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Practical Engineering Guidelines for Processing Plant Solutions

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Kolmetz Handbook Of Process Equipment Design

PROCESS PLANT LAYOUT

ENGINEERING DESIGN GUIDELINES

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INTRODUCTION

Scope

A plant layout substantially varies according to a client-specified economics, process requirements, operation philosophy and maintenance method. Consequently, this specification, which reflects the client's intent, is intended to help eliminate layout design difference among individual engineers and also to help minimize recycle work at subsequent stages. However, application of this specification is not simple.

Plant layout improvement, could be one of the tools to response to increasing industrial productivities. Plant layout design has become a fundamental basis of today's industrial plants which can influence parts of work efficiency. It is needed to appropriately plan, and position employees, materials, machines, equipment, and other manufacturing supports and facilities to create the most effective plant layout.

A good plant layout is designed to offer competitive advantage to manufacturers by enhancing the flow processes of inventory and information, thereby leading to reduction in manufacturing cost and improved productivity.

This engineering design guideline 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.

General Design Consideration

Little adjustments in the position of machines and equipment in a manufacturing plant can greatly alter the easy flow of materials; this also affects the production costs and efficiency of the entire manufacturing process. The inability to get manufacturing processes right leads to delays, inflexibility, inefficiency, excess inventory, high costs, low product quality, and unhappy customers. Modifying an ineffective layout is quite expensive; hence the need to design a functional plant layout right from the onset.

The purpose of plant layout and siting is to provide considerations for safety aspects that could be affected by the location and layout of plant containing equipment with respect to workers, environmental receptors and the surrounding community.

Some of the goals of designing plant layouts are to achieve a minimum amount of materials handling, reduce bottlenecks, minimize machine interference, and also enhance flexibility, throughput, safety, and employee's morale. To achieve optimum layout effectiveness when designing a plant layout, many factors of operation need to be seriously considered.

The design layout of equipment is an important factor to consider for both new construction and expansions. For existing operations, this is also important, but the review approach might be different because the equipment is already fixed in location. Aspects relevant to design layout include proximity to populated buildings, other operations and surrounding community. Consider any occupied temporary facilities such as trailers used during construction, maintenance activities and office space.

Siting means conducting a review of the location of equipment and piping with regard to:

1) possible impact on human or environmental receptors, or
2) where other plant operations could have impact on the dangerous equipment.

In case one, for example, design layout might consider such items as predominant wind direction and populated areas down wind.

In case two, the considerations might include items such as any flammable or potential explosive processes, which - if an event occurred - could have impact on the dangerous equipment.

The alternative methodology is to develop spacing distances for the site's specific layout and process parameters through fire, toxic, and explosion consequence modeling. Given the large numbers of equipment pieces involved in a site layout, this can be a time-consuming endeavor. Computer programs are available to facilitate these calculations. The basic steps when taking this approach are shown below.

1 Identify the hazards inherent in the process unit
2 Identify the consequences that could result from incidents involving the hazards
3 Calculate the fire, explosion, and/or toxic impacts on exposed process or off-site equipment, populations, facilities and adjacent areas.
4 Based on the calculations, estimate the spacing distance required to minimize the consequences of these impacts on the exposed equipment.
5 This distance provides the minimum separation required.
6 Identify opportunities to prevent the incidents
7 Identify the opportunities to mitigate the consequences of incidents.
8 Again, evaluate the spacing distances.

Plot plan is classified into two categories. The first category is a general plot plan and the second is a unit plot plan (equipment layout).

Plant location and site selection

The location of the plant can have a crucial effect on the profitability of a project and the scope for future expansion. The principal factors to consider are

1. Marketing area;
2. Raw material supply;
3. Transport facilities;
4. Availability of labor;
5. Availability of utilities: water, fuel, power;

6. Availability of suitable land;
7. Environmental impact, including effluent disposal;
8. Local community considerations;
9. Climate;
10. Political and strategic considerations.

Marketing Area

For materials that are produced in bulk quantities, such as cement, mineral acids, and fertilizers, where the cost of the product per metric ton is relatively low and the cost of transport is a significant fraction of the sales price, the plant should be located close to the primary market. This consideration is much less important for low-volume production and high-priced products, such as pharmaceuticals.

Raw Materials

The availability and price of suitable raw materials will often determine the site location. Plants that produce bulk chemicals are best located close to the source of the major raw material, as long as the costs of shipping product are not greater than the cost of shipping feed.

