ENGINEERING STANDARD

FOR

LAYOUT AND SPACING

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0. INTRODUCTION

The Standard practice Manuals titled as "Fundamental Requirements for the Project Design and Engineering" is intended for convenience of use and a pattern of follow-up and also a guidance.

These Standard Engineering Practice Manuals, also indicate the check points to be considered by the process engineers for assurance of fulfillment of prerequisitions at any stage in the implementation of process projects.

It should be noted that these Iranian Petroleum Standards (IPS), as Practice Manuals do not profess to cover all stages involved in every process project, but they effect the stages that exist in general in process projects of oil, gas and Petrochemical Industries of Iran.

These preparation stages describe the following three main phases which can be distinguished in every project & include, but not be limited to :

Phase I) "Feasibility Studies, Process Evaluation and the Basic Design Stages (Containing Nine Standards)"
Phase II) "Detailed Design, Engineering and Procurement Stages (Containing Six Standards)"
Phase III) "Start-Up Sequence and General Commissioning Procedures (Containing two Standards)"

The process engineering standards of this group include the following 13 Standards:

STANDARD CODE	STANDARD TITLE
I) Manuals of Phase I (Numbers 1-8)	
IPS-E-PR-110	"Introduction to IPS Codes and Standards"
IPS-E-PR-120	"Feasibility Studies and Basic Design Philosophies"
IPS-E-PR-150	"Basic Design Package"
IPS-E-PR-170	"Process Flow Diagram"
IPS-E-PR-190	"Layout and Spacing"
IPS-E-PR-200	"Basic Engineering Design Data"
IPS-E-PR-230	"Piping & Instrumentation Diagrams (P & IDs)"
IPS-E-PR-250	"Performance Guarantee"
II) Manuals of Phase II (Numbers 9-11)	
IPS-E-PR-260	"Detailed Design, Engineering and Procurement"
IPS-E-PR-300	"Plant Technical and Equipment Manuals (Engineering Dossiers)"
IPS-E-PR-308	"Numbering System"
III) Manuals of Phase III (Numbers 12-13)	
IPS-E-PR-280	" Start-Up Sequence and General Commissioning Procedures"
IPS-E-PR-290	"Plant Operating Manuals"

This Engineering Standard Specification covers:

" LAYOUT AND SPACING "

1. SCOPE

1.1 This Standard Specification covers the basic requirements of the plant layout and spacing of oil & gas refineries, petrochemical and similar chemical plants to ensure safety and fire prevention together with ease of operation and maintenance.

2. REFERENCES

Throughout this Standard the following Standards and Codes are referred to. The editions of these standards and codes that are in effect at the time of publication of this Standard shall, to the extent specified herein, form a part of this Standard. The applicability of changes in standards and codes that occur after the date of this Standard shall be mutually agreed upon by the Company and the Vendor/Consultant:

API (AMERICAN PETROLEUM INSTITUTE)

RP-500 A	"Recommended Practice for Classification of Location for Electrical Installation in Petroleum Refineries", Edition Fourth, Jan. 1982
API Std. 620	"On Large, Welded, Low Pressure Storage Tanks"
API Std. 650	"On Welded Steel Tanks for Oil Storage"

ASME (AMERICAN SOCIETY OF MECHANICAL ENGINEERS)

"Boilers and Pressure Vessel Codes":
- Section I, Power Boilers
- Section VIII, Pressure Vessels

ASCE (AMERICAN SOCIETY OF CIVIL ENGINEERS)

"Minimum Design Loads for Structures"

IPS (IRANIAN PETROLEUM STANDARDS)

IPS-C-ME-100	"Atmospheric Above Ground Welded Steel Storage Tanks"
IPS-E-EL-110	"Electrical Area Classification & Extent"
IPS-C-ME-110	"Large Welded Low Pressure Storage Tanks"
IPS-C-ME-120	"Aviation Turbine Fuel Storage Tanks"
IPS-C-ME-130	"Pressure Storage & Spheres (for LPG)"
IPS-E-CE-160	"Geometric Design of Roads"
IPS-E-PI-280	"Pipe Supports"
IPS-E-SF-200	"Fire Fighting Sprinkler Systems"
IPS-C-SF-550	"Safety Boundary Limits"
IPS-D-PI-102	"Typical Unit Plot Arrangement & Pipeway Layout"
IPS-D-PI-103	"Pipeline Spacing"

ANSI (AMERICAN NATIONAL STANDARD INSTITUTE)

ANSI-MSS Standards,	"Piping Hanger and Supports", 1969 Edition

NFPE (NATIONAL FIRE PROTECTION ASSOCIATION)

NFPA	"Recommendation Codes and Standards" (See Table A-1 in Appendix A)
NFPA, 59	"Standard for the Storage and Handling of Liquefied Petroleum Gases", Ed. 1989
NFPA, 251	"Standard Methods of Fire Tests of Building, Construction and Materials", Ed. 1985

IRI (INDUSTRIAL RISK INSURANCE)

"Requirement on Spacing of Flare"

TEMA (TUBULAR EXCHANGER MFRS. ASSN. STANDARD)

Uniform Building Code, (UBC)	"From International Conference of Building Office", 1991 Ed.

- Other referenced standards and code (See Tables A-1 and A-2 in Appendix A)

3. DEFINITIONS AND TERMINOLOGY

3.1 Boundary

Boundary of the equipment is the term used in a processing facility, by an imaginary line that completely encompassed the defined site. The term distinguishes areas of responsibility and defines the processing facility for the required scope of work.

3.2 Dike

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

3.3 Diversion Wall

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

3.4 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.

3.5 High Flash Stock

Are those having a closed up 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.

3.6 Low-Flash Stocks

Are those having a closed up 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.

3.7 Non-Combustible

Material incapable of igniting or supporting combustion.

3.8 Ordinary (See Table A.3 in Appendix A)

General masonry walls with wood roof and/or wood floors; also all frame construction.

3.9 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.

3.10 Plot Plan

The plot plan is the scaled plan drawing of the processing facility.

3.11 Sheathed Incombustible or Incombustible (See Table A.3)

Wood frame, incombustible sheathing.

3.12 Sleepers

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

3.13 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.

3.14 Tank Spacing

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

3.15 Toe Wall

Is a low earth, concrete, or masonery unit curb without capacity requirements for the retention of small leaks or spills.

3.16 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.

3.17 Vessel Spacing

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

4. SYMBOLS AND ABBREVIATIONS

ANSI	=	American National Standard Institute
API	=	American Petroleum Institute
ASME	=	American Society of Mechanical Engineers
BP	=	Boiling Point
HVAC	=	Heating, Ventilation and Air Conditioning
IC	=	Incombustibles
IRI	=	Industrial Risk Insurance
LPG	=	Liquefied Petroleum Gas
NFPA	=	National Fire Protection Association
OD	=	Outside Diameter
OGP	=	Oil, Gas and Petrochemical
OIA	=	Oil Insurance Association
SIC	=	Sheathed Incombustible
TEMA	=	Thermal Exchargers Manufacturers Association
UOP	=	Universal Oil Products.

5. UNITS

This Standard is based on International System of Units (SI), except where otherwise specified.

6. SOME KEY ISSUES RELATED TO LAYOUT

6.1 Terrain

6.1.1 In the first place, considerations should be given to the physical setting. It should not automatically be assumed that it is necessary to level the site. There may instead be ways that the process can take the advantage of whatever slopes are present.

6.1.2 With respect to terrain, assess should be made, whether, there is adequate space in general. If not, ingenuity will be required to meet such requirements as those for flares. Available space can help to govern whether the plant can be located on one floor or instead occupy several stories. The physical setting shall also be considered in light of the Transportation requirements for raw materials, products, wastes and supplies.

6.2 Safety and Environment

6.2.1 Familiarization with pertinent Environmental Regulations, (Local, National and International), and how they might change is essential perior to conclusion of pre-project studies.

6.2.2 Attention shall be given to the pertinent safety regulations, including health and welfare needs. Hazardous and flammable materials require special handling, which can take up layout space.

6.2.3 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.

6.2.4 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.

6.3 Throughput

6.3.1 It is important not only to know the initial capacity but also to have a good feel for how much the plant might be expanded in the future, as well as how likely the process technology is to be modernized. These factors indicate how much space should be left for additional equipment.

6.3.2 Multiple processing lines (trains), are often required for the plant. Pairs of trains can either be identical or be mirror images. The former option is less expensive. But the mirror image approach is sometimes preferable for layout reasons. Two such reasons are:

a) For operator access via a central aisle.

b) The need that the outlet sides of two lines of equipment (pumps, for instance) point toward each other so that they can be readily hooked to one common line.

