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		December, 2000	

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Revision Memo

12/00 General revision to update references and spacing requirements consistent with merged ExxonMobil experience. Detailed revision memo provided as an APPENDIX at end of this section.

**Documents**

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SCOPE

This section presents requirements for equipment spacing in the design and layout of new plants and expansions of existing plants.

REFERENCES

DESIGN PRACTICES

DP-XV-F	Emergency Isolation, Depressuring and Shutdown Systems
DP-XV-H	Blast Protection and Fireproofing
DP-XV-I	Fire Fighting Facilities
DP-XV-J	Loading Rack and LPG Storage Facilities

INTERNATIONAL PRACTICES

IP 3-2-1	Sewer Systems
IP 3-2-3	Firewater Systems
IP 3-7-1	Piping Layout, Supports and Flexibility
IP 9-1-1	Spacing and Dikes for Storage Vessels and Tanks
IP 15-10-1	Instrument Transmission Systems
IP 16-1-1	Area Classification and Related Electrical Design for Flammable Liquids, Gases or Vapors
IP 16-3-1	Wiring Methods and Material Selection
IP 16-6-1	Substation Layout
IP 17-3-1	Emergency Shower and Eyewash Facilities

TECHNICAL MANUALS

Blast Technology Manual, EMRE Manual No. TMEE065

TECHNICAL REPORTS

Fire Safety for Plate Heat Exchangers, ER&E Report No. EE.47E.87

NATIONAL FIRE PROTECTION ASSOCIATION CODES

NFPA 30 Flammable and Combustible Liquid Code

DEFINITIONS

Battery Limits - The boundaries of a process area that establish the outer limit for location of equipment associated with a complete process or a group of integrated processes that must be shut down together for turnaround or isolated in the event of an emergency.

Combustible Liquids - High-flash liquids (closed-cup flash point 100°F (38°C) or higher) when handled at a temperature lower than the flash point minus 15°F (8°C).

Flammable Liquids - Low flash liquids (closed-cup flash point less than 100°F (38°C), and high-flash liquids (closed-cup flash point 100°F (38°C) or higher) when handled at a temperature above or within 15°F (8°C) of their flash points.

Flammable Materials - Flammable liquids, hydrocarbon vapors, and any other vapors that are readily ignitable when released to atmosphere (e.g. hydrogen, carbon disulfide).

High-Flash Stocks - Stocks with a closed-cup flash point equal to or greater than 100°F (38°C).

Light Ends - Hydrocarbons having a Reid Vapor Pressure (RVP) of 15 psia (103 kPa) or greater. Includes liquids with pentane and lighter components. Pure hydrogen is excluded from the definition.

Low-Flash Stocks - Stocks with a closed-cup flash point less than 100°F (38°C).

Pipeband - A pipeway, piperack, or sleeperway containing piping.

Process Vessel - Any vessel, drum, column, tower or reactor associated with the processing or handling of hydrocarbons in a process area.

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BASIC DESIGN CONSIDERATIONS

OBJECTIVES OF SPACING DESIGN

The objectives of the spacing recommendations in this section are as follows:

- To permit access for firefighting, fire trucks and other emergency equipment.
- To permit access for operators to perform emergency shutdown actions in a fire situation.
- To minimize involvement of adjacent facilities in a fire and hence prevent further equipment failures.
- To ensure that critical emergency facilities are not subject to fire damage.
- To separate continuous ignition sources from probable sources of release of flammable materials.
- To avoid danger of nuisance to persons or facilities beyond the adjacent property lines.
- To minimize exposure of ExxonMobil facilities to adverse consequences resulting from events external to the site.
- To permit access for normal operation and maintenance.
- To permit access for turnaround maintenance activities.
- To permit turnaround maintenance activities to be carried out without impact to adjacent, non-involved units
- To enhance site security.

The equipment spacing distances detailed in this section are recommended minimum figures which, in most cases, will satisfy the above objectives. However, special considerations for a particular plant or local factors may justify deviations from the recommended standards, as described below.

DEVIATIONS FROM SPACING STANDARDS

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 fireproofing, water sprays, firefighting equipment, emergency shutdown facilities, etc. Reductions below recommended spacings should not be made, however, unless reviewed and approved in accordance with the plant's OIMS processes for management of change or accepting Design Practice deviations, as appropriate.

Factors which affect layout and spacing and which may justify deviations include the following:

- **Physical Limitations** on plot space available, e.g., roadways or boundaries of existing facilities.
- **Special Hazards** - Increased spacing may be justified where special hazards or incentives to minimize fire losses apply, or where continuity of operations is a prime consideration (e.g., certain chemical plants or LNG facilities).
- **Flexibility** - Space requirements for future expansion, which may be a complete unit or individual equipment items.
- **Onstream Maintenance** - This requires access space for personnel and equipment to individual items of equipment, and also separation of units within the plant which may be individually shut down for turnaround.
- **Topography** has a major influence on safety of layout design in sloped areas. For example, location of separators depends on sewer drainage, and the possibility of major tank spills gravitating downhill to process areas must be avoided.
- **Local conditions** may dictate that site security be greater than normal, requiring increased spacing between the plant facilities and the property lines.
- **Safety and public relations factors** associated with the type of adjacent property must be taken into consideration in the plant layout design. Distance from the plant facilities to the property line must be sufficient to prevent danger or nuisance to the neighbors and vice-versa. The spacing required depends on the type of plant nearest to the boundary, and the nature of the adjacent property, e.g., industrial or residential. In residential areas, additional space for screening may be required. Generous spacing would also be advisable where the adjoining land is undeveloped but is subject to future development.
- **Special Cases** - In certain cases, such as small independent chemical plants handling materials with flash points above 100°F (38°C), reductions below the recommended spacing distances may be justified where the associated risk is limited.