Transport

The transport of materials and products to and from the plant can be an overriding consideration in site selection. If practicable, a site should be selected that is close to at least two major forms of transport: road, rail, waterway (canal or river), or a sea port. Road transport is increasingly used and is suitable for local distribution from a central warehouse. Rail transport is usually cheaper for the long-distance transport of bulk chemicals. Air transport is convenient and efficient for the movement of personnel and essential equipment and supplies, and the proximity of the site to a major airport should be considered.

Availability of Labor

Labor will be needed for construction of the plant and its operation. Skilled construction workers are usually brought in from outside the site area, but there should be an adequate pool of unskilled labor available locally, and labor suitable for training to operate the plant. Skilled craft workers such as electricians, welders, and pipe fitters will be needed for plant maintenance. Local labor laws, trade union customs, and restrictive practices must be considered when assessing the availability and suitability of the local labor for recruitment and training.

Utilities

Chemical processes invariably require large quantities of water for cooling and general process use, and the plant must be located near a source of water of suitable quality. Process water may be drawn from a river, from wells, or purchased from a local authority. At some sites, the cooling water required can be taken from a river or lake, or from the sea; at other locations cooling towers will be needed. Electrical power is needed at all sites. Electrochemical processes (for example, chlorine manufacture or aluminum smelting) require large quantities of power and must be located close to a cheap source of power. A competitively priced fuel must be available on site for steam and power generation.

Environmental Impact and Effluent Disposal

All industrial processes produce waste products, and full consideration must be given to the difficulties and cost of their disposal. The disposal of toxic and harmful effluents will be covered by local regulations, and the appropriate authorities must be consulted during the initial site survey to determine the standards that must be met. An environmental impact assessment should be made for each new project or major modification or addition to an existing process

Local Community Considerations

The proposed plant must fit in with and be acceptable to the local community. Full consideration must be given to the safe location of the plant so that it does not impose a significant additional risk to the local population. Plants should generally be sited so as not to be upwind of residential areas under the prevailing wind. On a new site, the local community must be able to provide adequate facilities for the plant personnel: schools, banks, housing, and recreational and cultural facilities.

The local community must also be consulted about plant water consumption and discharge and the effect of the plant on local traffic. Some communities welcome new plant construction as a source of new jobs and economic prosperity. More affluent communities generally do less to encourage the building of new manufacturing plants and in some cases may actively discourage chemical plant construction.

Land (Site Considerations)

Sufficient suitable land must be available for the proposed plant and for future expansion. The land should ideally be flat, well drained, and have suitable load-bearing characteristics. A full site evaluation should be made to determine the need for piling or other special foundations. Particular care must be taken when building plants on reclaimed land near the ocean in earthquake zones because of the poor seismic character of such land.

Climate

Adverse climatic conditions at a site will increase costs. Abnormally low temperatures require the provision of additional insulation and special heating for equipment and pipe runs. Stronger structures are needed at locations subject to high winds (cyclone/hurricane areas) or earthquakes.

Political and Strategic Considerations

Capital grants, tax concessions, and other inducements are often given by governments to direct new investment to preferred locations, such as areas of high unemployment. The availability of such grants can be the overriding consideration in site selection. In a globalized economy, there may be an advantage to be gained by locating the plant within an area with preferential tariff agreements.

The process engineer has an important responsibility in site selection as well as plant layout, since many of the decisions regarding physical location of buildings and associated equipment require knowledge of what is taking place in the operation as well as the hazardous factors of explosion, fire, toxicity, and so on. The process engineer is usually called upon to describe the process requirements and limitation to the other engineers – civil, structural, mechanical, electrical, and instrument. By progressively discussing the process others can note the requirements, which might affect the normal or routine design approach to each phase of the project.

This review must not be limited to the design aspects of the engineering but rather must describe how the plant is to operate and how product is to be shipped, stored, and so on. After the project begins to take shape and preliminary layouts of the overall as well as sections of the plant are partially completed, design work by the other phases of engineering will require the answering of questions as well as the evaluation of details of a particular phase as they are related to the process performance. A general checklist of factors, which usually needs reviewing for the proper layout considerations of chemical and petrochemical plants, is given in Table below.