7. BASIC CONSIDERATIONS

7.1 General

The plant layout shall be arranged for:

a) maximization of safety;
b) prevention of the spread of fire and also ease of operation;
c) maintenance consistent with economical design and future expansion.

7.2 Blocking

The plant site shall be blocked in consideration of hazards attendant to plant operation in the area. All blocked areas shall be formed as square as possible by divided access roads and/or boundary lines.

7.3 Location and Weather

The plant layout shall be arranged in consideration of geographic location and weather in the region of the site.

7.4 Prevailing Wind

Where the prevailing wind is defined, the administration and service facilities and directly fired equipment, etc., shall be located windward of process Units and storage tanks, etc.

7.5 Layout Indication

The basic requirements to be met in the appropriate diagram when making a piping and equipment layout are:

7.5.1 All equipment, ladders, structures, davits, trolley beams, shall be indicated.

7.5.2 All instrument shall be located and indicated.

7.5.3 All valving and handwheel orientations shall be indicated.

7.5.4 Drip funnel locations for underground drains shall be indicated.

7.5.5 All electrical switch grears, lighting pannels shall be indicated.

7.5.6 All sample systems shall be indicated

7.6 Classification of Hazards

The plant layout shall be determined in consideration of classified hazardous areas, specified in following Standard Specifications:

- IPS-E-EL-110 "Electrical Area Classification and Extent";
- API RP-500A "Recommended Practice for Classification of Locations for Electrical Installations in Petroleum Refineries"

8. PLANT LAYOUT

8.1 Area Arrangement

Classified blocked areas, such as process areas, storage areas, utilities areas, administration and service areas, and other areas shall be arranged as follows:

1) The process area shall be located in the most convenient place for operating the process Unit.

2) The storage area shall be located as far as possible from buildings occupied by personnel at the site, but should be located near the process area for ready operation of the feed stocks and product run-downs.

3) The utilities area shall be located beside the process area for ready supply of utilities.

4) Loading and unloading area shall be located on a corner of the site with capable connection to public road directly, for inland traffics. For marine transportation, the area shall be located on the seaside or riverside in the plant site.

5) The administration and service area shall be located at a safe place on the site in order to protect personnel from hazards. It shall preferably be located near the main gate alongside the main road of the plant.

6) Flare and burn pit shall be located at the end of the site with sufficient distance to prevent personnel hazard.

7) Waste water treating Unit shall be located near at the lowest point of the site so as to collect all of effluent streams from the processing Unit.

8) 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.

9) The process Unit from which the final product(s) is (are) withdrawn, shall be located on the side near the products tanks to minimize the length of the product run-down line.

10) Process Units in which large quantities of utilities are consumed, should be preferably located on the side near the utility center.

8.2 Roadways

1) Road and access ways shall offer easy access for mobile equipment during construction and maintenance, fire fighting and emergency escape in a fire situation.

2) Unless otherwise specified by the Company, the defined roads shall be made as stated in IPS-E-CE-160, "Geometric Design of Roads".

3) Access roads shall be at least 3 m from processing equipment between road edges to prevent vehicle collisions.

8.3 Piperacks and Sleepers

8.3.1 In general, piperack for process Units and pipe sleeps for the off-site facilities shall be considered as the principals support of the pipe way. Run pipe lines overhead should be grouped in piperacks in a systematic manner.

8.3.2 Pipe rack runs oriented in the same direction shall be at consistent elevations. Pipe rack runs oriented opposite to these runs shall be at other elevations to accommodate crossing of lines at pipe racks junctions and to accommodate branch line intersections.

8.3.3 Single level pipe racks are preferred, if more than one level is required, the distance between levels oriented in the same direction shall be adequate for maintenance but not less than 1.25 meters.

8.3.4 Minimum spacing between pipe centerlines shall be in accordance with drawings number IPS-D-PI-102, "Typical Unit Arrangement and Pipeway Layout", and IPS-D-PI-103, "Pipeline Spacing".

8.3.5 Maximum piperack widths shall be 10 m. If widths larger than 10 m are required, the piperack shall be designed to be of two stage. Actual widths shall be 110% of the required widths or the required widths plus 1m. 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.

8.3.6 Avoid flat turns. When changing directions, change elevation.

8.3.7 Allow ample space for routing instrument lines and electrical conduit. Provide 25% additional space for future instrument lines and electrical conduit adjacent to that required.

8.3.8 Provide 20% additional space on the pipe rack for future piping. This space shall be continuod and clear on each level for the full length of the rack. The width allocation may be split in two sections but not more than two.

8.3.9 Allow a continuous clear area of 4 meters high by 4 meters wide below main racks in process Units for maintenance access ways.

8.3.10 Pipe racks outside process areas shall have the following minimum overhead refinery/plant clearances: main roadway -5 meters , access roads -4.5 meters, railroads -6.7 meters above top of rail.

8.3.11 Typical layout of piperack, for process plants depending on the number of process Units incorporated and the process complexities are given in Figs. 1 through 4 with reference descriptions as follow:

a) "Single Rack Type" layout, is suitable for small scale process complex consisting of two-three process Units. It is economical without requiring any large area.

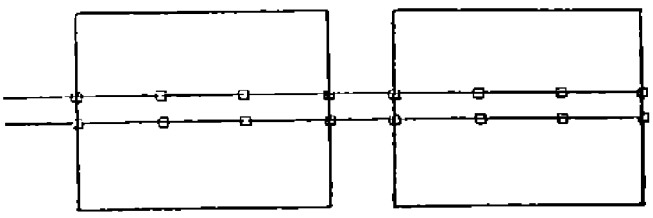


Fig. 1

b) "Comb Type" layout shown in Fig. 2, is recommended for use in process, complex consisting of three or more process Units. "Single Rack Type" in this case will not be suitable since separate maintenance and utility administration in normal operation will be difficult because of the utility and flare line which are placed on the common rack.

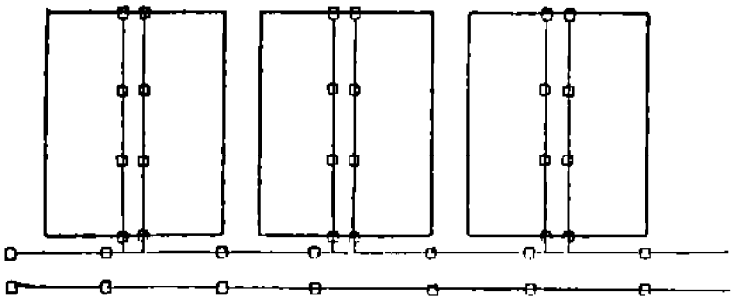


Fig. 2

c) "Double Comb Type" layout is an expansion of the "Comb Type" which is recommended for the use in large-scale process complexes where five to ten process Units are to be arranged. This layout as shown below in Fig. 3, can be conveniently utilized.

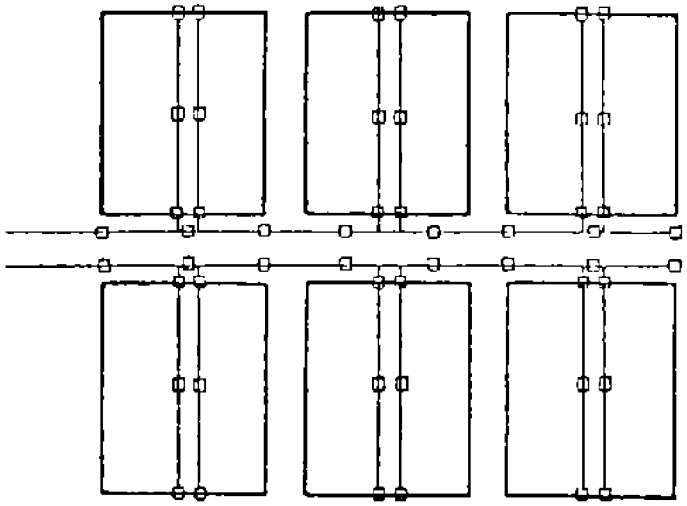


Fig. 3

d) "U Type" layout shown in Fig. 4, is recommended to be used in case of process Units whose maintenance cannot be conducted separately, within the complex. This type can be regarded as an expansion of the "Single Rack Type". Even process complexes of this nature, can be regarded as one process Unit in the planning of their layout.

