

**PLANT LAYOUT FOR
BASIC DESIGN ENGINEERING****JGS 210-120-1-50E**

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CONTENTSPAGE

1. SCOPE	2
2. WORK PROCEDURE.....	2
2.1 Input to the Design.....	2
2.1.1 Source of the Design Data.....	2
2.1.2 Required Design Data	2
2.2 Output by Basic Design Engineer.....	3
3. DESIGN CONSIDERATION	3
3.1 General Requirements	4
3.1.1 Process Requirements	4
3.1.2 Safety Requirements	4
3.1.3 Operational Requirements	4
3.1.4 Economic Requirements	4
3.2 Equipment Layout	4
3.2.1 General.....	4
3.2.2 Towers	4
3.2.3 Reactors	4
3.2.4 Onsite Pressure Storage Vessels	4
3.2.5 Compressors.....	5
3.2.6 Pumps	5
3.2.7 Drums	5
3.2.8 Fired Equipment (Furnaces)	5
3.2.9 Heat Exchangers	5
3.2.10 Air Cooled Heat Exchanger.....	5
3.2.11 Central Control Houses and Unit Control Houses	5
3.2.12 Electrical Unit sub-station and Critical Electric Switch Racks.....	5
4. RELATED DOCUMENTS	5
5. ATTACHMENT.....	6

1. SCOPE

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). The plant layout mentioned in this document refers to the unit plot plan.

- (1) The design of the plant layout and spacing is mainly executed by piping engineers. However, a basic design engineer is required to co-work with the piping engineer for several parts of the design work.
- (2) This standard practice provides the basic requirements for the basic design engineer to proceed with the design work of the plant layout and spacing of refining, chemical and similar plants.
- (3) ATTACHMENT is explanation on Fundamentals of Plant Layout Design which describes the requirements for plant layout design philosophy and conditions.
ATTACHMENT should be used for confirmation between Client and JGC at the early stage of engineering.

2. WORK PROCEDURE

2.1 Input to the Design

2.1.1 Source of the Design Data

The design data will be obtained from, but not limited to the following documents. The process engineer should refer to the following documents as necessary, in cooperation with the piping engineer.

- (1) ITB/Contract documents (ex. client's standards and the related documents)
- (2) Basic Engineering Design Data (BEDD)
- (3) PFD and/or Piping & Instrument Diagram (P&ID)
- (4) Design Basis for Plant Layout (DBPL)^(*1)
- (5) Detailed Engineering Design Data (DEDD)
- (6) Utility Flow Diagram

(*1) This document is applicable to supplement defective design data on the plant layout in the ITB, BEDD etc.,

However, when inconsistencies are found between the related documents, priority shall be given in the following order.

- (1) Basic Engineering Design Data (BEDD)
- (2) Detailed Engineering Design Data (DEDD)
- (3) Client's standards and the related documents
- (4) PFD and/or Piping and Instrument Diagram (P&ID)
- (5) JGC individual project documents
- (6) This document

2.1.2 Required Design Data

The data to be used for the design of plant layout are listed as follows. These data should be extracted and/or selected from the documents shown in para 2.1.1.

- (1) Information concerned with terrain, climate, related laws and regulations
- (2) Information concerning Client's standards, regulations and requirements
- (3) Safety requirements
- (4) Fire fighting requirements
- (5) General plot plan
- (6) Equipment layout of adjacent processes units
- (7) Process requirements
- (8) Erection and Maintenance requirements
- (9) Operational requirements
- (10) Economic requirements
- (11) Equipment list

2.2 Output by Basic Design Engineer

Plant layout shall be planned in accordance with the following steps. The split of work between basic design engineers and piping engineers is shown below.

The basic design engineer provides comments concerning the basic design engineer's portion in cooperation with the piping engineer from the viewpoint of process design, if necessary.

