PIP PNE00003
Process Unit and Offsites Layout Guide
PURPOSE AND USE OF PROCESS INDUSTRY PRACTICES

In an effort to minimize the cost of process industry facilities, this Practice has been prepared from the technical requirements in the existing standards of major industrial users, contractors, or standards organizations. By harmonizing these technical requirements into a single set of Practices, administrative, application, and engineering costs to both the purchaser and the manufacturer should be reduced. While this Practice is expected to incorporate the majority of requirements of most users, individual applications may involve requirements that will be appended to and take precedence over this Practice. Determinations concerning fitness for purpose and particular matters or application of the Practice to particular project or engineering situations should not be made solely on information contained in these materials. The use of trade names from time to time should not be viewed as an expression of preference but rather recognized as normal usage in the trade. Other brands having the same specifications are equally correct and may be substituted for those named. All Practices or guidelines are intended to be consistent with applicable laws and regulations including OSHA requirements. To the extent these Practices or guidelines should conflict with OSHA or other applicable laws or regulations, such laws or regulations must be followed. Consult an appropriate professional before applying or acting on any material contained in or suggested by the Practice.

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# PIP PNE00003
## Process Unit and Offsites Layout Guide

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1. Introduction

This Practice provides guidance for the design and layout of process units and offsites. This guide should be used as a starting point for the development of plans, electronic models, and working drawings for process units and offsites. This Practice should be coordinated with the overall site and offsites layout for geotechnical, grading, zoning, building codes, life safety code, fire codes, other regulatory requirements, and owner’s and insurer’s risk assessment requirements.

This Practice describes the guidelines for the layout of plot areas, equipment, pipe racks, piping, platforms, roadways, and other miscellaneous items.

Layout includes equipment location, access and egress for personnel safety, access for operations and maintenance, and provisions for operational housekeeping and constructability.

This Practice does not cover requirements for owner safety and property protection needs (e.g., loss prevention, vapor cloud explosions, or environmental or flare/vent stack requirements). Spacings shown in the “Recommended Equipment Spacing Charts” in this Practice are based on industry experience predominantly from a fire exposure/asset loss stand point and are generally applicable for facilities processing flammable and combustible gases and liquids.

This Practice should be used by persons knowledgeable in the governing laws, codes and regulations applicable to the specific facility to ensure that minimum access/egress and equipment spacing is provided to permit compliance with safety regulations. This Practice does not cover the requirements of laws, codes, and regulations in detail, it only provides general guidance or as a pointer for more information.

2. References

Applicable parts of the following Practices, industry codes and standards, and references should be considered an integral part of this Practice. The edition in effect on the date of contract award should be used, except as otherwise noted. Short titles are used herein where appropriate.

2.1 Process Industry Practices (PIP)

- PIP CVE02350 – Roadway Design Guide
- PIP CVE02350M – Roadway Design Guide (Metric)
- PIP PCCGN002 – General Instrument Installation Criteria
- PIP STE01100 – Constructability Design Guide
- PIP STE05501 – Fixed Ladders Design Guide
- PIP STE05511 – Standard Stairs Design Guide
- PIP STE05520 – Guards and Handrails Design Guide
- PIP STE05535 – Vessel Circular Platforms Design Guide

2.2 Industry Codes and Standards

- American Concrete Institute
  - ACI 376 – Code Requirements for the Design and Construction of Concrete Structures for the Containment of Refrigerated Liquid Gases and Commentary
• American Petroleum Institute (API)
  – API RP 500 – Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class 1 Division 1 and Division 2
  – API RP 505 – Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class 1 Zone 0, Zone 1, and Zone 2
  – API RP 752 – Management of Hazards Associated with Location of Process Plant Buildings
  – API RP 753 – Management of Hazards Associated with Location of Process Plant Portable Buildings
  – API STD 521 – Pressure–Relieving and Depressuring Systems
  – API STD 625 – Tank Systems for Refrigerated Liquid Gas Storage
  – API STD 2510 – Design and Construction of Liquefied Petroleum Gas Installations (LPG)

• International Code Council (ICC)
  – International Building Code (IBC)
  – International Fire Code (IFC)

• National Fire Protection Association (NFPA)
  – NFPA 1 – Uniform Fire Code (UFC) 7.8
  – NFPA 30 – Flammable and Combustible Liquids Code 13.1 table 1
  – NFPA 58 – Liquefied Petroleum Gas Code 13.1 table 1
  – NFPA 59A – Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG) 14.5
  – NFPA 70 – National Electrical Code (NEC) 10.3, 10.5, 10.6, 10.7, 10.8, table 4 (electrical)
  – NFPA 101 – Life Safety Code 6.1.1, 6.1.3, 6.1.5, 6.1.11, 6.3.2, 6.4.2
  – NFPA 497 – Recommended Practice for Classification of Flammable Liquids, Gases or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas 10.3
  – NFPA 499 – Recommended Practice for the Classification of Combustible Dusts and of Hazardous (classified) Locations for Electrical Installations in Chemical Process Areas

• Society of International Gas Tanker and Terminal Operators (SIGTTO)

• The Institute of Electrical and Electronic Engineers (IEEE)
  – IEEE C2 – National Electrical Safety Code 10.8

2.3 Government Regulations

• Environmental Protection Agency (EPA)
• Occupational Safety and Health Administration (OSHA)
  – 29 CFR 1910 Subpart D – *Walking-Working Surfaces*
• US Department of Defense (DoD), Unified Facilities Criteria (UFC)
  – UFC-4-020-01 – *Security Engineering Facility Planning Manual*
• US Department of Justice (DOJ-ADA)
  – 28 CFR Part 36 – *ADA Standards for Accessible Design*

### 3. Definitions

**access**: Provision of plot area around process equipment for operations and maintenance personnel, in addition, tools and equipment (e.g., hand carts, wagons, etc.) for maintenance and/or the removal of process equipment

**accessways**: Travel ways that provide occasional access to equipment or congested areas of a facility for maintenance, security, and firefighting vehicles. Also known as tertiary roadways.