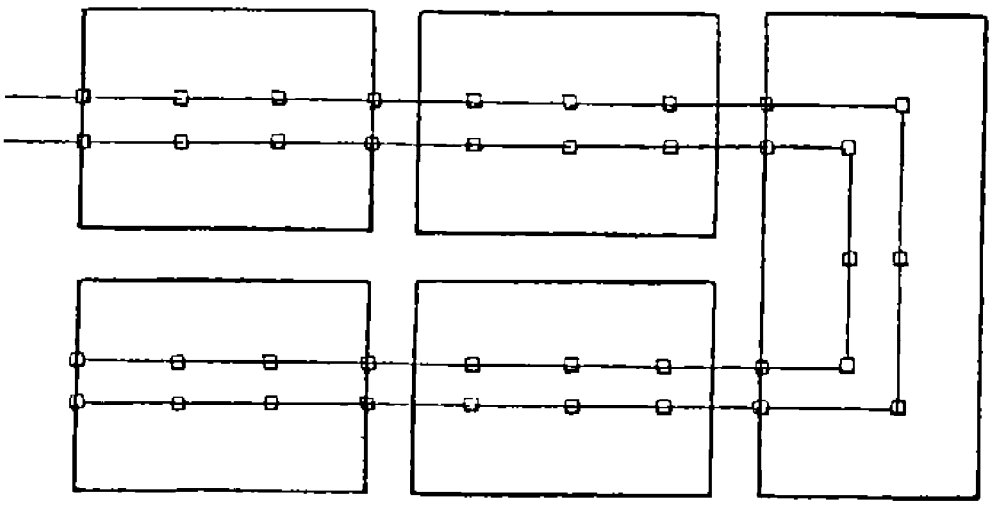


Fig. 4

8.3.12 Location of piperacks shall be in general agreement with the plot plan.

8.4 Layout of Control Room and Electrical Sub-Station

8.4.1 General recommendations for spacing of control room and substations in refinerys, petrochemical, utilities and pumps stations, etc. shall be in accordance with the "Oil Insurance Association" recommendation as given in Appendix A.

8.4.2 In addition the following basic requirements shall also be met when making control room and electrical substation.

1) The control room and substation shall be located as close as possible to the plant equipment, maintaining a minimum distance from viewpoint of noise and safety requirements.

2) The control rooms, and substation shall be spaced at least 15 m, if not in contrary with 8.4.1 above, from the nearest process equipment surface.

3) The control room and substation shall be located with consideration to convenience in daily operation.

4) The control room and substation shall be located from an economical standpoint so as to minimize the length of electrical and instrument cables entering and leaving therefrom.

5) The control room shall be positioned so that the operator can command a view of the whole system which is under control. Large buildings, or equipment shall not be placed in front of the control room.

8.5 Fire Fighting Requirements

8.5.1 Each individual process Unit shall be provided with sufficient open spaces therearound that, fire trucks can be run and operated thereat. The width of access way thereto, shall be 6 meters minimum.

8.5.2 Process Units consisting of large hazardous material storage tanks should be located desirably in outer area in the complex site,

8.6 Building Requirements

8.6.1 Service buildings include offices, control rooms, laboratories, houses, shops, warehouses, garages, cafeterias and hospitals. These structures and areas require protection of personnel from possible fires and explosions of major plant equipment and may require additional spacing from high risk facilities.

8.6.2 The service buildings shall be located near the entrance of the plant and be readily accessible to a public road or highway.

8.6.3 Spacing at refineries, petrochemicals, chemicals, and gasoline plants for buildings shall be in accordance with Oil Insurance Association (OIA) recommendation given in Appendix A, Tables A-3, A-4, A-5 and A-6.

9. LAYOUT IN PROCESS UNITS

9.1 General

9.1.1 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.

9.1.2 Since the directions of the incoming feed stocks, outgoing products and utility supply are determined on the over-all plot plan, first the direction of the piperack in the Unit shall be decided.

9.1.3 Equipment shall be arranged to minimize piping runs (particularly, for large-sized piping and alloy piping) as far as possible. Clear access ways having minimum width of 600 mm shall be provided for the operators access around equipment.

9.1.4 Large capacity storage tanks containing flammable and explosive fluids shall be located in outer areas as far as possible.

9.1.5 Space shall be allowed for the provision of future spare equipment. Consideration shall also be given to future plant expansion.

9.2 Process Requirements

9.2.1 Equipment shall be laid out along the flows on the process flow diagram.

9.2.2 Especially, the fractionator and its reboilers, condensers and overhead receivers shall be collectively located.

9.2.3 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 near at their boiling points, related equipment shall be located close to each other so that the lies need not be elevated.

9.2.4 Pieces of equipment which are to be connected by large-size piping or alloy piping, shall be located close to each other.

9.2.5 Air coolers shall be laid out so that no heated air may be recirculated.

9.3 Safety Requirements

9.3.1 All process equipment should be kept at least 15 meters from fired heaters. Exception are permitted for certain pieces of equipment where the heater in question is being used to heat the process flow of the equipment and where any leakage from the equipment would probably ignite instantly, thus no additional fire hazard. Such an exception is permit-

ted when locating reactors on a platforming Unit (an example). Each exception must be individually investigated as to its potential hazards and must not violate any process practices in OGP plants and governing codes.

9.3.2 Locate fire heaters on the side of the process Unit from which the prevailing wind blows. This is done to blow gas away from the heaters instead of towards them. Fired equipment shall not be located in "Hazardous Area Classification". Generally, fired equipment shall be located at a distance of more than 15 meters from any sources of hazards (hot oil pumps, light end pumps, compressors etc.).

9.3.3 Emergency showers, if required in a certain process, should be located as near the hazard as possible and indicated in the Plot Plan.

9.3.4 Adequate and easy access and egress must be considered for not only safety, but operation and maintenance requirements.

9.3.5 Control rooms and their roadways shall not be located in hazardous area, classified in project specification; generally, they shall be located at a distance of more than 15 meters from the nearest equipment.

9.3.6 High pressure gas compressors shall be located at leeward locations.

9.3.7 Large-Capacity hazardous material storage tanks shall be located in outer areas as far as possible.

9.3.8 Pumps intended to handle flammable materials (which fall under the control of the Hazardous Area Classification), shall be located on the following basis:

USE OF PUMP	UNDER PIPERACK	UNDER AIR COOLED EXCHANGERS
Cold oil pumps	Acceptable	Acceptable
Hot oil pumps*	Unacceptable**	Unacceptable
Light end pumps****	Acceptable	Unacceptable ***

Notes:

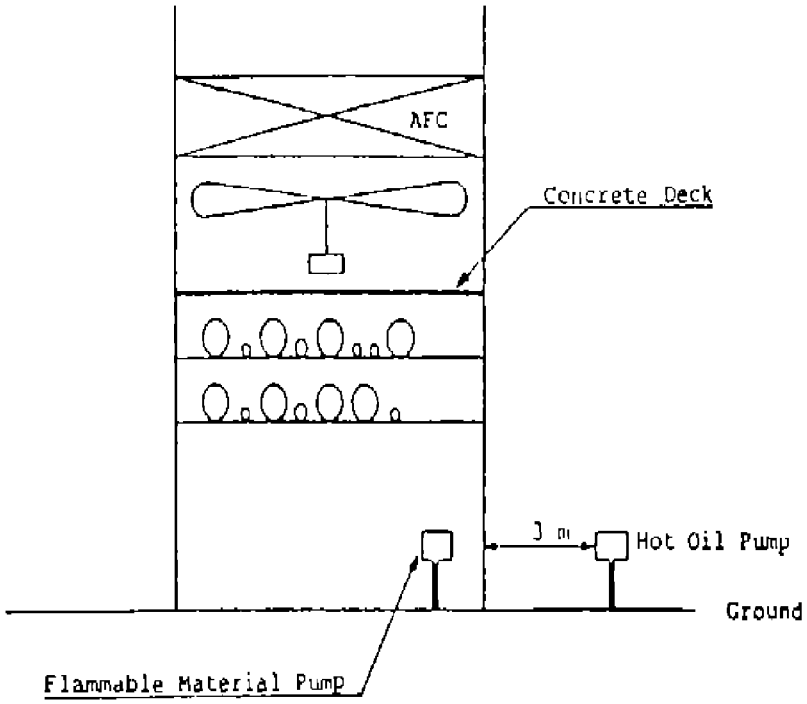
*** Hot oil means the oil whose operating temperature is higher than auto-ignition point.**

**** A space of minimum 3 m shall be provided from piperack, hot oil pumps can be located under piperack, when the proper devices for fire protection such as fire detector, water spray etc., are provided.**

***** 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. 5. Light ends pumps can be located under air coolers without concrete decks, when the proper devices for fire protection are provided**

****** Light ends means the fractional distillates with BP range 110-120°C, consisting mixtures of benzenes, toluenes, xylenes, pyridine, phenole, cresol, etc.**

9.3.9 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 wind 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.