Table 1. Table Layout and Process Development Engineering Checklist

SITE	**1.** Ground contour and its relation to general orientation of buildings and equipment. **2.** Drainage and waste disposal, details to prevent erosion. **3.** Set plant elevations: floor elevations of buildings and bottom of steel footings for equipment and large storage tanks. **4.** Location of any existing or probable locations for new railroads, roads, power lines and power sources, telephone lines, water supply, residential, and/or industrial buildings or structures. **5.** Legal Requirements and Permits. a. Rights of way for pipe crossing of road, highway, railroad, rivers, canals, etc. b. Easements of pipe lines, power lines, etc. c. C.A.A. approval on airports, and for construction and painting of structures in certain areas in airport vicinity. d. Underground storage wells for chemical and hydrocarbon products. e. Railroad approval of road crossings, additions to existing facilities, automatic railroad gates, required state, and railroad clearances. **f.** Navigable stream requirements and permits
CLIMATE	1. Prevailing wind; locate hazardous vents, burning flares, waste burning pits, waste settling ponds down-wind of plant proper.

	2. Nature of climate. Consider seasonal and daily temperature variations, dust, fog, tornados, hurricanes, earthquakes. 3. Define duration of conditions for design. Determine from US Weather Bureau yearly statistics for above, as well as rainfall. Establish if conditions for earthquakes, hurricanes prevail. For stormy conditions, structural design for 100 mi/h winds usually sufficient. For hurricanes, winds of 125 mi/h may be design basis. 4. Corrosion. Plants located close (within 100 ft) to seas, oceans, bays, lakes encounter more severe corrosion than if located one-fourth mile or more away. Some highly industrial areas are more corrosive than rural or non-industrial locations.. 5. Pollution of Air and water. Determine allowable limits for atmospheric vent as well as liquid wastes. Consider neutralization. **6.** Determine federal, state, and local regulations and effect of climatic conditions on dispersion.
UTILITIES AND RAW MATERIALS	1. Sources and methods of transportation and packaging. a. Water: potable, service, brackish, sea or ocean, cooling tower. b. Steam: condensate disposal, feed-water make-up c. Gas: (1) Process; may not be odorized (2) Fuel; odorized d. Oil: fuel, lubrication (or Liquefied Petroleum Gas) e. Air: (1) Utility (2) Instrument; must be dry below lowest equivalent dew point to prevent moisture condensation and freezing. f. Power 2. Warehouse receiving and storage: drum, boxes, carboys for raw processing materials as well as laboratory control and testing chemicals.
PRODUCT SHIPMENTS	1. Conditions for pipe line transfer of product to user or customer.

	2. Warehouse conditions for bagging, boxing, crating, palletizing, and methods of shipment (trailer truck, box car, tank car, hopper or special car). Consider in-transit and turnaround time to determine number in use.
GENERAL LAYOUT	1. Use of models 2. Maintenance considerations associated with each building, process area and equipment. Consider a. access for cranes and trucks b. work space for local repairs c. operating conditions of adjacent parts of process to allow local repairs. 3. Initial construction sequence and problems. 4. Materials of construction for buildings. 5. Roads: paving, width. 6. Basic pattern for concrete, gravel or asphalt paving or work floors in operating and adjacent areas. 7. Fencing. **8.** Plant guard or security system.
ELECTRICAL AND FREE HAZARDS	1. Define plant areas handling hazardous and lethal materials and set rules for design considerations, such as ventilation explosion, walls, etc. Flammable storage materials may require enclosed dikes, foam systems and the like. 2. Define plant areas requiring explosion-proof, drip-proof and Open motor and associated electrical components. Refer to National Electrical Code and National Electrical Manufacturer's Association Standards. 3. Define areas and building to use wet and dry sprinklers systems, foam systems, location to hand and hose fire extinguishers, fire carts, fire engines. 4. Define location of fire walls, fire hydrants. 5. Review layout for fire equipment access, and secondary and emergency exit roads from each area.

	6. Review entire fire and other hazards program with insurance representatives. Industrial insurance companies have excellent facilities for evaluating the associated problems.
Safety Requirements	1. Special design problems for emergency handling of dangerous or lethal materials. 2. Safety as it is reflected in factors of safety in design of pressure vessels, pressure testing of piping and vessels, use of **API**, **ASME** and **ISA** Codes; Code Stamps on equipment. 3. Areas requiring safety showers and eye wash stations. 4. Design and selection philosophy for use of safety devices for pressure relief and alarm. 5. Inside block valves on acid and caustic storage vessels. 6. Emergency power and other facilities to control safe operation or shut-down.
FUTURE GROWTH	1. Define areas of future growth and associated space requirements. 2. Correlate future expansion plans to required utilities and raw materials as related to economics of required installation. 3. Consider spare equipment, present and future.