	Basic design engineer	Piping engineer
(1) Confirmation of design conditions such as ITB, BEDD, and applicable laws and regulations (setting of necessary design conditions, if they are not specified).	☐	☐
(2) Map out the plot plan preparation course	☐	☐
(3) Preparation of plant area drawing	—	☐
(4) Location of pipe racks	—	☐
(5) Marking of equipment blocks on PFD (if necessary)	☐	☐
(6) Determination of whether to install each equipment item on the ground, on a rack, or on a structure	—	☐
(7) Preparation of equipment plan views on the basis of the equipment list, skeleton drawings, and others	—	☐
(8) Rough layout study of equipment blocks on the basis of PFD	—	☐
(9) Layout study of equipment, racks and structure	—	☐
(10) Study of process requirements (including hydraulic studies, if necessary)	☐	☐
(11) Checking of the requirements from ITB and applicable laws and regulations (including maintenance areas and space)	—	☐
(12) Minimization of BQ and study of VE items	—	☐
(13) Checking of equipment space	—	☐
(14) Study of objects to be buried	—	☐
(15) Plant layout study from the standpoint of construction work such as equipment installation	—	☐
(16) Overall review for finalization	☐	☐

3. DESIGN CONSIDERATION

The plant layout shall be checked and reviewed in reference to, but not limited to, the following points.

The plant layout shall include not only the best location for each item for process requirements, but must also satisfy many other requirements: such as related laws and regulations, safety, erection, maintenance, operation and expansion in the future. In addition, economic considerations shall be taken into account, so that the layout is often a major source of cost saving. Process engineer should check and review the following items, referring to the documents cited in Para. 2.1.1, in cooperation with piping engineer, if necessary.

3.1 General Requirements

3.1.1 Process Requirements

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

3.1.2 Safety Requirements

- (1) Location of fired equipment (refer to JGS 210-120-1-44E)
- (2) Control rooms and their roadways
- (3) Locations of high pressure gas compressors
- (4) Location of large-capacity storage tanks containing hazardous and/or flammable or explosive material
- (5) Location of pumps intended to handle flammable materials
- (6) Location of fired heater stacks
- (7) Escape way for emergency
- (8) Where spacing is reduced significantly below the guidelines in the related documents, 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.

3.1.3 Operational Requirements

- (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

3.1.4 Economic Requirements

- (1) Design of piperack structure for cost saving and to minimize piperack lengths
- (2) Minimize common duct lengths
- (3) Minimize piping lengths
- (4) Minimize cable lengths

3.2 Equipment Layout

3.2.1 General

The equipment layout should be designed in consideration of proximity to the adjoining facilities, location of roadways, prevailing wind direction, site topography, etc. A degree of equipment stacking should achieve a reasonable utilization of plot space, but the potential heavy fire risk of equipment stacked in several layers should be avoided.

3.2.2 Towers

- (1) Location of the tower
- (2) Arrangement of the processing equipment such as overhead condensers, overhead receivers, or reboilers, etc. for towers
- (3) Space for assembling and disassembling tower internals such as trays demistor, etc.

3.2.3 Reactors

- (1) Adequate space shall be provided for handling and storing catalysts (both fresh and spent), chemicals, hydrogen, nitrogen, etc., including truck access where appropriate.
- (2) Maximum use of mobile equipment shall be made for transporting and handling these commodities.

3.2.4 Onsite Pressure Storage Vessels

The inventory of onsite pressure storage should be held to minimum and location should be at the unit boundary, as far as possible from furnace and other sources of ignition.

3.2.5 Compressors

- (1) Location of the compressors to minimize the pressure drop at the suction side.
- (2) Relation between the compressors and the control room or sub-station, since a large amount of electrical and instrument cabling is required for the compressors.
- (3) Maintenance space

3.2.6 Pumps

- (1) Consideration of their operation, maintenance and emergency shut down
- (2) Location of pumps carrying light end and hot fluids with a temperature above their auto-ignition points

3.2.7 Drums

Distance between the drums and the related equipment

3.2.8 Fired Equipment (Furnaces)

- (1) Relation between the furnace and boilers location and the wind direction
- (2) Space for maintaining furnace tubes
- (3) Fired equipment shall not be located in a Class I Division 2 area of "Hazardous Area Classification". Where practical and economical, isolated fired equipment shall preferably be grouped together. Where a common stack shall be employed, isolating dampers or suitable barriers may be provided in individual ducting to the stack.