LAYOUT OF FLAMMABLE MATERIAL PUMPS

Fig. 5

9.3.10 In layout design for safety and fire protection requirements consideration of NFPA Codes, Standards and recommendations as specified in Appendix A, Table A-1 is strongly recommended along with requirements specified under Clause 9 hereto:

9.3.11 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.

9.3.12 Process Units in which poisonous gas is to be handled, shall be located leewards.

9.3.13 Desirably, process Units in which high pressure gas is to be handled, should be located leewards.

9.4 Basic Design Considerations

9.4.1 The equipment spacing distances tabulated in Tables A-4, A-5 of Appendix A of this Standard Specification are general recommendation for minimum requirements and are based on the following:

a) To permit access for fire fighting.
b) To permit access for normal operation and maintenance.
c) To permit access for operation to perform emergency shutdown action in fire situation.
d) To ensure that critical emergency facilities are not subject to fire damage.
e) To separate continuous ignition sources from possible sources of release of flammable materials.
f) To allow for likely additional equipment that may be added at some time during the life of the plant.
g) To consider recommendations of NFPA Codes, Standards and Regulations for safety and fire protection.
h) To consider recommendation of NFPA Codes, Standards and Regulations for safety and fire protection.

9.4.2 Where spacing is reduced significantly below the recommended distances, it is usually necessary to compensate for the increased degree of risk by providing additional safety features such as emergency shutdown facilities, fireproofing, water sprays, etc. Reduction below the recommended spacing shall require the Company's approval.

9.4.3 Location of such equipment as, fired heaters, heat exchangers, towers, vessels, drums, pumps and compressors shall be in general agreement with the plot plan.

9.4.4 Space around equipment must be left for items like pipe supports, control valve manifolds, hose station etc. where required.

9.4.5 Consideration of following factors which affect spacing and layout may justify deviations from the basic requirement:

a) Physical limitations of site available.
b) Special hazards.
c) Flexibility-Space requirements for future expansion.
d) Topography and prevailing winds.
e) Environmental considerations.
f) Location conditions.
g) Association with the type of adjacent property.

9.4.6 Erection and maintenance requirements

9.4.6.1 Special maintenance requirements for each item of equipment in a given process shall be considered. For example, most machines that consist principally of a stirring mechanism require space for removal of the impeller shaft, large compressors and crashers need floor or ground area for laying down components during maintenance.

9.4.6.2 Process Units 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.

9.4.6.3 Sufficient access areas shall be provided around each individual Unit for use in the operation of mobile cranes.

9.4.6.4 Process Units which will require maintenance specially separately from other Units shall be provided with a minimum spacing of 6 meters between them and the nearest Unit

9.4.6.5 Space requirements for maintenance access shall be in conformity with Codes, Standards and Regulation set forth in Appendix A, Table A.2 .

9.4.6.6 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.

9.4.6.7 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.

9.4.6.8 An open space shall be provided under the tower top davit as a tower internal maintenance area.

9.4.6.9 A working area required for catalyst loading and unloading shall be provided.

9.4 6.10 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.

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

9.4.6.12 Generally, pumps shall be located collectively under piperacks. However, this requirement need not be applied to pumps whose suction line lengths must be minimized in connection with the process performance.

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

9.4 7 Operational requirements

9.4.7.1 Clear access ways (whose minimum widths shall be 600 mm) 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.

9.4.7.2 Entrances of structure ladders shall be located on the side near the control room.

9.4.7.3 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.

9.4.8 Economic requirements

9.4.8.1 The following shall be considered for cost reduction purposes:

a) minimize piping lengths;
b) minimize piperack lengths;
c) minimize common duct lengths;
d) minimize cable lengths.

9.4.9 Distances/Clearances requirements

9.4.9.1 Not in contrary with spacing requirements indicated in Appendix A, Tables A-4, A-5, A-6 and in Tables A-7, A-8, A-9 and A-10 of Appendix A, the data given below are typical distances between equipment surface to equipment surface, and clearances which must be adjusted based on the result of piping layout at detail planning stage:

a) Distances between individual equipment:

a-1 Column to column	3 meters
a-2 Drum to drum	2 meters
a-3 Exchanger shell to exchanger shell	1 meters
a-4 Pump to pump (foundation) for;	
- Small pumps, 3.7 kW & less mount on common foundations with suitable center to center distances.	
- Medium pumps, 22.5 kW & less	1 meters
- Large pumps, above 22.5 kW	1.5 meters

b) Distance of equipment to other boundaries and facilities:

b-1 Exchangers to other equipment	1 meter minimum clear aisle
b-2 Piperack to equipment	6 meters
b-3 Piperack to structure	5 meters
b-4 Driver end of pumps to truck access, (if required)	3 meters.

9.5 Equipment Layout and Spacing

9.5.1 Reactors

9.5.1.1 Adequate space shall be provided for handling and storing catalysts (both fresh and spent), chemicals, hydrogen, nitrogen, etc., including truck access where appropriate.

9.5.1.2 In general , maximum use of mobile equipment shall be made for transporting and handling these commodities.

9.5.2 Towers

9.5.2.1 Towers closely related with processing equipment such as overhead condensers, overhead receivers, or reboilers, etc., shall be arranged adjacent to each other.

9.5.2.2 The location of the tower shall be studied with consideration to the transportation route and erection procedure.

9.5.2.3 Space shall be provided for assembling and disassembling tower internals such as trays demistor, etc.

9.5.2.4 Where two (2) or more towers are installed, their center-lines shall be aligned parallel with the piperack, except those small in diameter which may be grouped and aligned perpendicularly to the piperack.

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

9.5.2.6 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 with the Company for confirmation.

9.5.3 Fired equipment

9.5.3.1 Furnance and boilers shall be located on the windward side of the plant to avoid contact with inflammable gases (light hydrocarbon) which may leak out.

9.5.3.2 Space for maintaining furnace tubes shall be provided. Fired equipment shall not be located in a Class-I-Division 2 area of "Hazardous Area Classification"(See IPS-E-EL-110, Electrical Area Classification and Extent").

9.5.3.3 Where practical and economical, isolating 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.

9.5.3.4 Heaters should be located near the edge of a process area rather than in the center of the area. This provides more area for maintenance and helps isolate them from other equipment. In many places it is now necessary to have tall stacks. Because of the high cost and the minimum size a tall stack can be for all heaters and must be located in one area or at least in clusters. This can be a major factor in layout and must be resolved early.

9.5.3.5 Tube pulling areas shall not encroach on any main roadways or other process areas.

9.5.3.6 Good drainage shall be provided around and under fired heaters to direct any liquid spills to a safe location.

9.5.3.7 Generally, fired equipment shall be placed at a minimum distance specified in Appendix A Tables A-4, A-5 , A-6 of this Specification as the case m+ay employs. However fired equipment may be placed within 15 meters from a source of hazard depending upon the requirement of process design.

9.5.4 Heat exchangers

9.5.4.1 Heat exchangers should be located close to related the vessels or equipment. Some items such as bottoms coolers may be placed away from the vessels.

9.5.4.3 Horizontal clearance between heat exchanger shells and between heat exchangers and major equipment, for access purposes, shall be a minimum of 1.0 meter in any direction.

9.5.4.4 Where there is a plural number of heat exchangers, the centerlines of their channel nozzles shall be aligned as a rule.

9.5.4.5 Piping around heat exchangers and its relevant equipment in high pressure/temperature service, shall be provided with sufficient flexibility against thermal stress.

9.5.4.6 Clearance around heat exchangers shall be adequate to permit safe installation and removal of bolting, and also pulling out bundles.

9.5.4.7 Where air fins are used extensively they may actually determine the unit length. Air fins should not be located close to heater.

9.5.4.8 Where air cooled heat exchangers are installed on piperacks or structures, adequate space shall be provided around them to perform maintenance work.

9.5.4.9 Attention shall be paid to prevent hot air being taken into air cooled heat exchangers from other adjacent high temperature equipment since the atmospheric temperature at the suction side is the design base for the air cooled heat exchangers.

9.5.4.10 Air cooled exchangers should all be located at the same level within a unit unless they are so widely separated that one will not be able to suck up the discharged air from another one.

9.5.4.11 Thermosyphon reboilers shall be located next to the related vessels.

9.5.5 Vessels and drums

9.5.5.1 Vessels and drums shall principally be laid out as close as possible to the related equipment.

9.5.5.2 Where horizontal drums are arranged near a pipeway, the horizontal centerline of the drums shall be located at right angles to the pipeway.

9.5.5.3 The centerlines of vertical drums which are located adjacent to vertical type equipment shall be aligned with the centerline of the said vertical equipment.

