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1. SCOPE

This manual covers the minimum requirements for the layout of process units and process complexes.

In cases where matters concerned fall under the jurisdiction of any laws and conformance to the clients standard and regulations in requested, of the requirements the severer shall be satisfied.

Should any conflicts occur between any two or more requirements, the safer one shall govern.

If two or more different layouts can be provided in accordance with this manual, the most economic one shall be adopted with the client's and project manager's approval.

2. PROCESS COMPLEXES

This chapter discusses the preparation of a block layout covering two or more process units.

In addition to the following requirements, consideration shall be given to future plant expansion, if necessary.

2.1 Requirements Associated with Offsite Facilities

- (1) The process unit to which the feed stock is charged first, shall be located on the side near the feed stock tanks, to minimize the length of the feed line.
- (2) The process unit from which the final product(s) is(are) withdrawn, shall be located on the side near the product tanks to minimize the length of the product rundown line.
- (3) Process units in which large quantities of utilities are consumed, should be preferably located on the side near the utility center.

2.2 Requirements Associated with Material Flows

- (1) Any two process units between which a material(s) is(are) to be transferred directly, shall be located next to each other.
- (2) A process unit to and/or from which materials are to be transferred to and/or from other several process units, shall be located in the central position of the other process units.

2.3 Safety Requirements

- (1) All units in which heaters exist shall be collectively located on the windward side of their process units.

If this is impracticable, the leeward heater shall be located at a distance of more than 15 m from the windward equipment.

- (2) Process units in which poisonous gas is to be handled, shall be located leewards.
- (3) The central control room shall be located windward at a minimum distance of 15 m from the nearest equipment.
- (4) Desirably, process units in which high pressure gas is to be handled, should be located leewards.

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2.4 Firefighting Requirements

- (1) Each individual process unit shall be provided with such sufficient open spaces therearound that fire trucks can be run and operated thereat.

The width of access ways thereto shall be 6m minimum.

If overhead piperacks cross the roadways, the piperacks shall be elevated at least 4.5 m from grade.

- (2) Process units consisting of large hazardous material storage tanks should be located desirably in outer areas in the complex site.

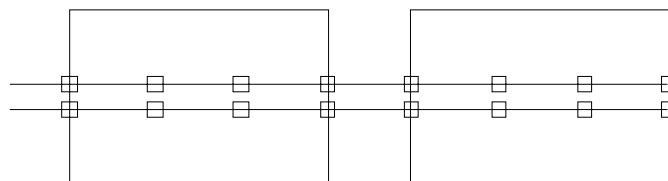
2.5 Erection and Maintenance Requirements

- (1) Process units (for instance, crude distillation units, vacuum distillation units, FCC units, coker units, etc.) consisting of large equipment shall be located in outer areas in the complex site, so that sufficient spaces will be available for their haulage and erection.
- (2) Sufficient access areas shall be provided around each individual unit for use in the operation of mobile cranes: They can serve as open space mentioned in (1) of Para. 2.4.
- (3) Process units which will require maintenance specially separately from other units, shall be provided with a minimum spacing of 6 m between them and the nearest units.

2.6 Typical Layout

- (1) Relatively small-scale process complex

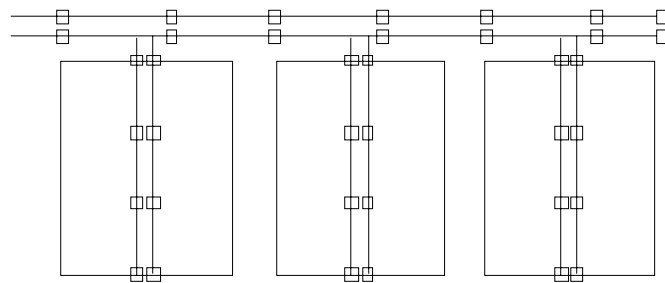
In the case of a small process complex consisting of two - three process units, the "Single Rack Type" layout shown below is suitable: it is economical without requiring any large area.