**constructability**: Optimum use of construction knowledge and experience in planning, design/engineering, procurement, and field operations to achieve overall project objectives

**dirty service**: A system that contains fluids that may contain particulates which can plug passages, cause erosion, or has materials that need to be contained in the event of a spill

**fixed ladder**: (see standard stairs)

**main operating levels**: Areas which require plant personnel to be continuously present during plant operation or scheduled for presence at least once every shift

**means of egress**: A continuous and unobstructed way of travel from any point in a building or structure to a public way. A means of egress consists of three separate and distinct parts: (1) the exit access, (2) the exit, and (3) the exit discharge. Public way is considered as beyond the battery and/or unit limit.

**offsites**: Equipment (e.g., tanks, loading/unloading facilities, cooling towers, flares) typically grouped outside a process unit battery limits

**operation**: Plant operation consideration is a vital part of plant layout and spacing requirement. The control room needs to be located in a safe location to allow operations to shut down the units in emergency situations. Access to valves, instruments, and ladders must be considered in layout.

**primary roadways**: Main traffic routes. Primary roadways provide access to product shipping and receiving points and sufficient space for major maintenance and firefighting vehicles to pass. Primary roadways include all roadways typically used by large trucks and cranes.

**process unit**: A group of equipment performing a predetermined process operation as defined by the enclosing battery limit lines. Battery limits are as shown on the plot plan.

**secondary roadways**: Secondary roadways provide access for maintenance vehicles (except cranes) and personnel vehicles to equipment within plant areas. Secondary roadways are not subject to high traffic loads.
standard stairs: A fixed or permanently installed stairway. Ship, spiral, and alternating tread-type stairs are not considered standard stairs (see OSHA 29 CFR 1910.21(b))

4. General

4.1 Prevailing weather and site conditions should be considered in the development of general plant arrangements.

4.2 Site topography, soil conditions and geology should be considered and used to minimize earthmoving and foundation requirements. Multiple ground elevations may be used in a plant to avoid extensive cut and fill.

4.3 Grade elevation should be referenced to a datum (e.g., Elevation = 100 feet) for convenience in design and to establish a consistent elevation relationship between design disciplines. Reference point or reference coordinates are necessary for locating the plant relative to its surroundings.

4.4 Process Flow Diagrams, Piping & Instrumentation Diagrams, equipment lists, and additional process information show how the pieces of process equipment are interconnected and provide special required elevation requirements.

4.5 Plant equipment should be located far enough from public areas and thoroughfares to minimize risk to or from the public.

4.6 Applicable local zoning, building codes, and regulations for specific setback, type of facilities permitted, and type of construction permitted should be obtained and applied.

4.7 The process unit should be integrated within a common plant site such that independent operating and shutdown requirements for maintenance of other process units are not affected.

4.8 If independent operation and shutdown is required for maintenance of a process unit, battery limit valving should be provided for the isolation of the process unit.

4.9 Plant and equipment layout should ensure that a safe means of egress is provided for personnel evacuation in the event of an emergency (see Section 6.1 of this Practice). Egress routes should be continuous (not necessarily in a straight line), unobstructed, clearly marked, and lighted. Multiple points of egress may be required.

4.10 Any future plot needs, as required by the owner for process and supporting equipment, should be considered early and shown on the plot plan.

4.11 Process lines, utility headers, power and instrumentation services should be supported on overhead pipe racks at elevations designated for each fluid service.

4.12 Fire and safety equipment should be located to maximize accessibility and minimize exposure to fires, explosions, or releases.

4.13 Equipment noise levels should be considered during process unit location and layout.

4.14 Equipment that handles flammable liquids (e.g., light hydrocarbons) should be located downwind, with respect to prevailing wind direction, of fired heaters, boilers, and other equipment that may cause ignition.

4.15 Layout should permit full utilization of plant mobile handling equipment for construction, servicing, and maintenance from roadways through or adjacent to the unit.

4.16 Permanent handling equipment should be limited to specific items that cannot be serviced manually or by plant mobile equipment.
4.17 Location of process equipment should minimize lifting activity over process equipment. Locations for spotting lifting equipment during maintenance activities should be considered.

4.18 If cost effective, equipment that shares common service should be grouped together.

4.19 Equipment containing hazardous materials should be grouped within a paved and curbed or diked area that is drained or transferred to waste neutralizing.

4.20 All special process requirements (e.g., gravity flow, self-draining, critical Net Positive Suction Head, etc.) should be considered.

4.21 If possible, catch basins, floor drains, and other flammable fluid spill collection points should not be located under fixed ladders, stairs, low platforms, or flammable/heat-sensitive fluid storage equipment or close to egress points. Consideration should be given to the location of drains with relation to fired equipment.

4.22 Offsites and process units equipment spacing requirements should be in accordance with Tables 1 and 2, respectively, of this Practice. Recommended equipment spacing in Tables 1 and 2 should be measured edge-to-edge and be unobstructed.