9.5.5.4 For spacing of drums see Fig. 6 and Table A-8.

9.5.6 Pumps

9.5.6.1 Pumps shall be located as a group where feasible to facilitate their operation and maintenance.

9.5.6.2 Pumps shall be located so that the suction lines are short.

9.5.6.3 Pumps shall generally be located in a row or rows under or adjacent to the piperacks. The drivers shall be located toward the center of the piperack.

9.5.6.4 Some pumps, such as vacuum column bottoms pumps may be located closer to the equipment they take suction from and don't conform to 9.5.6.3 above.

9.5.6.5 Aisles between rows of pumps shall be 3 meters minimum (clear).

9.5.6.6 The suggested spacing for pumps requiring a 0.5 meters to 1.0 meter wide foundation is 2 meters center to center. (A range of 1.5 to 3.0 meters is acceptable).

9.5.6.7 The location of small chemical pump, in line and injection pumps is governed by the above minimums.

9.5.6.8 Pump house spacing where feasible shall be conform to distances given in Tables A-3, A-4, A-5 of Appendix A in respective with OGP plants.

9.5.7 Compressors

9.5.7.1 Where there are several large compressors in a Unit, it is economical for operation and maintenance to locate them in one area.

9.5.7.2 Compressor orientation should consider the possibility of major mechanical failure in relation to surrounding equipment.

9.5.7.3 Access for firefighting must be available from at least two sides of the building.

9.5.7.4 Associated inter-coolers, knockout drums, etc. may be located in the compressor area provided that they do not restrict access for fire fighting and maintenance.

9.5.7.5 Large capital investments such as major equipment and compressors shall be protected from fires involving other equipment.

9.5.7.6 Compressors shall be located adjacent to an access way for ease of maintenance.

9.5.7.7 Space shall be provided, at grade, next to the compressors for the manifold piping and compressors auxiliary equipment, such as suction drums and intercoolers.

9.5.7.8 Compressors shall be located to minimize the pressure drop at the suction side.

9.5.7.9 Compressors shall be located as close as possible to the control room and sub-station, since a large amount of electrical and instrument cabling is required for the compressors.

9.5.7.10 Sufficient space shall be provided around compressors to permit maintenance.

9.5.7.11 Gas compressor house shall be located in distance with service building and other locations in conformity with Appendix A, Tables A-3, A-4 and A-5 in respective with OGP process plant.

9.5.8 Storage vessels/tanks

9.5.8.1 Location, layout and spacing of storage vessels/tanks shall be subject to the following mandatory requirement.

9.5.8.1.1 Vessels shall be located to permit maximum dissipation of vapors by free circulation of air. Ground contours and other obstacles shall be taken into account for their effects on air circulation.

9.5.8.1.2 Vessels shall be arranged in rows not more than two deeps. Every vessel shall be adjacent to a road or access way.

9.5.8.1.3 A firewater system must be provided, otherwise more stringent requirements apply.

9.5.8.1.4 The minimum spacing from vessels to boundaries or between vessels and other facilities shall be as given in Table A-7 and/or in accordance with the latest editions of NFPA 30 "Flammable and Combustible Code".

9.5.8.1.5 Spill control shall be accomplished by dike enclosure. The volume of dikes shall be divided upon in accordance with NFPA 30. Dike arrangement and design shall be in accordance with NFPA 30 and the following IPS Standards:

- IPS-C-ME-100 "Atmospheric Above Ground Welded Steel Storage Tanks"
- IPS-C-ME-110 "Large Welded Low Pressure Storage Tanks"
- IPS-C-ME-120 "Aviation Turbine Fuel Storage Tanks"
- IPS-C-ME-130 "Pressure Storage & Spheres (for LPG)"

a) Doom roof tanks: one vessel diameter
b) Spheres or spheroids: ¾ vessel diameter
c) Doom roof tanks and spheres or spheroids: one vessel diameters

9.5.8.2 For atmospheric storage tanks designed for 20 kPa or less containing flammable and combustible liquids:

9.5.8.2.1 Tanks containing crude or low-flash stocks shall be located in areas remote from process Units, property lines and other areas of high occupancy.

9.5.8.2.2 The minimum spacing from atmospheric tanks to boundaries or other facilities shall be as specified in Appendix A, Table A-8 and/or Tables A-4, A-5, A-6 applicable.

9.5.8.2.3 Tanks for crude of low-flash stocks shall be arranged in rows not more than two deep. Every tank shall be adjacent to a road or access way.

9.5.8.2.4 Tanks for high flash stocks shall be arranged in rows not more than three deep. None of the tanks shall be more than one row away from a road or access way.

9.5.8.2.5 Minimum spacing between atmospheric storage tanks shall be as specified in Appendix A, Table A.9 and/or Tables A.4, A.5, A.6 where applicable.

9.5.8.2.6 Dike enclosures shall be accomplished for spill control. Dike design and arrangement shall be made in accordance with NFPA 30 requirement and as per IPS-C-ME-100. In case of any contradiction between requirements of NFPA 30 and these IPS specifications, NFPA 30 requirements shall govern.

9.5.8.3 For non-refrigerated pressure storage vessels, designed for 20 kPa or greater containing flammable liquid or liquefied compressed gases:

9.5.8.3.1 Vessels shall be located to permit maximum dissipation of vapors by free circulation of air. Ground contours and other obstacles shall be taken into account for their effects on air circulation.

9.5.8.3.2 Spheres and spheroids shall be arranged in rows not more than two deeps. At least one side of every vessel shall be adjacent to a road or access way.

9.5.8.3.3 The minimum spacing between the vessels and boundaries, or between the vessels and other facilities, shall be as specified in Appendix A Table A-10 provided that not to be in contrary with those specified in Appendix A, Tables A-4, A-5 and A-6.

9.5.8.3.4 Pressure storage LP-gas tanks may not be provided with spill dikes. However, a dividing bond of 600 mm must be provided between each vessel. Such bonds must not be totally enclosed.

9.5.8.3.5 Location of LP-gas storage tanks shall be in accordance with the latest edition of NFPA 59 "Liquefied Petroleum Gases at Utility Gas Plant".

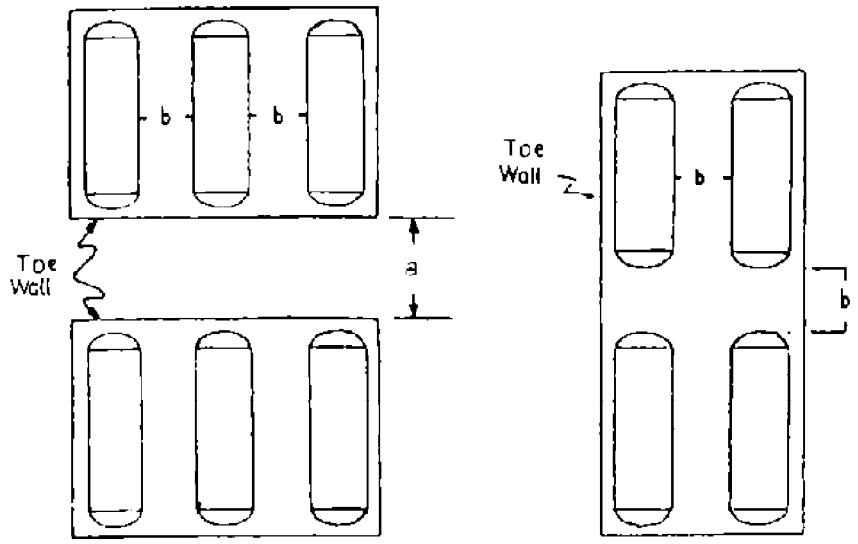
9.5.8.3.6 Spacing between pressure storage vessels shall be as follows:

a) Between any two spheres and spheroids shall not be less than ¾ vessel diameter.
b) Between shells of any two drums, spacing shall not be less than one shell diameter.
c) Between heads of horizontal vessels/drums, spacing shall not be less than as indicated in Fig. 6.

9.5.8.3.7 Spill controls shall be made by dikes and toe walls. Dike arrangement and design shall be decided on the basis of requirement of NFPA 30 and IPS-C-ME-100.

a = Sufficient distance to permit access by fire fighting equipment

b = One shell diameter of larger vessel



Three Drums or More in a Row **Two Drums in a Row**

SPACING BETWEEN HORIZONTAL VESSELS/DRUMS

Fig. 6

10. LAYOUT OF PIPING

10.1 General

10.1.1 In spacing and arrangement of piping, the Codes and Standards, indicated herein below shall apply:

- ASME Codes B31.1 and 31.3 "Power Piping and Chemical-Plant"
- NFPA pamphlets 13 and 14 "Sprinkler Systems and Private Fire Service Mains"
- IPS-E-SF-200, "Firefighting Sprinkler Systems"
- ANSI-MSS Standards, P 58 and 60 "Pipe Hangers and Supports"
- IPS-E-PI-280 "Pipe Supports"

10.2 Requirements and Design Criteria

10.2.1 All equipment and piping shall be indicated or accounted for on the layout. The layout shall be made to scale.

10.2.2 Piping shall be routed in accordance with the piping and instrumentation diagrams and project specifications.

10.2.3 Piping shall be routed to provide convenience, to provide ease of erection and maintenance, and to provide consistency in appearance. These requirements shall be met with consideration given to economy.