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(2) Medium-scale process complex

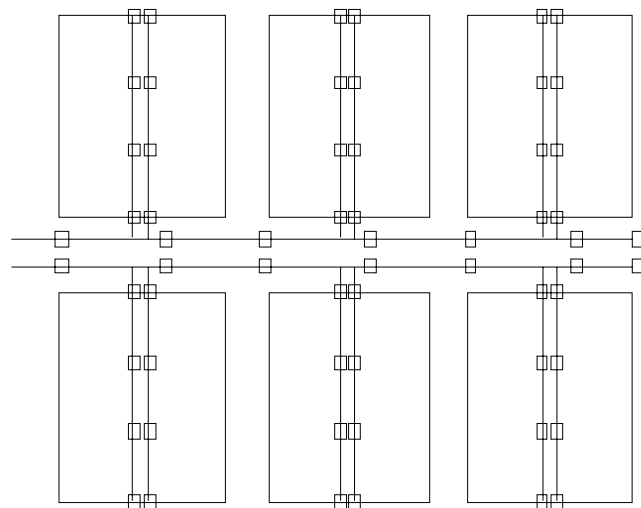
In the case of a process complex consisting of three or more process units, if the "Single Rack Type" layout is used, separate maintenance and utility administration in normal operation will be difficult since the utility and flare lines are placed on the common rack. To settle this, the "Comb Type" layout shown below can be used.



(3) Large-scale process complex

This layout is an expansion of the "Comb Type" which is called "Double Comb Type".

In cases where five to ten process units are to be arranged, this layout can be conveniently utilized.



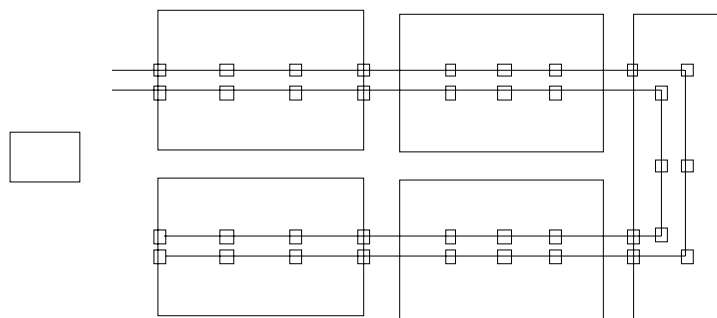
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(4) Integrated Units

In the case of process units whose maintenance cannot be conducted separately, even process complexes can be regarded as one process unit in the planning of their layout.

The "U-type" layout shown below is used in some instances.

This type can be regarded as an expansion of the "Single Rack Type"



2.7 Typical Process Area

Typical process areas are as shown on Fig. 2-1 attached hereto.

3. PROCESS UNITS

This chapter discusses the planning of equipment layouts in process units.

3.1 General Requirements

- (1) In cases where process fluid is run by gravity head, elevated layouts must be considered. Unless there are any such limitations as indoor arrangement and confined locations, equipment shall be placed at grade as a rule except in cases where gravity flow is specifically required for any reason.
- (2) Since the directions of the incoming feed stocks, outgoing products and utility supply are determined on the overall plot plan, first the direction of the piperack in the unit shall be decided.
- (3) Space shall be allowed for the provision of future spare equipment, if required

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3.2 Process Requirements

- (1) Equipment shall be laid out along the flows on the process flow diagram.
- (2) Especially, the fractionator and its reboilers, condensers and overhead receivers shall be collectively located.
- (3) Gravity flow lines shall be laid out with consideration given to related elevations, so that their lengths will become minimum. Especially in the case of lines in which liquids will flow nearly at their boiling points, related equipment shall be located close to each other so that the lines need not be elevated
- (4) Pieces of equipment which are to be connected by large-size piping or alloy piping, shall be located close to each other.
- (5) Air coolers shall be laid out so that no heated air may be recirculated.

3.3 Safety Requirements

- (1) Fired equipment (heaters, boilers, etc.) shall not be located in Class I Division 2 areas set forth in the Basic Design Manual (SEM-9438 "Hazardous Area Classification").
Generally, fired equipment shall be located at a distance of more than 15 m from any source of hazard (hot oil pumps, light end pumps, compressors, etc.).
- (2) Control rooms and their roadways shall not be located in Class I Division 2 areas.
Generally, they shall be located at a distance of more than 15 m from the nearest equipment.
- (3) High pressure gas compressors shall be located at leeward locations.
- (4) Large capacity hazardous material storage tanks shall be located in outer areas as far as possible.
- (5) Pumps intended to handle flammable materials (which fall under the control of the Basic Design Manual SEM-9438), shall be located on the following basis:

	Under Piperack	Under Air Cooled Exchangers
Coil oil pumps	Acceptable	Acceptable
Hot oil pumps (Note 1)	Unacceptable (Note 2)	Unacceptable
Light ends pumps	Acceptable	Unacceptable (Note 3)

Note :

1. Hot oil means the oil whose operating temperature is higher than the auto-ignition point.
2. A space of minimum 3 m shall be provided from piperack.
3. Light ends pumps shall not be located under air cooled exchangers except where concrete decks are provided under the air cooled exchangers as shown in Fig. 3-1.