4.23 Constructability considerations for facilities should be in accordance with the guidelines of PIP STE01100.

4.24 ADA considerations for facilities should be in accordance with DOJ-ADA 28 CFR Part 36.5.

5. **Site Plan Development**

For preparing plot plans, the following information should be considered:

- a. Prevailing wind direction and meteorology
- b. True North as related to Plant North
- c. Location and elevation of railroads
- d. Location and extent of fencing
- e. Location of gates
- f. Location of wells
- g. Existing and original grade elevations
- h. Emergency response requirements
- i. Legal boundaries
- j. Adjacent land usage
- k. Nearby public facilities
- l. Location and elevation of public roadways
- m. Location and elevation of public utilities
- n. Local regulations (e.g., noise, visual, sediment control, etc.)
- o. Location and elevation of waterways both drainage and navigable
- p. Site data (e.g., contaminated soil, seismic, wetlands, etc.)
- q. Topography
r. Future development
s. Risk assessment findings
t. Location of plant roadways
u. Crane access and laydown

6. **Accessways, Platforms, Stairs, Fixed Ladders**

6.1 **Access and Egress**

6.1.1 Means of egress components, including doors, stairs, ramps, and fixed ladders, must comply with the applicable requirements of OSHA 1910 Subpart E, NFPA 101, and IBC when enforced by the authority-having-jurisdiction.

6.1.2 Dimensional criteria is shown in Table 4 of this Practice. The interface with the structural department when setting platform elevations, stair rises, ladder lengths and fall protection is a critical factor for access and egress considerations.

6.1.3 Recommended equipment spacing parameters are shown in Table 1 and Table 3. Requirements for number, location, and arrangement of means of egress from industrial occupancies are provided in NFPA 101, Chapter 40 with references to Chapter 7. Chapter 7 has requirements for public occupancies.

6.1.4 OSHA 29 CFR 1910.36 governs the design and construction of exit routes. This regulation is mostly applicable to enclosed exit routes; however, portions of the regulation are applicable to outdoor exit routes.

6.1.5 Walking-working surfaces, including fixed ladders, stairs, fall protection, and falling object protection, must comply with OSHA 1910 Subpart D.

6.1.6 The width of fixed industrial stairs, walkways, and landings should be evaluated for rescue purposes. DOJ-ADA requires a minimum clear width of 36 inches along routes which may be accessed by disabled persons.

6.1.7 If disabled persons may access the facility, local regulations should be checked for more restrictive requirements than DOJ-ADA.

6.1.8 Personnel accessways should be provided where plant personnel are likely to pass through while carrying out routine duties.

6.1.9 In accordance with OSHA 29 CFR 1910.22 (a)(1) through (3), aisles and passageways including stairs and ladders are to be kept clear and in good repair, without obstructions across or in aisles that could create a hazard.

6.1.10 In accordance with NFPA 101, means of egress are to be continuously maintained free of all obstructions or impediments to full instant use in the case of fire or other emergency.

6.1.11 In accordance with IBC, obstructions are not to be placed in the required width of a means of egress except projections permitted by code. The required capacity of a means of egress system are not to be diminished along the path of egress travel.

6.1.12 Elevators may be considered for maintenance and operations in tall structures for moving small numbers of personnel and equipment. Elevators should not be considered as a means of egress for emergency use.
6.2 Platforms

6.2.1 Platforms should be provided and arranged to provide access around equipment for inspection and maintenance. Refer to the platform requirements in Tables 3 and 4 of this Practice.

6.2.2 Platforms serving vertical and horizontal exchangers should not interfere with removal of the channel end or bundle.

6.2.3 Platforms around furnaces should permit unobstructed access for plant personnel at and around piping manifolds, instruments, and furnace appurtenances.

6.2.4 The distance between the edge of equipment and the pipe rack should be set to permit operator and/or maintenance access to equipment and grade level instruments.

6.2.5 See PIP STE05535 for additional guidance on layout and design of vessel circular platforms.

6.3 Stairs

6.3.1 Standard stairs should be used to provide access between walking-working surfaces when operations necessitate regular and routine travel between levels. This includes access to operating platforms for equipment (See OSHA 1910.25(b)(7).) The term “regular and routine travel” includes access to different levels daily or during each shift. It also includes access necessary to perform routine activities or tasks on a scheduled or periodic, albeit not daily, basis, particularly if the tasks may expose workers to acids, caustics, gases, or other harmful substances, or require workers to manually carry heavy or bulky materials, tools, or equipment.

6.3.2 Standard stairs include winding stairways on tanks and similar round structures when the diameter of the tank or structure is at least 1.5 m (5 ft). (See OSHA 1910.25(b)(7).)

6.3.3 Non-standard stairs, including spiral, ship, or alternating tread-type stairs may only be used when the owner can demonstrate that it is not feasible to provide standard stairs. (See OSHA 1910.25(b)(8).)

6.3.4 Standard stairs should have sufficient clearance to permit unobstructed passage for plant personnel. See Table 4 of this Practice for clearances.

6.3.5 Standard stairs or fixed ladders should be considered for access to electrical equipment and instrumentation not installed at grade.

6.3.6 See PIP STE05511 and PIP STE05520 for additional guidance on layout and design of standard stairs and guards and handrails associated with standard stairs.