10.2.4 Piping shall be routed in groups overhead wherever possible. Firewater and sewer systems shall be buried. All piping shall be arranged to avoid or minimize gas and liquid traps except when noted otherwise on the piping and instrumentation diagrams.

10.2.5 Piping shall be routed to permit normal bends and offsets to take thermal expansion. Where this is not sufficient, provide expansion loops or other means to accommodate thermal expansion.

10.2.6 Do not use trenches unless otherwise is specified.

10.2.7 All branch lines off the instrument air, steam and cooling water supply headers are taken off the top of the header.

10.2.8 Overhead clearance should be provided above access areas of 2.2 meters minimum.

10.2.9 Clear gap between under ground pipes shall be 300 mm minimum. Clearance for above ground is normal-flange to bare pipe (or insulation) plus 25 mm.

10.2.10 Operating drains shall be so arranged that the discharge is visible from the drain valve.

10.2.11 Uninsulated lines lie directly on the pipe support member. Heat insulate lines set on 100 mm (4 inch) "T" - Bar supports (shoes). Adjust height if insulation is greater than 100 mm thick.

11. UTILITY LAYOUT AND SPACING

11.1 Requirements and Design Criteria

11.1.1 The utility area should be near the process area.

11.1.2 The utility area should be arranged for easy access and adequate working area provided around all equipment, for maintenance.

11.1.3 The cooling tower should be located to provide the least possible restriction to the free flow of air, and away from areas where drift or fogging might create a problem.

NFPA Code, Standard and Recommendation 214, Chapters 2 and 5 shall be considered for locating and spacing of cooling towers.

11.1.4 The circulating fuel oil system that supplies oil for process heaters and boilers is usually located in one corner of the utility area including tanks and circulating pumps. Tanks are to be diked.

11.1.5 All boilers are grouped together with space provided for at least one future boiler. All boiler auxiliaries including deaerator, feed pumps, flash drums and chemical feed systems are located in close proximity to the boiler. Consideration must be given to single stacks for each boiler or one common stack.

11.1.6 Plant and instrument air compressors including dryers should be located in the utility area.

11.1.7 Switchgear for the electrical system is placed in an enclosed building and located within the utility area. Substation serving process Units and offsite facilities are usually located in OGP process areas dependent upon the areas served.

11.1.8 Utility control house shall be provided to house all board mounted instruments used for operation and control of utility equipment.

11.1.9 Raw water storage and fire pumps shall be located adjacent to either the boilers or the cooling towers whichever provides the more economic arrangement.

11.1.10 Critical steam and power facilities feeding major portions of the plant shall be protected from possible fire or explosion in equipment handling hydrocarbons.

11.2 Spacing

General recommendation for spacing of boilers, utility & electric generating equipment, control houses, etc.,shall be as specified in Appendix A, Tables A-4, A-5, and A-6 .

12. OFFSITE FACILITIES

12.1 General

12.1.1 A large number of facilities including storage facilities, loading and unloading facilities etc., shall be located in offsite area.

12.2 Tank Farm

12.2.1 The tank farm area will be adjacent to the process and utility area.

12.2.2 Product storage tanks shall be located on the lee side of, and preferably downslope from the remainder of the plant.

12.2.3 Horizontal product storage tanks shall be located so that their longitudinal axess are not in line with buildings and plant equipment.

12.2.4 Exposure of storage tanks to potential sources of fire shall be minimized.

12.2.5 Minimum distance between the aboveground storage vessels/tanks containing highly dangerous, flammable and combustible liquids to the boundaries and other facilities shall be in accordance with requirements specified in 9.5.8 of this Standard.

12.2.6 Dikes are not usually required for LPG, storage. The storage areas should be graded to drain to a safe area.

12.2.7 Sufficient areas around all diked area should be provided for fire fighting, maintenance and required pipeways. The number of tanks within a dike, spacing within the dike and volume of dikes should be in accordance with Oil Insurance Association (given in Appendix A, Tables, A-4, A-5 and A-6), the NFPA Codes (Table A-1, and Tables A-7, A-8, A-9 and A-10) whichever deam more applicable for safety requirement in case of discrepancy between one with the others.

12.2.8 Transfer pumps should be grouped in one or more locations, located outside a tank dike and provided with a minimum of a roof shelter. The number of pumps locations should be a minimum.

12.2.9 In general, piping in the tank farm is run on sleepers located between roadways and tank dikes.

12.2.10 Shell to shell spacing of adjacent aboveground tanks shall be determined in accordance with NFPA 30.

12.3 Loading and Unloading Facilities

12.3.1 The main loading and unloading racks for tank trucks and rail tank cars should be consolidated at one location as near to the plant site as practical, and close to an access gate, so that traffic through the plant is minimized and high risk areas are avoided.

12.3.2 Loading facilities must be provided with adequate space and roadways for safe truck maneuvering and parking.

12.3.3 In the case of rail loading and unloading areas allowance must be made for parking and shunting of tank cars.

12.3.4 Allow for dispersal of vapors and liquid spills so as to minimize the damage to other equipment in case of fire.

12.3.5 Truck and rail loading racks for flammable and combustible liquids shall be located at a distance of at least 30 meters from process Unit and other facilities to avoid truck traffic near process areas.

12.3.6 LP gas truck and rail loading rack, shall be placed at least 75 meters from process Unit, 30 meters from other types of truck loading racks, and 60 meters from atmospheric or pressurized storage tanks.

12.3.7 Wharves handling flammable liquids shall be spaced a minimum of 60 m from process Unit and shall be spaced at least 75 m from fired heaters or other continuously exposed sources of ignition.

12.3.8 An adequate parking area for trucks waiting to load must be provided out of the path of moving trucks.

12.3.9 If weigh scales are required, for truck loading they should be located near the entrance for ease in weighing trucks as they enter and just perior to their leaving.

13. FLARE

13.1 Flaring of process Units that generate combustible by products (gas or vapor), when required, sufficient space must be left between the flare and the nearest adjacent equipment to keep the radiant heat flux below allowable limits.

13.2 The flare stack should be located remote from offsite and process facilities and preferably down wind from any areas where personnel are required for continuous operation.

13.3 In conformity with requirement of 13.2 above, the flare stack shall be located at least 90 meters from other facilities.

13.4 There should be a totally clear area surrounding the flare stack. The size of this area is dependent on heat intensity requirements which depends upon the height of the flare and relieving quantity.

13.5 The flare knockout drum, pumpout pump, and flare ignition system should be located at the periphery of the clear area.

13.6 Along with requirements above, on spacing arrange of flare in OGP plants, recommendations made by Industrial Risk Insurance, (IRI) and requirements of IPS-C-SF-550,"Safety Boundary Limits", in this regard shall be considered.

14. WASTE TREATMENT FACILITIES

14.1 The preferred location of the waste treatment area should be at a refinery/plant low point to insure gravity flow from all areas. Where this is not possible lift stations must be provided as required.

14.2 The waste treatment area should be remote from the process and utility area and arranged to permit future expansion of the system.

14.3 Layout of the area must include vehicle accessibility for maintenance purposes.

APPENDICES

APPENDIX A

TABLE A.1 - NFPA CODES, STANDARDS AND RECOMMENDATIONS

No.	DESCRIPTION
30	"On Flammable and Combustible Liquids", Vol. 1, 1987.
31	"On Oil Burning Equipment", Vol. 2, 1987.
36	"On Solvent Extraction Plants", Vol. 2, 1988.
43 A	"On Oxidizer Storage", Vol. 2, 1980.
38	"On Handling Liquefied Petroleum Gases", Vol. 2, 1989.
91	"On Blowers and Exhaust Systems for Dusts and Vapors", Vol. 4, 1983.
92 A	"On Smock Control System", Vol. 9,1988.
101 M	"On Life Safety" Vol. 5, 1988.
204	"On Fireplaces, Venting, and Solid Fuel Burning" Vol. 9, 1985.
214	"On Cooling Towers", Vol. 6, 1988.
220	"On Type of Building Construction", Vol. 6, 1985.
231	"On Storage General", Vol. 6, 1987.
497 A & B	"On Hazardous Locations for Electrical Installations", Vol. 11, 1986.
650	"On Pneumatic Conveying of Combustion Materials", Vol. 7, 1984.