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(6) Fired heater stacks shall be located at such points that the performance of the air coolers and operators on tower tops may not be adversely affected by hot flue gas emitted through them: the directions of prevailing winds shall be taken into consideration in the determination of the stack locations.

If this problem cannot be settled in the equipment layout, the heights of the heater stacks shall be increased or a common stack shall be provided.

3.4 Erection and Maintenance Requirements

- (1) Sufficient access spaces shall be provided around large-size equipment (for instance, main columns, reactors, coke chambers, etc.) for use in haulage and erection.

In cases where gin-poles are to be used, spaces will be required to haul the equipment and to assemble and disassemble the gin-poles and to provide guy wire anchors.

These access spaces shall be consulted by construction engineer.

- (2) An open space shall be provided on one side of the equipment for crane access.

In the case of air coolers placed on piperacks, if equipment are installed on both sides of the air coolers, access ways (whose minimum width shall be 5 m) shall be provided at a proper interval on one side of the air coolers.

If no such access can be provided, trolley beams shall be installed over the air coolers for use in bundle maintenance.

- (3) An open space shall be provided under the tower top davit as a tower internal maintenance area.

- (4) A working area required for catalyst loading and unloading shall be provided.

- (5) Shell-and-tube heat exchangers shall be located collectively at one point as far as possible and their tube bundle pulling area (tube bundle length + min 2 m) shall be provided thereat.

- (6) Horizontal coil arrangement (fired) heaters require a mechanical cleaning and tube pulling area.

- (7) Pumps shall be located collectively under piperacks as a rule.

However, this requirement need not be applied to pumps whose suction line lengths must be minimized in connection with the process performance.

- (8) Compressors of large capacity shall be sheltered unless otherwise requested by the client. Permanent gantry cranes may be provided for the compressors if necessary and an open space shall be provided on one side of the shelter.

3.5 Operational Requirements

- (1) Clear access ways (whose minimum widths shall be 0.60 m) shall be provided as operator's access around each individual item of equipment.

No auxiliaries and accessories, such as piping and instruments shall be present in the access ways.

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- (2) Entrances of structure ladders shall be located on the side near the control room.
- (3) Stages and platforms through which patrol personnel will frequently pass, shall be provided with stairways patrol routes shall be considered in the preparation of the plot plan.

3.6 Economic Requirements

The following shall be considered for cost reduction purposes:

- (1) Minimize piping lengths
- (2) Minimize piperack lengths
- (3) Minimize common duct lengths
- (4) Minimize cable lengths

3.7 Equipment Layout

(1) Towers and drums

Towers and drums shall be lined up on the basis of centerlines.

Self-standing towers exceeding 30 in L/D, may require support structures.

Hence, in the case of such towers, the equipment design engineer in charge shall be contacted in advance for confirmation.

Also, as table top (concrete) structures may be used instead of skirts in the case of large towers and reactors, the matter shall be clarified in advance by the equipment design engineer in charge.

(2) Shell-and-tube heat exchangers

Exchangers of this type shall be lined up on the basis of channel side nozzle centerlines.

Maximum stack of heat exchanger train shall be limited to two-folded as a rule.

(3) Air fin coolers

Air fin coolers shall be placed on piperacks as a rule. Common fans may be used in the case of small air fin coolers where combinations of coolers shall be planned in advance.

(4) Pumps

Pumps shall be lined up on the basis of motor side foundation faces.

Some types of pumps may require to be lined up on the basis outlet nozzle centerlines.

(5) Piperacks

Maximum piperack widths shall be 10 m. If widths larger than 10 m are required, the piperacks shall be designed to be of two stage.

Actual widths shall be 110% of the required widths or the required widths plus 1 m.

In cases where air fin coolers are to be placed on the piperacks, the piperack widths shall be adjusted based on the length of the air coolers.

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(6) Distances between individual equipment

The data given below are typical equipment surface-to-equipment surface distances which must be adjusted based on the results of the piping layout at the detail planning stage.

Column-to-column	3 m
Drum-to-drum	2 m
Exchanger shell-to-exchanger shell	1 m
Pump-to-pump (foundation)	1 – 1.5 m
Piperack-to-structure	5 m
Piperack-to-equipment	6 m

4. TYPICAL EXAMPLE

This chapter discusses the form and contents of proposed plot plans.

For a typical example, see Fig. 4-1 attached hereto.

4.1 Title Blocks

Title blocks shall be of SECL's standard and the drawing name shall be "Proposed Plot Plan".