6.4 Fixed Ladders

6.4.1 Fixed ladders may be used to access walking-working surfaces when standard stairs are not required (see Section 6.3.1 above). Fixed ladders may also be used to access circular vessel platforms, towers, and similar structures, overhead cranes, etc., where the use of fixed ladders is standard or common industry practice and regular and routine access is not required.
6.4.2 Fixed ladders may be used as means of egress to isolated platforms, provided the maximum occupancy is expected to be not more than three persons at any time. Fixed ladders may also be used as a secondary egress for not more than three persons where standard stairs serve as primary egress for other occupants. See NFPA 101 for more information.

6.4.3 Fixed ladders should not be used as work platforms for operating, reading or maintaining instruments or other items unless three-point contact on the ladder can be maintained.

6.4.4 See PIP STE05501 for additional guidance on layout and design of fixed ladders and requirements for personal fall arrest or ladder safety systems.

6.4.5 Ladders extending more than 24ft. (7.32m) above a lower level must have a personal fall arrest system or ladder safety system installed, per OSHA 1910.28.b.9.

7. Roadways and Area Paving

7.1 Design and layout of roadways should be in accordance with the guidelines in PIP CVE02350 or PIP CVE02350M.

7.2 Primary roadways should have sufficient horizontal and vertical clearance to permit unobstructed access to shipping and receiving points, and travel of major maintenance vehicles including cranes.

7.3 Table 4 of this Practice describes minimum horizontal and vertical clearances to be provided for roadways. Clearances required for the actual vehicles expected to use the roadways should also be considered.

7.4 Access clearances and roadway geometry should be provided as follows:
   a. Under pipe racks as required to permit access for routine maintenance and removal of equipment
   b. To reactors as required to permit catalyst transfer vehicles to reach the area near catalyst unloading nozzles
   c. At compressors as required to permit vehicles such as flatbed trucks to enter a dropout area and remove components using mobile equipment or permanent handling facilities
   d. Around other equipment as required by owner

7.5 Concrete and area paving should extend as follows:
   a. To the outside edge of the supporting column piers of equipment such as bottom oil-fired or combustible-liquid-containing furnaces or elevated structures supporting coke drums
   b. Around catalyst-containing vessels
   c. Around groups of two or more pumps located outdoors
   d. Around compressors and related servicing equipment (e.g., lube oil consoles)
   e. Around equipment in dirty service that requires frequent turnaround maintenance
   f. Around equipment handling materials detrimental to the environment (i.e., hazardous gas/liquid/solid materials) to control spills
7.6 Containment curbs required to retain spilled materials should be specified to contain the required spill volume but not less than 150 mm (6 inches) wide. Curb height should be specified to contain the required spill volume of a single container: 100% of container plus 10%.

7.7 Secondary containment requirements are addressed by EPA. RCRA requires secondary containment in two different areas as follows:
   a. Portable storage containers (e.g., 55-gallon drums) for hazardous waste (see EPA 40 CFR 264.175)
   b. Large stationary containers (e.g., tank systems) for hazardous waste (see EPA 40 CFR 264.193)

7.8 Facilities that store hazardous materials may also be required to be in accordance with either NFPA 1, UFC-06 60.3.2.8.3 or ICC, IFC-06 2704.2 depending on the applicable code.

7.9 Strategies and plot plan areas for managing and containing contaminated fire water volumes should be considered.

7.10 Roadways to have enough width and clearance to allow emergency vehicles, trucks and tankers traffic as required.

8. Piping

8.1 All piping should be routed considering the following:
   a. Provide the shortest possible run while avoiding pockets and permitting thermal expansion.
   b. Group piping together to present a neat appearance, permit orderly branching to various users, and use common supports.

8.2 Provision of a centralized pipe rack should be considered. Equipment can be located on both sides of the pipe rack. The area under the pipe rack can be used to provide access to properly maintain adjacent equipment.

8.3 Specific elevations for pipe running north-south and other specific elevations for east-west piping should be selected.

8.4 Piping at ground level should be located a minimum of 30 cm (12 inches) off the ground, and supported. Runs of lines located at ground level should not obstruct any maintenance, operational accessways, and emergency egress/access. If crossing of walkways is unavoidable, stiles should be provided.

8.5 Steam, instrument air, plant air, nitrogen, gas and vapor branch lines to/from main headers should be connected at the top of the headers.

8.6 Discharge piping for relief valves should be connected into top of the relief header.

8.7 Steam and condensate piping should be arranged to permit expansion by using vertical and horizontal offsets, loops, or expansion joints. The support system can require anchors at certain places to control the direction and effect of expansion. Hot lines requiring expansion loops should be grouped at one side of the pipe rack for ease of support.

8.8 For a two level pipe rack, utility lines and service piping should be placed on the upper level.
8.9 Space should be provided in pipe racks for instrument piping and electrical conduit and cable tray.

8.10 Requirements for piping spacing around equipment should be considered in the layout.

8.11 Additional insulation thickness should be considered in the requirements for piping spacing.

8.12 Process piping should be located above ground.

8.13 Firewater mains, process sewer, sanitary sewer, and storm water drainage piping should be located below grade.

8.14 Underground piping should have sufficient horizontal clearance from structures to provide room for maintenance. Depth of piping burial should be determined based on the following factors:
   a. Commodity being carried
   b. Whether flow depends on pressure or gravity
   c. Traffic loads
   d. Weight of cover loads
   e. Depth of frost line

8.15 Underground piping should be located above the bottom of spread footings or mat foundations or beyond a line sloping downward at 45 degrees from the base of the foundation.

