. 10 200 ft from atmospheric storage tanks having a tank sidewall greater than 16 ft in height and containing naphtha, gasoline, benzene, methyl ethyl ketone, MTBE, acetone, pentane and natural |
|------|---|