Site layout

The process units and ancillary buildings should be laid out to give the most economical flow of materials and personnel around the site. Hazardous processes must be located at a safe distance from other buildings. Consideration must also be given to the future expansion of the site.

The basic objective of the layout decision is to ensure a smooth flow of work, material, people, and information through the system. Effective layouts also:

1 Minimize material handling costs; Material handling and internal transportation from one operation to the next is minimized and efficiently controlled.
2 Utilize space efficiently. Should utilize the space most effectively; may be cubical utilization.
3 Utilize labor efficiently. Should provide worker's convenience, promote job satisfaction and safety for them.
4 Eliminate bottlenecks; The production bottle necks and points of congestions are to be eliminated so that input raw materials and semi-finished parts move fast from one work station to another.
5 Facilitate communication and interaction between workers, between workers and their supervisors, or between workers and customers;
6 Reduce manufacturing cycle time and customer service time;
7 Eliminate wasted or redundant movement. Should avoid unnecessary investment of capital.
8 Facilitate the entry, exit, and placement of material, products, and people;
9 Incorporate safety and security measures;
10 Promote product and service quality;
11 Encourage proper maintenance activities;
12 Provide a visual control of operations or activities;
13 Provide flexibility to adapt to changing conditions.
14 Should provide overall satisfaction to all concerned.
15 Should provide high work in process turnover.
16 Should help in effective utilization of labor.
17 Should lead to increased productivity and better quality of the product with reduced capital cost.
18 Should provide space for future expansion of the plant.
19 Should provide proper lighting and ventilation of the areas of work stations

The ancillary buildings and services required on a site, in addition to the main processing units (buildings), include

1 Storage for raw materials and products: tank farms and warehouses;
2 Maintenance workshops;
3 Stores, for maintenance and operating supplies;
4 Laboratories for process quality control;
5 Fire stations and other emergency services;
6 Utilities: steam boilers, compressed air, power generation, refrigeration, transformer stations;
7 Effluent disposal plant: waste water treatment, solid and or liquid waste collection;
8 Offices for general administration;
9 Canteens and other amenity buildings, such as medical centers;
10 Parking lots.

Whatever be the type of layout being contemplated the following factors are to be considered because these factors have got significant influence on the design of the layout.

1 Man Factor:

- Safety and working conditions.
- Man power requirements-skill level of workers, their number required and their training program.
- Man power utilization in the plant.
- Human relations.

2 Material Factor:

It includes the various input materials like raw materials, semi-finished parts, and materials in process scrap, finished products, packing materials, tools and other services.

- Design and specifications of the product to be manufactured.
- Quantity and variety of products and materials.
- Physical and chemical characteristics of various inputs materials.

- Component parts or material and their sequence of operations i.e. how they go together to generate the final product.

3 Machinery Factor:

The operating machinery is also one of the most important factors therefore all the information regarding equipment and the tools are necessary for inspection, processing and maintenance etc.

- The processes and methods should be standardized first.
- Machinery and tools selections depend upon the type of process and method, so proper machinery and other supporting equipment should be selected on the basis of volume of production.
- Equipment utilization depends on the variation in production, requirements and operating balance.
- Machines should be used to their optimum levels of speed, feed and depth of cut.
- Machinery requirement is mostly based on the process/method.
- Maintenance of machines and replacement of parts is also important.

4 Movement Factor:

It mainly deals with the movement of men and materials. A good layout should ensure short moves and should always tend towards completion of product. It also includes interdepartmental movements and material handling equipment. This includes the flow pattern reduction of unnecessary handling, space for movement and analysis of handling methods.

5 Waiting Factor:

Whenever material or men is stopped, waiting occurs which costs money. Waiting cost includes handling cost in waiting area, money tied up with idle material etc. Waiting may occur at the receiving point, materials in process, between the operations etc.

The important considerations in this case are:

- Location of storage or delay points.
- Method of storing.
- Space for waiting.
- Safeguard equipment for storing and avoiding delay.

6 Service Factor:

It includes the activities and facilities for personnel such as fire protection, lighting, heating and ventilation etc. Services for material such as quality control, production control, services for machinery such as repair and maintenance and utilities like power, fuel/gas and water supply etc.

7 Building Factor:

It includes outside and inside building features, shape of building, type of building (single or multi-story) etc.