4.2 Entries to be Made

At least the following matters shall be entered on proposed plot plans:

- (1) Title block
- (2) North marks (construction north and geographical north).
- (3) Key plan around process area
- (4) Wind direction
- (5) Equipment and their item numbers
- (6) Feed and product directions
- (7) Utility and flare gas flow directions
- (8) Overall widths and lengths
- (9) Piperacks and structures
- (10) Safety areas around fired heaters and control rooms.
- (11) Mobil crane access areas
- (12) Heat exchanger and heater tube pulling areas

4.3 Wind Directions

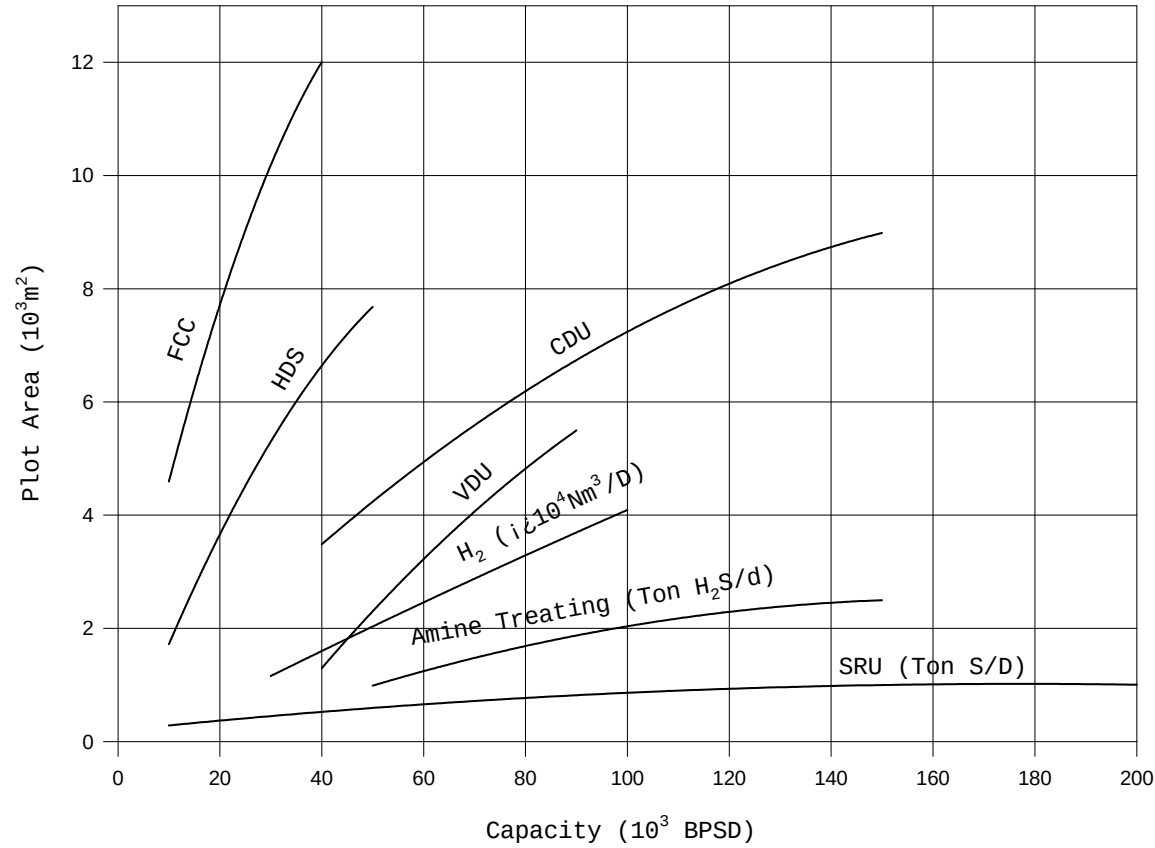
In few cases, winds blow in one fixed direction throughout the year: almost in all cases, winds blow in various directions. The percentage of wind in each direction in the year shall be shown in the form of table on the proposed plot plan. The wind direction to be used in the preparation of plot plans shall be those of prevailing winds.