3.2.9 Heat Exchangers

- (1) Space among the shell and tube heat exchangers
- (2) Alignment to the centerline of their channel nozzles for a plural number of heat exchangers
- (3) Consideration of the thermal stress for piping around heat exchangers and related equipment in high pressure / temperature service
- (4) Space for removing tube bundle.
- (5) Clearances around heat exchangers to permit safe installation and removal of bolting, and also for pulling out bundles.

3.2.10 Air Cooled Heat Exchanger

- (1) Space for maintenance work to the air cooled heat exchangers installed on piperacks or structures.
- (2) Location between the air cooled heat exchangers and other adjacent high temperature equipment.

3.2.11 Central Control Houses and Unit Control Houses

- (1) Central control houses should be located to face a roadway.
- (2) Unit control houses should be located at battery limits, next to a roadway.

3.2.12 Electrical Unit sub-station and Critical Electric Switch Racks

The electrical transformers, circuit breakers, switches, etc for a process unit are normally grouped together in a load center or unit substation. Location should be at edge of unit.

4. RELATED DOCUMENTS

- (1) JGS 210-120-1-44E : Hazardous Area Classification
- (2) JGS 214-132-1-01 : Drafting Practice of Plot Plan Drawing
- (3) JGS 220-322-1-01 : Design Practice for Piping Arrangement (Pipe Rack)

5. ATTACHMENT

Explanations on Fundamentals of Plant Layout Design

Introduction:

This specification concerns plant layout. 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. Applicable criteria for plant layout substantially vary with the client. On the whole, the major oil companies have their respective established specifications of this sort, while some of Japanese chemical companies do not have established specifications at all. Most of such specifications of the major oil companies are written from the viewpoint of plant owners, and therefore are not readily usable as they are.

On the other hand, should JGC offer the whole of this specification to those clients who do not have their own, it would only help them increase plant costs.

Such being the case, it is essential for JGC to change to contents of this specification according to different clients.

Furthermore, it is necessary to change the content of this specification according to its intended use or timing - whether to be used as an attachment to JGC's proposal before contract award, or to be used as an integral part of the contract after the contract award. Furthermore, this specification can be used to help ensure consistency of design philosophy within JGC, without being submitted to the client.

This specification, thus prepared against a specific background, should be used by each engineer in strict accordance with its intended use.

1. General

This specification applies to the general requirement of plant layout design philosophy and conditions for petroleum refineries; chemical plants, offsite facilities, etc.

It describes the general design basis and requirements for plant layout. It shall be used together with BEDD (Basic Engineering Design Data), Process Design Practice and Instruction (PDPI), Criteria for P & ID and other DEDDs (Detailed Engineering Design Data). This specification prevails over DEDD, while BEDD and Process Design Practice and Information (PDPI) overrides this specification. It shall also be used together with Client Design Standards noting that priority of documents is specified in Para. 1.2.

More detailed layout and spacing requirement shall conform to each DEDD for Piping/Instrument/Civil Electrical respectively.

Statements in this specification shall be as follows unless otherwise described in each paragraph separately.

- Square blocks hereinafter to be marked as follows.

☒ : Yes, to be applied

☐ : Not to be applied

- Additional remarks may be applied to the block above if the set words are not applicable.

1.1 Glossary and Definition of the Abbreviations and Term

Abbreviated words and/or terms in this document shall be as follows:

BEDD	: Basic Engineering Design Data
DEDD	: Detailed Engineering Design Data
CCR	: Central Control Room
B/L	: Battery Limit
U/G	: Underground Facilities
PDPI	: Process Design Philosophy and Information
NEPA	: National Fire Protection Association
IP	: Institute of Petroleum (Britain)
API	: American Petroleum Institute
RP	: Recommended Practice
NEC	: National Electrical Code (U.S.A)
HPGCL	: High Pressure Gas Control Law (Japan)