8 Flexibility Factor:

This includes consideration due to changes in material, machinery, process, man, supporting activities and installation limitations etc. It means easy changing to new arrangements or it includes flexibility and expendability of layouts.

When the preliminary site layout is roughed out, the process units are normally sited first and arranged to give a smooth flow of materials through the various processing steps, from raw material to final product storage. Process units are normally spaced at least 30m apart; greater spacing may be needed for hazardous processes.

The location of the principal ancillary buildings should then be decided. They should be arranged so as to minimize the time spent by personnel in traveling between buildings. Administration offices and laboratories, in which a relatively large number of people will be working, should be located well away from potentially hazardous processes. Control rooms are normally located adjacent to the processing units, but those with potentially hazardous processes may have to be sited at a safer distance.

The siting of the main process units determines the layout of the plant roads, pipe alleys, and drains. Access roads to each building are needed for construction and for operation and maintenance. Utility buildings should be sited to give the most economical run of pipes to and from the process units.

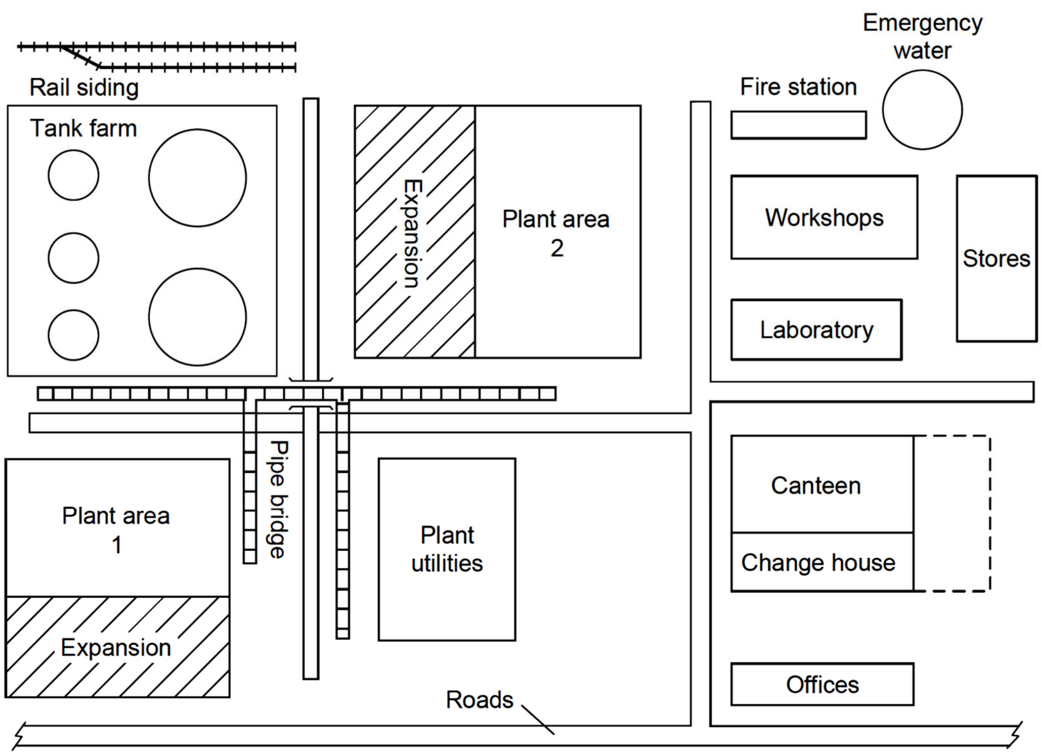

Figure 1. Typical Site Plant

Plant layout

The final plant layout combines the various engineering considerations for soil conditions: drainage; railroad, truck and services access; receiving raw materials; waste materials removal; effect of climate on outdoor versus indoor operations and on types of structures; prevailing wind direction for vent as well as climate moisture; corrosion; plant expansion and growth; access to public; and many other general evaluation points. From these broad considerations the details are developed to suit the particular plant process and the combined effects of the location.

The economic construction and efficient operation of a process unit will depend on how well the plant and equipment specified on the process flowsheet is laid out.

The principal factors to be considered are

1. Economic considerations: construction and operating costs;
2. The process requirements;
3. Convenience of operation;
4. Convenience of maintenance;
5. Safety;
6. Future expansion;
7. Modular construction.