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5. REFERENCES

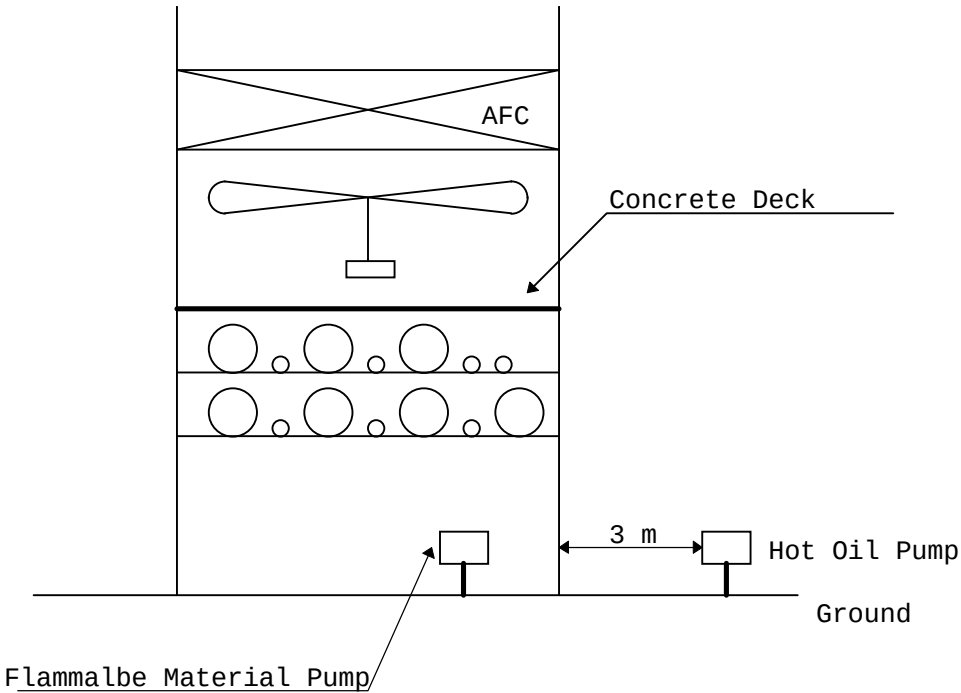
- 1) API-RP 500A: The Classification of hazardous areas
- 2) NFPA

Fig. 2-1 Typical Process Area



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Fig. 3-1. Layout of Flammable Material Pumps



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1. SCOPE

This manual covers the procedures to be taken by process engineers when reviewing engineering models.

2. FORMAT

Model check sheet shall be used.

3. RESPONSIBILITY

The responsibilities of process engineers shall be limited to process performance and safety.

All information included in the latest piping and instrument diagrams shall basically be incorporated into the engineering models under the responsibility of piping engineers. Consequently, the process engineers shall put stress on the review of lines whose piping layout will have adverse effects on process performance and safety.

4. PROCEDURE

The latest P & I diagrams on which points for review have been marked up shall be prepared in advance of the model review and the engineering models shall be checked on the basis of these review points. The points which have been reviewed shall be marked accordingly on the same P & I diagrams. Be sure to take notes of revisions required in the models for attention at the next model review.

After these reviews, summary sheets shall be prepared by the process engineers concerning noteworthy points. Copies of these sheets shall be distributed to the department in charge of piping matters.

5. REVIEW POINTS

Review points for special process will be separately added. The review points shall generally be as follows.

5.1 Safety

- (1) Are remote shutdown and valve closing and/or opening devices installed at safe locations?
- (2) Are emergency and smothering steam headers installed at safe distances from protected equipment?
- (3) Are valves for emergency operations workable from grade level?
- (4) Are hot oil block valves well accessible in view of fire risk?
- (5) Is the emergency shutdown switch at a safe location?
- (6) Check the locations of sampling points at safe areas (not near fired furnaces).
- (7) Check the locations of vents for safe discharge.

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5.2 Flow Stability

- (1) Is the flow in pump suction piping as smooth as possible?
- (2) Have high points in pump suction lines been avoided?
- (3) Are gravity flow lines such as main column draw-off to the stripper as smooth as possible?
High points must be avoided.
- (4) Are the straight lines to/from branch/divided flow points of sufficient length?
- (5) Are the suction lines for centrifugal blowers and fans of adequate length?

5.3 Drains

- (1) Are start-up and circulation lines short with minimum dead end?
- (2) Do vapor and steam lines branch off from the top of main lines?
- (3) Look for pockets in vapor lines where condensation may occur.
- (4) Do compressor suction lines slope toward knockout drum?
- (5) Are stripping steam lines short and horizontal or sloping from the last valve?
- (6) Check absorber gas feed inlets for pockets near the inlet to avoid the backflow of absorbent into the gas line.

5.4 Two-phase Flow

- (1) Look for pockets in the two-phase line.
- (2) Is liquid column formation avoided at the upstream side of two-phase flow distribution?
- (3) Check the height of liquid seal for condensate subcooling system and condensate separator, etc.

5.5 Flare Lines

- (1) Are inlet lines to safety/relief valves self-draining into process equipment?
- (2) Is piping minimized for safety/relief valves discharging into a closed system?
- (3) Are outlet lines from safety/relief valves self-draining into the top of the flare header?
- (4) Flare lines shall have no pockets and must slope to the flare knockout drum.

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6. HISTORY

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