8.16 Underground piping can require room for massive thrust blocks for piping restraint at bends and elbows. Large pipelines, especially water supply or cooling lines, typically require thrust blocks.

9. Buildings

9.1 Buildings should be located in accordance with applicable zoning, building regulations, API RP 752, and the results of risk assessment analyses.

9.2 If feasible, buildings should be located upwind (based on prevailing wind direction) of process units, or storage tank areas containing combustible or flammable gases, liquids or solids.

9.3 Buildings should be located upwind or cross wind from cooling towers.

9.4 All drainage should be directed away from buildings.

9.5 Emergency evacuation and egress routes should be considered.

9.6 Portable occupied buildings should be located in accordance with API RP 753.

10. Instrument and Electrical Equipment

10.1 Electrical power distribution equipment should be located in an unclassified area and in a manner to minimize the length of power distribution conductors.

10.2 Minimizing exposure of electrical equipment to damage from heat sources, as well as chemical and particulate contamination should be considered.
10.3 Requirements for electrical equipment installations are specified in *NFPA 70*. Area classifications are established in accordance with requirements in *NFPA 497*, *NFPA 499*, *API RP 500*, or *API RP 505*, and local codes if applicable.

10.4 Consideration should be given for the location of instrument I/O buildings, electrical buildings (e.g., motor control centers, substations), and electrical equipment (e.g., transformers, switches) to minimize the exposure potential from fire or corrosive atmosphere.

10.5 Requirements for clearances for electrical lines over roadways, walkways, rail, water, open land, buildings, and other structures are specified in *NFPA 70*, Table 225.60 and 225.61, and *IEEE C2*, Section 23.

10.6 Requirements for minimum cover for underground cables, conduits, and duct banks are specified in *NFPA 70*, Tables 300.5 and 300.50, and *IEEE C2*, Table 352-1.

11. **Equipment and Instrument Access**

11.1 **General**

11.1.1 Equipment and instruments should have minimum access provisions and minimum clearance dimensions in accordance with Tables 3 and 4 and the other spacing requirements in this Practice.

11.1.2 Instrumentation access and clearances should also be in accordance with *PIP PCCGN002*.

11.1.3 Unless located at grade, service platforms should be provided for orifices or meter runs requiring certified calibration, as specified by owner.

11.1.4 Equipment for which permanent access is not provided should be located so that temporary access can be provided.

11.1.5 Reserved space should be provided for routine maintenance activities (e.g., filter cartridge removal, catalyst handling, tray removal, relief valve removal, etc.).

11.1.6 Access and clearances for operation and maintenance on proprietary equipment or parts of proprietary equipment should be in accordance with the equipment manufacturer’s standards.

11.2 **Fired Heaters and Furnaces**

11.2.1 Space should be provided for tube replacement for heaters and furnaces.

11.2.2 Sufficient access and clearance should be provided for removal of sootblowers, air preheaters, burners, fans etc. and for operation of pressure relief doors.

11.2.3 Heater stacks should be extended or heaters should be located so that stack gases cannot drift into tall structures and columns where maintenance or operating personnel can be present.

11.2.4 Fired heater are generally 1) located at the end and/or near the periphery of a process unit and 2) placed upwind of all other process equipment.

11.3 **Towers and Drums**

Sufficient drop space, free of obstructions, should be provided for removal of tower/drum internals and relief valves. Location of towers and drums are generally located in close
proximity to their related equipment (e.g. pumps, reboilers, condensers, etc), and in a suitable position for operator and maintenance access.

11.4 Heat Exchangers

11.4.1 Clearance should be provided for tube bundle removal and channel or bonnet removal.

11.4.2 Access to air cooled exchangers should be provided for cooler removal, cooler maintenance, fan motor maintenance, and header box access.

11.4.3 Heat exchangers, other than air cooled exchangers, should be located at grade and grouped. Consideration should be given for vapor cloud explosion risks as identified in the results of a risk assessment analysis.

11.4.4 Air cooled heat exchangers may be located on the top level of pipe racks provided that the pumps are located in accordance with Section 11.5.5.

11.4.5 Tubular heat exchangers should not be stacked higher than 4 m (12 feet) to the top unit centerline.

11.4.6 If locating exchangers beneath other facilities cannot be avoided, the channel should be clear of overhead obstructions and readily accessible for removal.

11.4.7 Access should be provided for exchanger cleaning and/or disassembly.

11.4.8 Bundle pulling methodology and equipment should be considered (e.g., bundle extractors or external anchorage).

11.5 Pumps

11.5.1 Access should be provided to operate and maintain pump auxiliaries (e.g., seal support systems, motor control stations, motor conduit connections, etc). Note: access implies room for any tools needed for removal of equipment (e.g., hand-carts, wagons, etc.).

11.5.2 Clearances and access should be provided for removal of pumps, drivers, pump rods, impellers, and other parts without removing process piping or other components.

11.5.3 Access should be provided around and between pumps. See Table 2 for equipment spacing. The recommended distances should be measured from edge-to-edge of foundations and unobstructed.

11.5.4 Vertical pumps should have appropriate overhead clearances and access to both sides for removal of drivers, shafts, impellers and other parts.