Costs

The cost of construction can be minimized by adopting a layout that gives the shortest run of connecting pipe between equipment and the least amount of structural steel work; however, this will not necessarily be the best arrangement for operation and maintenance. To minimize cost, these should be considered:

1 Design of pipe rack structure for cost saving and to minimize pipe rack lengths
2 Minimize common duct lengths
3 Minimize piping lengths
4 Minimize cable lengths

Process Requirements

An example of the need to take into account process considerations is the need to elevate the base of columns to provide the necessary net positive suction head to a pump or the operating head for a thermosiphon reboiler. Below should be considered in process requirement:

1 Relation between PFD and the equipment layout
2 Relation between the gravity flow lines and elevation of related equipment
3 Spaces between equipment

Operation

Equipment that needs to have frequent operator attention should be located convenient to the control room. Valves, sample points, and instruments should be located at convenient positions and heights. Sufficient working space and headroom must be provided to allow easy access to equipment. If it is anticipated that equipment will need replacement, then sufficient space must be allowed to permit access for lifting equipment. Below should be considered in operation:

1 Access ways for operator's access around each individual item of equipment
2 Location of entrances to structure ladders and the control room.
3 Considerations for patrol routes

Maintenance

Heat exchangers need to be sited so that the tube bundles can be easily withdrawn for cleaning and tube replacement. Vessels that require frequent replacement of catalyst or packing should be located on the outside of buildings. Equipment that requires dismantling for maintenance, such as compressors and large pumps, should be placed under cover.

Safety

Plant layout is often a compromise between a number of factors, including safety aspects such as blast walls may be needed to isolate potentially hazardous equipment and confine the effects of an explosion. At least two escape routes for operators must be provided from each level in process buildings.

1 The geographical limitations of the site.
2 Location of fired equipment
3 Control rooms and their roadways
4 Locations of high pressure gas compressors
5 Location of large-capacity storage tanks containing hazardous and/or flammable or explosive material
6 Location of pumps intended to handle flammable materials
7 Location of fired heater stacks
8 Escape way for emergency
9 Where spacing is reduced significantly, it's necessary to compensate for the increased degree of risk by providing additional safety facilities such as firefighting equipment, water sprays, fire proofing, emergency shutdown facilities, etc.
10 Familiarization with pertinent Environmental Regulations, (Local, National and International), and how they might change is essential period to conclusion of pre-project studies.

11 Attention shall be given to the pertinent safety regulations, including health and welfare needs.

12 Hazardous and flammable materials require special handling, which can take up layout space.

13 If the process fluids are especially toxic, layout is affected by the need for close chemical sewers and other protection measures. Security requirements may require special layout design when the plant produces a high-value product.

14 If a plant site is governed by particular building, piping, plumbing, electrical and other codes, these can affect plant layout. Similar governing standards and regulation in plant site affects the layout concept.

15 The distances for transfer of materials between plant and storage units to reduce costs and risks.

16 Interaction with existing or planned facilities on site such as existing roadways, drainage and utilities routings.

17 The spaces for plant operability and maintainability.

18 Preventing and/or mitigating the escalation of adjacent events (domino effect)

19 Ensure that safety within on-site and off-site occupied buildings is maintained

Plant Layout design techniques applicable to the reduction of the risks from release of flammable or toxic materials include:

1 Locating the storage of flammable/toxic material outside process areas.

2 Locating hazardous plants away from main roadways through the site.

3 Fitting remote-actuated isolation valves where high inventories of hazardous materials may be released into vulnerable areas.

4 Allowing for the provision of dykes and sloping terrain to contain releases, increase the safety and reduce environmental effects.

5 Siting of plants within buildings as secondary containment.

6 Siting of plants in an open air environment to ensure rapid dispersion of minor releases of flammable gases and vapors and thus prevent concentration build-up which may lead to flash fires and explosions.

7 Hazardous area classification for flammable gases, vapors and dusts to designate areas where ignition sources should be eliminated.

Plant Expansion

Equipment should be located so that it can be conveniently tied in with any future expansion of the process. Space should be left on pipe racks for future needs, and service pipes should be oversized to allow for future requirements.

Modular Construction

In recent years there has been a move to assemble sections of a plant at the plant manufacturer's site. These modules include the equipment, structural steel, piping, and instrumentation. The modules are then transported to the plant site, by road or sea.

The advantages of modular construction are
1. Improved quality control;
2. Reduced construction cost;
3. Less need for skilled labor on site;
4. Less need for skilled personnel on overseas sites.