(to be continued)

APPENDIX A (continue)

TABLE A.2 - CODES AND STANDARDS AFFECTING MAINTENANCE REQUIREMENTS

a) for Vessels

- American Soc. of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code: Section 1, Power Boilers. Section VIII, Pressure Vessels.

- American Petroleum Institute (API): Standard 620, "on large, welded, low-pressure storage tanks". Standard 650, "on welded steel tanks for oil storage".

- Tubular Exchanger Mfrs. Assn. Standards.

- American Soc. of Civil Engineers:
- Minimum Design Loads for Structures.

- Uniform Building Code, from International Conference of Building Officials

b) for Mechanical Equipment

- API, OSHA, EPA.
- National Fire Code.
- National Fire Protection Assn., (NFPA).
- Crane Mfrs. Assn. of America.
- Monorail Mfrs. Assn. of American.
- Conveyer Equipment Mfrs. Assn.
- Hydraulic Institute.
- Nationals Electrical Code (NEC).

(to be continued)

APPENDIX A (continue)

TABLE A.3 - OIA RECOMMENDED SPACING AT REFINERIES, CHEMICALS, PETROCHEMICALS AND GAS PLANTS FOR BUILDINGS

MINIMUM DISTANCE IN METERS						
Fire resistive construction with non-comb. contents	None	None	9	6	9	12
Non-Comb. construction with non-comb. contents	None	None	9	9	12	15
Ordinary construction, IC, and SIC, with non-comb. contents	9	9	15	12	15	18
Fire resistive construction with comb. contents	6	9	12	9	12	15
Non-Comb. construction with comb. contents	9	12	15	12	12	15
Ordinary construction with comb. contents	12	15	18	15	15	24

(to be continued)

APPENDIX A (continue)

TABLE A.4 - OIA GENERAL RECOMMENDATIONS FOR SPACING IN REFINERIES

Note:

* Control houses serving unusually large or hazardous units and central control houses for multiple units or housing computer equipment, require greater spacing and may require blast-resistant construction.

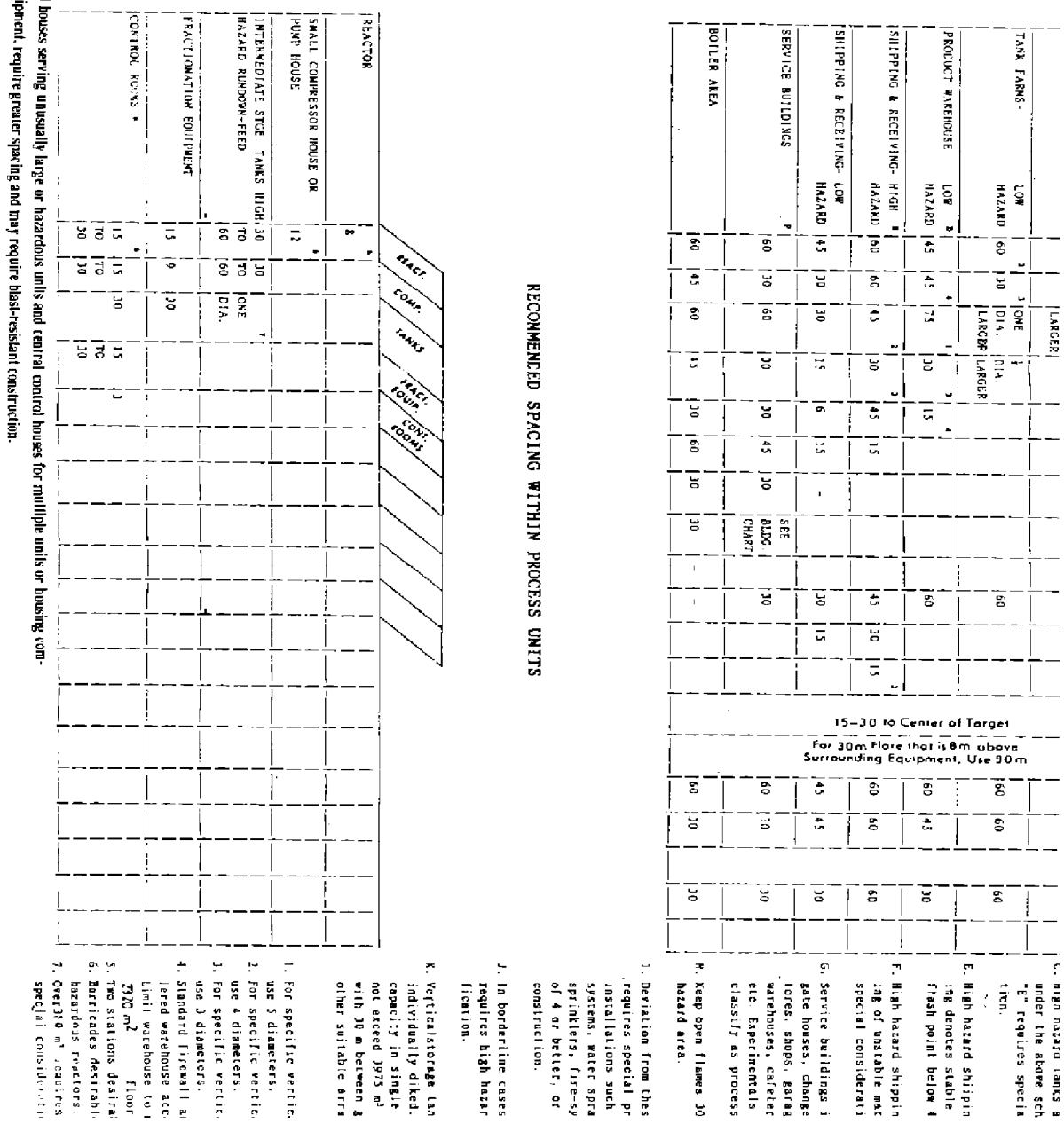
Note:

*** Control houses serving unusually large or hazardous units and central control houses for multiple units or housing computer equipment, require greater spacing and may require blast-resistant construction.**

(to be continued)

APPENDIX A (continue)

TABLE A.5 - OIA GENERAL RECOMMENDATIONS FOR SPACING IN PETROCHEMICAL PLANTS



C. High hazard tanks a under the above sch "E" requires specia tion.

E. High hazard shippin ing denotes stable flash point below 4

F. High hazard shippin ing of unstable mat special considerati

G. Service buildings i gate houses, change torer, shops, garag warehouses, cafeter etc. Experimentals classify as process

M. Keep open flames 30 hazard area.

I. Deviation from thes requires special pr installations such systems, water spra sprinklers, fire-sy of 4 or better, or construction.

J. In borderline cases requires high hazar fication.

K. Vertical storage tan individually diked. capacity in single not exceed 3975 m³ with 30 m between a other suitable arra

1. For specific vertic use 5 diameters.

2. For specific vertic use 4 diameters.

3. For specific vertic use 3 diameters.

4. Standard firewall al lered warehouse acc Limit warehouse to 1 7320 m² floor

5. Two stations desira

6. Barricades desirabl hazardous reactors.

7. Over 340 m³ requires special consideratio

Note:

*** Control houses serving unusually large or hazardous units and central control houses for multiple units or housing computer equipment, require greater spacing and may require blast-resistant construction.**

(to be continued)

APPENDIX A (continue)

TABLE A.6 - OIA GENERAL RECOMMENDATIONS FOR SPACING IN GAS PLANTS

	CHART																	
																TO 30		whses.
GAS COMPRESSOR HOUSE	30	-							75 TO 150	60	30	15		15	15	15 TO 30	15	Utilit water
LARGE PROCESS OIL PUMP HOUSE	30	15	-						75 TO 150	60	30		15	15	15	15 TO 30		1. Wh cl co
DISTILLATION AND FRACTIONATION	30	15	9	-					75 TO 150	60	30		15	15	15	15 TO 30	15	2. Ne or
UTILITIES	15	30	30	30	-				75 TO 150	0	0			15		15 TO 30	30	3. 15 ha Fi va
PRESSURE TANKS	45	60	60	60	45	2 -			30	75	30		15	30		15 TO 30	60	4. No or co
ATMOSPHERIC TANKS	30	60	60	60	30	15	TWO DIA. OF LARGEST		30	75	30		15	30		15 TO 30	60	
LOADING RACKS	30	60	60	60	30	30	30	15 TO 30	30	45	30	30	15	30		15 TO 30	60	
FIRED HEATERS	30	30	30	30	15	45 TO 60	30	30	30	45	-			15	15	15 TO 30	30	
COOLING TOWERS	15 ³ TO 30	15 ³ TO 30	15 ³ TO 30	30	30	75	60	60	30		30		15 TO 30	15 TO 30		15 TO 30	15 TO 30	
SKID UNIT FOR PACKAGE PLANT	30	15	15	12	30	30	30	60	75 TO 150	45	30		15	30			15	
CONTROL HOUSES *	15	30	30	15	15	60	60	60	60 TO 150	15	30		15	15		15 TO 30	30	

BOTH STATIONS SHOULD BE LOCATED AT LEAST 75 AND NOT OVER 150 FROM COMPRESSOR H
PROCESS AREA. LOADING RACKS, HEATERS, AND MAIN GAS LINES. MINIMUM BETWEEN STAT

HEIGHT LESS THAN 25, 90 FROM PLANT.
HEIGH OVER 60 FROM PLANT.