11.5.5 Pumps should be located close to and below their point of suction.

11.5.6 Pumps should be grouped for convenient operation and maintenance.

11.6 Compressors, Fans, Blowers, and Auxiliaries

11.6.1 Clearance should be provided so that compressors, fans, blowers, and associated auxiliaries (e.g., lube oil consoles, large castings, rotating elements, and valves) are readily accessible for maintenance.
11.6.2 Clearance and adequate laydown areas should be provided for maintenance activity equipment (e.g., lifts for large compressor cylinders and pistons, casing and impellers for centrifugal compressors, and rotors for large motors).

11.6.3 All air compressor intakes should be located to avoid intake of contaminants. Prevailing wind direction should be considered for possible cooling tower overspray and/or waste heat from other equipment around compressor intakes.

11.6.4 Adequate space should be provided for personnel on compressor decks and around compressor auxiliaries.

11.6.5 Lay down areas on compressor decks should be provided on elevated structures.

11.7 Reactor and Dryers

Adequate space should be provided for handling drums and/or tote bags at dryers, reactors, etc. that require frequent catalyst changes or raw material charging.

11.8 Pressure Reliefs and De-pressurizing Systems

Pressure reliefs and de-pressurizing systems should be located in accordance with API STD 521.

11.9 Electrical Equipment

Requirements for access and working space for electrical equipment are specified in NFPA 70, Article 110 Part II and Part III.

12. Cooling Towers

Cooling towers should be located downwind or crosswind (based on prevailing wind direction) of buildings, process units, and electrical substations and equipment.

13. Storage Tanks

13.1 Tank spacing and location should be in accordance with NFPA 30, NFPA 58, and API STD 2510 as appropriate.

13.2 Equipment such as pumps, exchangers, and electrical equipment (e.g., transformers, circuit breakers) should be located outside of diked storage areas.

13.3 Equipment inside dikes should be placed at an elevation above the top of the dikes or above the elevation of the design storm water event.

13.4 Adequate space should be provided for containment dikes to avoid unnecessary expenses for dike construction. Typically an economically and properly constructed earthen dike is 2.4 m (8 ft) wide at the top and has side slopes of three horizontal to one vertical. Therefore, the plot plan space for an earthen dike is six times the height required plus 2.4 m (8 ft).

13.5 If there are constraints on plot plan space, other types of containment dike construction may be considered in lieu of an earthen dike.

13.6 A ditch or other drainage at the bottom of a dike is typically required.

13.7 Secondary containment of hazardous materials should be specified to contain the required spill volume as follows:
14. **Gas Processing, Storage and Terminal Facilities**

14.1 Liquefied petroleum gases (LP-Gases) are gases at normal room temperature and atmospheric pressure. LP-Gases liquefy under moderate pressure and readily vaporize upon release of the pressure.

14.2 Storage, handling, transportation, and use of LP-Gas facilities should be in accordance with NFPA-58.

14.3 Design, construction, location, installation, operation and maintenance of refrigerated and non-refrigerated LP-Gas plants should be in accordance with NFPA 59.

14.4 Coverage of LP-Gas systems at utility gas plants extends to the point where LP-Gas or a mixture of LP-Gas and air is introduced into the utility distribution system.

14.5 NFPA 59A should apply to the following:

   a. Facilities that liquefy natural gas
   b. Facilities that store, vaporize, transfer, and handle liquefied natural gas (LNG)
   c. The training of all personnel involved with LNG
   d. The design, location, construction, maintenance, and operation of all LNG

14.6 LNG storage facilities should be in accordance with NFPA 59, ACI 376 and API STD 625.

14.7 Marine terminals handling liquefied gases should be in accordance with the contingency planning described in the SIGTTO publication *A Guide to Contingency Planning for Marine Terminal Handling Liquefied Gases*.

15. **Miscellaneous Considerations**

15.1 The following code issues should be considered:

   a. Occupancy requirements: normal, turnarounds
   b. Removable guards and grating
   c. Potential blast pressures, blast resistance
   d. Access/egress for emergency response vehicles
   e. Evacuation routes to egress and plant evacuation
   f. Environmental issues

15.2 The following utility issues should be considered:

   a. Transformer containment complexity, trenches, grating
   b. Power delivery & distribution; sub-stations, transmission lines
c. Water supply and fire protection
d. Trash, sewage and hazardous waste disposal
e. Storm water runoff, detention ponds, and sediment control

15.3 The following construction issues should be considered:

a. Construction lay down and office, location, remote, blast resistant
b. Crane pads
c. Heavy haul and modular delivery
d. Large erection equipment such as heavy lift cranes or transporters
e. Revamp; adding levels to existing structures, tight clearances
f. Underground obstructions

15.4 The following operational issues should be considered:

a. Monorails and davits, clearances, lifting
b. Fencing, security issues
c. DoD Manual UFC-4-020-01
d. Plant entry and exit control, truck inspection
e. Maintenance shops, warehouses, operator shelters
| ROW | A | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z | AA | BB |
|     | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10| 11| 12| 13| 14| 15| 16| 17| 18| 19| 20| 21| 22| 23| 24| 25| 26| 27| 28| 29| 30| 31| 32|

**Table 1 - Recommended Offsites Equipment Spacing**

**Notes:**
1. This table does not account for vapor cloud explosions, customer safety and property protection, environmental or flare vent/stack dispersal requirements.
2. Distances are in meters (feet).
3. Distances are from PIP Member Company input.
4. "A" indicates that an engineering/safety decision is required. For location of buildings, refer to Section 9.1.
5. "B" indicates refer to NFPA 30.
6. "C" indicates refer to NFPA 58.
7. "D" indicates refer to API 2510.
8. Greater spacing may be required if control or distribution center serves more than one process unit.
Table 2 - Recommended Process Unit Equipment Spacing