Some of the disadvantages are
1. Higher design costs;
2. More structural steel work;
3. More flanged connections;
4. Possible problems with assembly, on site;

Maximum flexibility - good plant layout should be easily modified in order to meet up with the ever-changing demands of the customer and market.

1 Throughput – plant layouts should be designed to assist the business to attain its production output at the shortest possible time, in order to ensure repeat patronage and customer satisfaction.

2 Efficient utilization of space – this entails the provision of sufficient space around the machines and the traffic lanes, as well as ensuring that adequate spaces are made available for storage points within the facility.

3 Ease of Communication – plant layouts should be designed to enhance communication and easy flow of information among the various departments/units, as well as the customers.

4 Promotional value – a well-designed layout enhances the image and reputation of a company, thereby serving as a good promotional factor.

5 Safety – as the importance of safety in all human endeavors should not be overemphasized, a good plant layout should be designed to function efficiently and ensure that accidents and its causes are reduced to the barest minimum.

6 Maximum accessibility: the repairs and maintenance sections should be made readily accessible. This implies that equipment and machines must not be placed against the walls in order to ensure that maintenance and servicing operations are easily undertaken.

DEFINITION

ASME - American Society of Mechanical Engineers.

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

Accumulator: a storage vessel for liquid refrigerant; also known as surge drum.

Bearing – Is a device to permit constrained relative motion between two parts, typically rotation or linear movement. Compressors employ at least half a dozen types of journal bearings. Essentially all of these designs consist of partial arc pads having a circular geometry

Blow down - The process of releasing pressure in e.g. a refinery pressure vessel by venting to atmosphere OR primary production of a crude oil or condensate reservoir using the pressure of the associated gas

Boundary- Boundary of the equipment is the term used in a processing facility, by an imaginary line that completely encompassed the defined site.

Casing - Steel pipe placed in an oil or gas well as drilling progresses to seal the well and to prevent the wall of the hole caving in during drilling, to prevent seepage of fluids, and to provide a means of extracting petroleum if the well is productive. A number of casing strings (lengths) are used in decreasing diameters

Capacity - Is the water handling capability of a pump commonly expressed as either gallon per minute (gal/min) or cubic meter per minute (m3/min).

Completion - Installation in a well of production tubing and equipment, wellhead and Christmas Tree OR fulfilment of a contractual obligation

Compressor – A device that compressing the fluid to raise its pressure.

Concession - a license, lease, or other permit for exploration and/or production in an area or block. It usually donates a government lease

Condensate - Volatile liquid consisting of the heavier hydrocarbon fractions that condense out of the gas as it leaves the well, a mixture of pentanes and higher hydrocarbons. See also gas condensate.

Condenser: a heat exchanger in which the refrigerant, compressed to a suitable pressure, is condensed by rejection of heat to a cooling medium.

Crude Oil - An unrefined mixture of naturally-occurring hydrocarbons. Because it is essentially a mixture, the density and properties of Crude Oil vary widely. Light Crude normally has an A.P.I. gravity of 30° or more. Gravities of 20° to 30° include the medium gravity crudes, while those below 20° are known as Heavy. Heavy oils are found right down to the residual solid state

Dike- Is an earth or concrete wall providing a specified liquid retention capacity.

Dirty service - Contains fluids that may contain particulates which can plug passages or cause erosion or has materials for which containment must be provided in the event of a spill

Diversion Wall- Is an earth or concrete wall which directs spills to a safe disposal area.

Differential pressure - The difference between the pressure in a well due to the mud column and the pressure in the surrounding rock at any point. See also sticking.

Distillation - The process of heating and “flashing” or boiling off successive fractions (component hydrocarbon substances) from a crude oil feedstock, or a product of earlier distillation.

Downstream - a relative term (the opposite of “Upstream”) in oil industry operations. For instance, a refinery is “downstream” of a crude oil production unit, and a petrochemical unit, and a petrochemical plant usually downstream of a refinery. The term has also come to mean all operations occurring after the delivery or lifting of saleable quality crude or gas from the production unit or associated delivery terminal.

Downtime - A period when any equipment is unserviceable or out of operation for maintenance etc.

Elevators - A clamp used in a drilling rig to latch onto the grip drill pipe, casing etc when lifting them.

Exploration - The process of identifying a prospective hydrocarbon region and structure, mainly by reference to regional, and specific geochemical, geological and geophysical (seismic) surveys, including core testing, and the drilling of wildcats.

