PLANT LOCATION AND LAYOUT

8.1 Introduction

A suitable site must be found for a new project, and the site and equipment layout planned. Provision must be made for the ancillary buildings and services needed for plant operation; and for the environmentally acceptable disposal of effluent.

8.2Plant 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. Many factors must be considered when selecting a suitable site, and only a brief review of the principle factors are given below. The principle factors to consider are:

1. Location, with respect to the marketing area.
2. Raw material supply.
3. Transport facility.
4. Availability of labour.
5. Availability of utilities: water, fuel, power.
6. Availability of suitable land.
7. Environmental impact and effluent disposal.
8. Local community considerations.
9. Climate.
10. Political and strategic considerations.

8.2.1 Marketing area

For materials that are produced in bulk quantities; such as Isoamyl Alcohol where the cost of the product per tonne is relatively low and the cost of transport a significant fraction of the sales price, the plant should be located close to the primary market. This consideration will be less important for low volume production, high-priced products; Pharmaceuticals.

In an international market, there may be an advantage to be gained by locating the plant within an area with preferential tariff agreements;

8.2.2 Raw Materials

The availability and price of suitable raw materials will often determine the site location. Plants producing bulk chemicals are best located close to the source of the major raw material; where this is also close to the marketing area.

8.2.3 Transport

The transport of materials and products to and from the plant will 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 being increasingly used, and is suitable for long- distance transport of bulk chemicals.

Air transport is convenient and efficient for the movement personnel and essential equipment and supplies, and the proximity of the site to a major air port should be considered.

8.2.4 Availability of labour

Labour will be needed for construction of the plant and its operation. Skilled construction workers will usually be brought in from outside the site area, but there should be an adequate pool of unskilled labour availability locally; and labour suitable for training to operate the plant. Skilled tradesmen will be needed for plant maintenance. Local trade union customs and restrictive practices will have to be considered when assessing the availability and suitability of the local labour for recruitment and training.

8.2.5 Utilities (Services)

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 will be needed at all sites. Electrochemical processes that require large quantities of power; need to be located close to a cheap source of power.A competitively priced fuel must be available on site for steam and power generation.

8.2.6 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 he standards that must be met.

An environmental impact assessment should be made for each new project or major modification or addition or an existing process.

8.2.7 Local community considerations

The proposed plant must be 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 community.

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.

8.2.8 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 would be made to determine the need for piling or other special foundations.

8.2.9 Climate

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

8.2.10 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 overriding of such grants can be the overriding considerations in site selection.

8.3 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 be given to the future expansion of the site. The ancillary buildings and services required on a site, in addition to the main processing units (buildings), will include:

1. Storages for raw materials and products: tank farms and warehouses.
2. Maintenance workshops.
3. Stores, for maintenance and operating supplies.
4. Laboratories for process control.
5. Fire stations and other emergency services.
6. Utilities: Steam boilers, compressed air, power generation, refrigeration, transformer station
7. Effluent disposal plant.
8. Offices for general administration.
9. Canteens and other amenity buildings, such as medical centre.
10. Car parks.

When roughing out the preliminary site layout, the process units will normally be sited first and arranged to give a smooth flow of materials through the various processing

steps, from raw materials to final product storage. Products units are normally spaced at least 30 m apart; grater 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 will normally be located adjacent to the processing units, but with potentially hazardous processes may have to be sited at a safer distance.

The siting of the main process units will determine the layout of the plant roads, pipe alleys and drains. Access roads will be needed to each building 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.

Cooling towers should be sited so that under the prevailing wind the plume of condensate spray drifts away from the plant area and adjacent properties.

The main storage area should be placed between the loading and unloading facilities and the process units they serve. Storage tanks containing hazardous materials should be sited at least 70 m (200 ft.) from the site boundary.

8.4 Plant layout

The economic construction and efficient operation of the process unit will depend on how well the plant and equipment specified on the process flow-sheet 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.

8.4.1 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.

8.4.2 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 head to a pump or the operating head for a thermosyphon reboiler.

8.4.3 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.

8.4.4 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.

8.4.5 Safety

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.

8.4.6 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 alleys for future needs, and service pipes over-sized to allow for future requirements.

8.4.7 Modular construction

In recent years, there has been a move to assemble sections of plant at the plant manufacturer's site. These modules will 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 labour 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.

8.4.8 General considerations

Open, structural steelwork, buildings are normally used for process equipment; closed buildings are only used for process operations that require protection from the weather.

The arrangement of the major items of equipments will usually follow the sequence given on the process flow-sheet: with the columns and vessels arranged in rows and the ancillary equipment, such as heat exchangers and pumps, placed along the outside.