<table>
<thead>
<tr>
<th>ROW</th>
<th>COLUMN</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>B</td>
<td>15(50) 3 (10)</td>
</tr>
<tr>
<td>C</td>
<td>A</td>
</tr>
<tr>
<td>D</td>
<td>15 (50) 8 (25)</td>
</tr>
<tr>
<td>E</td>
<td>15 (50) 8 (25)</td>
</tr>
<tr>
<td>F</td>
<td>15 (50) 8 (25)</td>
</tr>
<tr>
<td>G</td>
<td>15 (50) 8 (25)</td>
</tr>
<tr>
<td>H</td>
<td>15 (50) 8 (25)</td>
</tr>
<tr>
<td>I</td>
<td>15 (50) 8 (25)</td>
</tr>
<tr>
<td>J</td>
<td>15 (50) 8 (25)</td>
</tr>
<tr>
<td>K</td>
<td>30 (100) 30 (100)</td>
</tr>
<tr>
<td>L</td>
<td>6 (20) 5 (15)</td>
</tr>
<tr>
<td>M</td>
<td>2 (5)</td>
</tr>
<tr>
<td>N</td>
<td>15 (50) 8 (25)</td>
</tr>
<tr>
<td>O</td>
<td>8 (25) 2 (8)</td>
</tr>
<tr>
<td>P</td>
<td>15 (50) 8 (25)</td>
</tr>
<tr>
<td>Q</td>
<td>15 (50) 8 (25)</td>
</tr>
<tr>
<td>R</td>
<td>15 (50) 6 (20)</td>
</tr>
<tr>
<td>S</td>
<td>15 (50) 8 (25)</td>
</tr>
<tr>
<td>T</td>
<td>15 (50) 8 (25)</td>
</tr>
<tr>
<td>U</td>
<td>15 (50) 8 (25)</td>
</tr>
</tbody>
</table>

**Notes:**
1. This table does not account for vapor cloud explosions, customer safety and property protection, environmental or flare vent/stack dispersal requirements.
2. Distances are in meters (feet).
3. Distances are from PIP Member Company input.
4. "A" indicates that an engineering/safety decision is required. For location of buildings, refer to Section 9.1.
### Table 3 - Minimum Access Provisions