Evaporator – A device used to turn the liquid into gaseous form. Heat exchanger used to absorb heat energy.

Fire Resistive- Fire resistance rating, as the time in minutes or hours, that materials or assemblies have withstand a fire exposure as established in accordance with the test of NFPA 251.

Fired Heater Efficiency - The ratio of heat absorbed to heat fired, on a lower heating value basis

Fines - Small particles of rock or other solid.

Fixed industrial stairs - This classification includes interior and exterior stairs around machinery, tanks, and other equipment, and stairs leading to or from floors, platforms, or pits.

Fixed ladders - A fixed ladder is a ladder permanently attached to a structure, building, or equipment.

Flash Point - The lowest temperature at which a vapour will burn or explode when ignited.

Flowline - The pipe through which produced fluid travels from a well to a manifold, to processing equipment or to storage.

High Flash Stock- Are those having a closed cup flash point of 55°C or over (such as heavy fuel oil, lubricating oils, transformer oils etc.). This category does not include any stock that may be stored at temperatures above or within 8°C of its flash point.

Induced Draft - Use of a fan to provide the additional draft required over that supplied by the stack, to draw the flue gas through the convection section, and any downstream heat recovery equipment.

Lower Heating Value (LHV) - The theoretical heat of combustion of a fuel, when no credit is taken for the heat of condensation of water in the flue gas.

Low-Flash Stocks- Are those having a closed cup flash point under 55°C such as gasoline, kerosene, jet fuels, some heating oils, diesel fuels and any other stock that may be stored at temperatures above or within 8°C of it's flash point.

Main operating levels - Areas which, during plant operation, require plant personnel to be continuously present or to be scheduled for presence at least once every shift

Non-Combustible- Material incapable of igniting or supporting combustion.

Offsites - Equipment grouped outside a process unit battery limits (e.g., tanks, loading/unloading facilities, cooling towers, flares, etc.)

Pipe Rack- The pipe rack is the elevated supporting structure used to convey piping between equipment. This structure is also utilized for cable trays associated with electric-power distribution and for instrument tray.

Pipelines / Lines - A network of lines generally transporting hydrocarbon -fluids "from one facility (such as GC and BS) to another facility, terminal or storage such as Tank Farm. For the purpose of this RP the pipelines I transit line are not considered as flowlines.

Plant - A general term to describe a processing / operational unit on a given site.

Plot - An area of the site containing one or more process units, offsite and/or tankage

Plot Plan- The plot plan is the scaled plan drawing of the processing facility.

Primary roadways -: Main traffic routes. Primary roadways provide access to product shipping and receiving points and sufficient space for major maintenance 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.

Quantitative Risk Assessment - A detailed qualitative and quantitative is to evaluate / measure potential Likelihood and consequences of site-specific scenarios of risks and associated hazards leading to human death, or injury, environmental damage or economic loss and their magnitude and then to compare the findings with acceptance criteria.

Refrigerant – A substance that used as a medium to cool the process in refrigeration system. the fluid used for heat transfer in a refrigeration system, which absorbs heat at a low temperature and low pressure and rejects heat at a higher temperature and a higher pressure.

Refrigeration – A process in which work is done to move heat from one circumstances to the other environment. the heat transfer of heat from a lower temperature region to a higher temperature one. A device called a refrigerator or heat pump accomplishes refrigeration.

Secondary roadways - Secondary roadways provide access to equipment within plant areas by maintenance vehicles (except cranes) and personnel vehicles. Secondary roadways are not subject to high traffic loads.

Sleepers- The sleepers comprise the grade-level supporting structure for piping between equipment for facilities, e.g., tank farm or other remote areas.

Tank Diameter- Where tank spacing is expressed in terms of tank diameter, the following criteria governs: (a) If tanks are in different services, or different types of tanks are used, the diameter of the tank which requires the greater spacing is used. (b) If tanks are in similar services, the diameter of the largest tank is used

Tank Spacing- Is the unobstructed distance between tank shells, or between tank shells and the nearest edge of adjacent equipment, property lines, or buildings.

Toe Wall- Is a low earth, concrete, or masonry unit curb without capacity requirements for the retention of small leaks or spills

Vessel Diameter- Where vessel spacing is expressed in terms of vessel diameter, the diameter of the largest vessel is used. For spheroids, the diameter at the maximum equator is used.

Vessel Spacing- Is the unobstructed distance between vessel shells or between vessel shells and nearest edge of adjacent equipment, property lines, or buildings.

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