Note:

* Control houses serving unusually large or hazardous units and central control houses for multiple units or housing computer equipment, require greater spacing and may require blast-resistant construction.

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Note:

*** Control houses serving unusually large or hazardous units and central control houses for multiple units or housing computer equipment, require greater spacing and may require blast-resistant construction.**

(to be continued)

APPENDIX A (continue)

TABLE A.7 - PROXIMITY OF REFRIGERATED STORAGE VESSELS TO BOUNDARIES AND OTHER FACILITIES

BOUNDARY LINES OR OTHER FACILITIES	MINIMUM SPACING OF DOME ROOF TANKS	MINIMUM SPACING OF SPHERES OR SPHEROIDS
Property lines adjacent to land which is developed or could be built upon public highways, and main, line railroads	60 m (1)	60 m (1)
Utility plants. buildings of high occupancy (offices, shops, labs, wear-houses etc.)	1½ vessel diameter but not less than 45m not exceed 60 m (1)	60 m (1)
Process equipment (or nearest process unit limits if firm layout not available)	1 vessel diameter, but not less than 45 m need not exceed 60 m (1)	60 m (1)
Non-Refrigerated pressure storage facilities	1 vessel diameter, but not less than 30 m need not exceed 60 m	¾ vessel diameter but not less than 30 m need not exceed 60 m
Atmospheric storage tanks (stock closed cup flash point under 55°C)	1 vessel diameter, but not less than 30 m need not exceed 60 m	1 vessel diameter, but not less than 30 m need not exceed 60 m
Atmospheric storage tanks (stock closed cup flash point 55°C or higher)	½ vessel diameter, but not less than 30 m need not exceed 45 m	½ vessel diameter, but not less than 30 m need not exceed 45 m

Note:

1) Distance from boundary line or facility to centerline of peripheral dike wall surrounding the storage vessel shall not be less than 30 m at any point.

(to be continued)

APPENDIX A (continue)

TABLE A.8 - PROXIMITY OF ATMOSPHERIC STORAGE TANKS TO BOUNDARIES AND OTHER FACILITIES

BOUNDARY LINES OR OTHER FACILITIES:	MINIMUM DISTANCE FROM:			
	Low flash or crude stocks in floating roof tanks	Low flash stocks in fixed roof tanks	Crude stocks in fixed roof tanks	High flash stocks (1) in any type of tank
Property lines adjacent to land which is developed or could be built upon, public highways, main line railroads, and manifolds located on marine piers	60 m	60 m	60 m	45 m (3)
Buildings of high occupancy (offices, shops, labs, ware-houses, etc.)	1½ tank diam; but not less than 45 m need not exceed 60 m	1½ tank diam; but not less than 45 m need not exceed 60 m	60 m	1 tank diam., but not less than 30 m need not exceed 45 m (3)
Nearest process equipment, or utility plant (or nearest unit limits if firm layout not available)	45 m	45 m	60 m	1 tank diam., but not less than 30 m need not exceed 45 m (3) (3) (4)

Notes:

1) When future change ("switch service") to low flash or crude service is specified, use other applicable columns of this Table.

2) Spacing may be reduced to 30 m for a tank or group of tanks meeting all of the following.

a) All tanks are an integral part of the given process operation.
b) Each tank is less than 15 m in diameter.
c) The total capacity of the group does not exceed 7950 m^3 (50,000 bbl).

3) Spacing need not exceed 30 m provided that all of the following requirements are met:

a) The stock is stored at ambient temperature and the closed up flash point is above 93°C; or if heated, not above 93°C and not within of its flash point.

b) The stock is not received directly from a premise Unit where upset conditions could lower its flash point.

c) The total capacity of any tank does not exceed 31800 m^3 (200,000 bbl) and the total capacity of any group of tanks does not exceed 79500 m^3 (500,000 bbl).

d) There are not tanks storing low flash stocks within the same group.

4) Spacing need not exceed 15 m provided that all of the following requirements are met.

a) The requirements given in Note (3) subpar. 3. a. and b. above.

b) All tanks are an integral part of the given process operation.

c) Each tank is less than 25 m in diameter and the total capacity of a group of tanks does not exceed 7950 m^3 (50,000 bbl).

d) There are no tanks storing low-flash stocks within the same group.

(to be continued)

APPENDIX A (continue)

TABLE A-9 - PROXIMITY OF ATMOSPHERIC STORAGE TANKS TO EACH OTHERS

TYPES OF STOCKS AND TANKAGE	MINIMUM SPACING BETWEEN (1) (2)		
	Single or paired tanks	Grouped tanks	Adjacent rows of tanks in separate groups (1)
Low flash stocks in floating roof tanks	¾ tank diameter need not exceed 60 m	½ tank diameter need not exceed 60 m	¾ tank diameter, not less than 25 m need not exceed 60 m
Low flash stocks in fixed roof tanks	1 tank diameter	½ tank diameter	1 tank diameter not less than 30 m
Crude oil stocks in floating roof tanks	¾ tank diameter, need not exceed 60 m	Not permitted	
Crude oil stocks in fixed roof tanks	1½ tank diameter (pairing not permitted)	Not permitted	
High flash stocks in any type tank	½ tank diameter, need not exceed 60 m	½ tank diameter, need not exceed 60 m (3) (4)	½ tank diameter not less than 15 m need not exceed 60 m

Notes:

1) Spacing between high flash and low flash tank groups shall be governed by the low-flash criteria.

2) A minimum spacing of 3m shall be provided between any tank shell and the peripheral dike or toe wall.

3) Finished stocks with a closed up flash point above 93°C may be spaced a minimum of 2m apart provided that all of the following requirements are met.

a) The stock is stored at ambient temperature: of if heated, not above 93°C and not within 10°C of its flash point.

b) The stock is not received directly from a process unit where upset conditions could lower its flash point below the limits of subpar. a. above.

c) There are not tanks storing low-flash stocks within the same group.

4) Finished stocks with a closed up flash point of 54°C or higher but less than 43°C may be spaced 1/6 of the aim of their diameters apart, except.

Where the diameter of one tank is less than one-half the diameter of the adjacent tank, the spacing between the tanks shall not be less than one half the diameter of the smaller tank, provided that all of the following requirements are met.

a) The spacing between tanks is not less than 2m.

b) The stock is not heater above 93°C and not within 10°C of its flash point.

c) Corporations do not exceed at total capacity of 15900 m^3 (100,000 bbl) and there are no tanks storing low-flash stocks within the same group.

d) The stock is not received directly/from a process Unit where upset conditions could lower its flash point below the limits of subpar b. above.

(to be continued)

APPENDIX A (continue)

TABLE A.10 - PROXIMITY OF NON-REFRIGERATED PRESSURE STORAGE VESSELS/DRUMS TO BOUNDARIES AND OTHER FACILITIES

BOUNDARY LINES OR OTHER FACILITIES	MINIMUM SPACING TO SPHERES, SPHEROIDS AND DRUMS
Property lines adjacent to land which is developed or could be built upon, publishways main railroads, and manifolds located on marine piers	60 m (1)
Buildings of high occupancy (offices, shops, lab., warehouses, etc.)	60 m (1)
Nearest process equipment or utilities, point (or nearest unit admits if firm layout is not available)	60 m (1)
Refrigerated storage facilities	¾ tank diam., but not less 30 m, need not exceed 60 m
Atmospheric storage tanks (stock closed up flash point of 55°C and below)	1 tank diam, but not less than 30 m need not exceed 60 m
Atmospheric storage tanks (stock closed up flash point above 55°C)	½ tank diam., but not less than 30 m need not exceed 45 m

Note:

Distance from boundary line or facility to centerline of peripheral dike wall surrounding the storage vessel shall not be less than 30 m at any point.