<table>
<thead>
<tr>
<th>Minimum Access</th>
<th>Type of Item to be Accessed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Platform - Items Located Over Platform</td>
<td>Elevated heat exchangers&lt;br&gt;Elevated control valves (all sizes)&lt;br&gt;Manholes (higher than 3660 mm (12 ft) above grade)&lt;br&gt;Relief valves (DN 100 (NPS 4) inlet and larger on vertical vessel)&lt;br&gt;Process blinds (higher than 3660 mm (12 ft) above grade)&lt;br&gt;Furnace soot blowers&lt;br&gt;Furnace burners (when not accessible from grade)&lt;br&gt;Furnace observation doors and sample ports (higher than 3660 mm (12 ft) above grade)&lt;br&gt;Elevated cleanouts</td>
</tr>
<tr>
<td>Platform - Items Located at Edge of Platform</td>
<td>DN 100 (NPS 4) and larger gate and globe valves at vessels&lt;br&gt;Battery limit valves in elevated pipe racks&lt;br&gt;Elevated motor operated valves&lt;br&gt;Relief valves - DN 75 (NPS 3) inlet and smaller on vertical vessels&lt;br&gt;Relief valves - All sizes on horizontal vessels&lt;br&gt;Sampling devices on vessels (higher than 3660 mm (12 ft) above grade)</td>
</tr>
<tr>
<td>Fixed Ladder</td>
<td>All sizes of check valves at vessels&lt;br&gt;DN 75 (NPS 3) and smaller gate and globe valves at vessels&lt;br&gt;Level gauges and valves&lt;br&gt;Furnace observation ports between 2130-3660 mm (7-12 ft) above grade&lt;br&gt;Instruments requiring routine access during unit operations&lt;br&gt;Handholes&lt;br&gt;Elevated electrical substations and equipment</td>
</tr>
<tr>
<td>Mobile Stair</td>
<td>All servicing between 2130-3660 mm (7-12 ft) above grade except as noted in this Table</td>
</tr>
<tr>
<td>No Permanent Access</td>
<td>Block valves in pipe racks (except at battery limit)&lt;br&gt;Elevated orifices or meter runs&lt;br&gt;Nozzles on vessels (without process blinds or valves)&lt;br&gt;Check valves not at vessels&lt;br&gt;Temperature connections in piping&lt;br&gt;Pressure connections in piping&lt;br&gt;Silencers or exhaust heads&lt;br&gt;Metal temperature measuring points on vessels&lt;br&gt;Instrument connections on furnaces</td>
</tr>
<tr>
<td>Item</td>
<td>Description</td>
</tr>
<tr>
<td>-----------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Roadways</strong></td>
<td>Clearance over primary roadways where major maintenance vehicles are expected to pass</td>
</tr>
<tr>
<td></td>
<td>Clearance over roadways to electrical transmission and distribution lines</td>
</tr>
<tr>
<td></td>
<td>Width of primary roadways including shoulders</td>
</tr>
<tr>
<td></td>
<td>Clearance over secondary roadways and accessways</td>
</tr>
<tr>
<td></td>
<td>Width of secondary roadways including shoulders (single lane)</td>
</tr>
<tr>
<td></td>
<td>Width of secondary roadways including shoulders (double lane)</td>
</tr>
<tr>
<td></td>
<td>Width of accessways w/shoulders (single lane)</td>
</tr>
<tr>
<td></td>
<td>Width of accessways w/shoulders (double lane)</td>
</tr>
<tr>
<td></td>
<td>Clearance to equipment</td>
</tr>
<tr>
<td></td>
<td>Horizontal clearance from edge of roadway to structures projecting above ground</td>
</tr>
<tr>
<td><strong>Railroads</strong></td>
<td>Clearance over through-railroads (from top of rail)</td>
</tr>
<tr>
<td></td>
<td>Clearance over dead ends and sidings (from top of rail)</td>
</tr>
<tr>
<td></td>
<td>Horizontal clearance from track centerline to obstructions</td>
</tr>
<tr>
<td></td>
<td>Clearance over railroads (from top of rail) to electrical lines</td>
</tr>
<tr>
<td><strong>Access Walkways</strong></td>
<td>Clearance height for projections over platforms, working areas, walkways (exit access routes)</td>
</tr>
<tr>
<td>and Standard Stairs</td>
<td>Minimum head room over stairs</td>
</tr>
<tr>
<td></td>
<td>Projections into stairs at or below handrail height, each side</td>
</tr>
<tr>
<td></td>
<td>Width of industrial equipment access stairs serving ≤ 20 persons</td>
</tr>
<tr>
<td></td>
<td>Width of means-of-egress stairs serving &lt; 50 persons</td>
</tr>
<tr>
<td></td>
<td>Width of means-of-egress stairs serving ≥ 50 and &lt; 2000 persons</td>
</tr>
<tr>
<td></td>
<td>Length of landings in direction of stairs, minimum</td>
</tr>
<tr>
<td></td>
<td>Length of landings in a straight run of stairs, not required to exceed</td>
</tr>
<tr>
<td></td>
<td>Minimum width of means-of-egress walkways</td>
</tr>
<tr>
<td></td>
<td>Minimum width of walkways for industrial equipment access ≤ 20 persons</td>
</tr>
<tr>
<td></td>
<td>Maximum vertical rise of one flight of stairs</td>
</tr>
<tr>
<td></td>
<td>Maximum travel distance from any point on platform to an emergency exit</td>
</tr>
<tr>
<td></td>
<td>Maximum length of outdoor dead-end platforms and exit routes (depends on occupancy class)</td>
</tr>
<tr>
<td><strong>Fixed Ladders</strong></td>
<td>Maximum fixed ladder height (above a lower level to which a person could fall) for a fixed ladder without a personal fall arrest or ladder safety system</td>
</tr>
<tr>
<td></td>
<td>Maximum fixed ladder height (above a lower level to which a person could fall) for a fixed ladder with a personal fall arrest or ladder safety system</td>
</tr>
<tr>
<td></td>
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<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------------</td>
<td>-----------------------------------------------------------------</td>
</tr>
<tr>
<td>Maximum height between platforms for a fixed ladder with a personal fall arrest or ladder safety system</td>
<td>75 to 90 degrees</td>
</tr>
<tr>
<td>Pitch of fixed ladders from horizontal</td>
<td>180 mm (7 inches)</td>
</tr>
<tr>
<td>Minimum clearance from centerline of rung to nearest permanent object in back of ladder</td>
<td>380 mm (15 inches)</td>
</tr>
<tr>
<td>Minimum clear width on each side of ladder from centerline of ladder to nearest permanent object</td>
<td>760 mm (30 inches)</td>
</tr>
<tr>
<td>Minimum perpendicular distance from centerline of rungs to nearest object on the climbing side</td>
<td>760 mm (2.5 ft)</td>
</tr>
<tr>
<td>Platforms</td>
<td>Maximum variance in platform elevations without an intermediate step</td>
</tr>
<tr>
<td>Minimum unobstructed width of platforms</td>
<td>760 mm (2.5 ft)</td>
</tr>
<tr>
<td>Occasional obstructions (level glass, transmitter, etc.)</td>
<td>460 mm (1.5 ft)</td>
</tr>
<tr>
<td>Minimum width of manhole platforms on vertical vessels</td>
<td>1070 mm (3.5 ft)</td>
</tr>
<tr>
<td>Minimum platform extension beyond centerline of manhole flange on vertical vessels</td>
<td>760 mm (2.5 ft)</td>
</tr>
<tr>
<td>Minimum width of platform from three sides of manhole on vessel top head platforms</td>
<td>760 mm (2.5 ft)</td>
</tr>
<tr>
<td>Minimum width of platforms at ends of horizontal tube furnaces</td>
<td>1070 mm (3.5 ft)</td>
</tr>
<tr>
<td>Operation &amp; Maintenance</td>
<td>Minimum clearance in front of channel end of horizontal exchanger for tube removal or cleaning</td>
</tr>
<tr>
<td></td>
<td>Minimum clearance around exchanger body flanges</td>
</tr>
<tr>
<td></td>
<td>Vertical exchangers</td>
</tr>
<tr>
<td></td>
<td>Unobstructed vertical access</td>
</tr>
</tbody>
</table>

Note: for Electrical items, refer to Sections 10.5, 10.6, and 11.9 of this Practice and the local Electrical Engineering department for electrical equipment clearance requirements. Reference NFPA 70, Tables 225.60 and 225.61, and IEEE C2, Section 23.