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DESIGN PROCEDURE

INSTRUCTIONS FOR USE OF SPACING CHARTS AND TABLES

Required spacing distances are presented in the Onsite Spacing Chart (**Figure 1A Customary** and (**Figure 1B Metric**) and the Offsite Spacing Chart (**Figure 2A Customary** and **Figure 2B Metric**).

For each facility, the Basic Spacing is indicated in the diagonal column. Basic Spacing is the recommended horizontal distance between a given facility and other general processing equipment. This basic spacing is not required between items of equipment in similar services, e.g., between a pump and its spare.

The spacing requirement between two facilities is obtained from **Figure 1A** (Customary) and **Figure 1B** (Metric) or **Figure 2A** (Customary) and **Figure 2B** (Metric) at the intersection of the appropriate horizontal and vertical columns. For spacing between two facilities of the same type, refer to the first square adjacent to the appropriate reference letter in **Figure 1A** (Customary) and **Figure 1B** (Metric) or **Figure 2A** (Customary) and **Figure 2B** (Metric).

It is essential that the Onsite and Offsite Spacing Charts be used in conjunction with their respective guides, i.e., **Table 1** or **Table 2**.

The table supplements the charts with the following information:

- **Spacing variations** which may apply, for each facility.
- **General remarks** on locations and spacing, for each facility.
- **Explanatory remarks** on the spacing basis, for each facility.
- **Spacing and location requirements** for other miscellaneous facilities which are not included in the charts.

The spacing guidelines provided in these charts and tables are based solely on the considerations listed under "**OBJECTIVES OF SPACING DESIGN**" (see **BASIC DESIGN CONSIDERATIONS**). In the case of buildings, additional spacing beyond these guidelines may be required for blast protection. The size and congestion of process units determine the overpressure that could be developed from ignition of a potential process area vapor cloud, which will impact the building spacing requirements. Such considerations are discussed in **Section XV-H** of the Design Practices and in the *Blast Technology Manual* (TMEE 065) and are beyond the scope of this Section.

GENERAL ONSITE LAYOUT

Within the unit plot, the location of the major facilities, i.e., control house, electrical substation, fired heaters, compressors, etc., should be designed not only in accordance with the spacing standards, but also with consideration of proximity to adjoining facilities, location of roadways, prevailing wind direction, site topography, etc.

Whenever practical, locate process units, utility, flare and other areas with similar open flames at a higher elevation than tank farms and other bulk quantities of hydrocarbons; this minimizes the potential for ignition of hydrocarbon vapor releases or liquid spills.

Where it is not feasible to locate tank farms at elevations lower than process areas, increased fire protection measures may be required to offset the increased potential for ignition. These measures may include all or some of the following:

- Diversion diking
- High capacity drainage systems
- Vapor detection placed at potential release points
- Additional fire protection systems such as foam, water sprays or similar protection measures

Similar precautions for spills and vapor releases are needed when siting plants that will contain extensive quantities of toxic materials.

Prevailing wind should be considered when locating ignition sources such as fired heaters and flares. Areas with high concentrations of personnel, such as office buildings, shop areas and existing neighboring community areas, should also be considered—in reference to prevailing wind to reduce potential exposures.

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DESIGN PROCEDURE (Cont)

The overall layout of the process area must be subdivided with accessways for firefighting, turnarounds, fire risk areas, and maintenance in accordance with the following:

1. **Access for Firefighting** - 20 ft (6 m) minimum width accessways for firefighting are required and these are normally arranged in a rectangular pattern such that the shorter dimension of each rectangle does not exceed 100 ft (30 m). Consideration should be given to limiting the longer dimension of each subdivision to 400 ft (120 m) by the inclusion of additional firefighting accessways where necessary. 20 ft (6 m) of clear space under an overhead pipeband (including the case where air-fin exchangers are located above the pipeband) is acceptable as firefighting access on one side only of an area subdivision.
2. **Turnaround Isolation** - 50 ft (15 m) separation between groups of equipment which shut down separately for turnaround [75 ft (22.5 m) for light ends units], as detailed in ITEM KK in **Tables 2A/B**.
3. **Process Area Subdivisions for Determining Fire Water Rates** - 50 ft (15 m) minimum separation between process area subdivisions which are used as the bases for determination of fire water application rates, as described in **Section XV-I, Fire Fighting Facilities**.
4. **Access for Mobile Equipment for On-Stream and Turnaround Maintenance** - 20 ft (6 m) minimum accessways are required to allow mobile equipment to reach equipment for maintenance.
5. **Fire Risk Areas for the Sizing of Safety Valve Headers** - In laying out a unit plot plan, 20 ft (6 m) accessways are provided for maintenance. These unit areas, surrounded by at least 20 ft (6 m) clear spacing on all sides, are the maximum areas which can reasonably be expected to be totally involved in a single fire. These areas are used to determine the combined requirement for pressure relief due to fire exposure. This should not be confused with the areas used to determine fire water and sewer capacities, which are defined as plot subdivision areas in **Section XV-I, Fire Fighting Facilities**. Where the size of the fire risk areas determined by other criteria in Paragraphs 1 through 4, result in an abnormally large flare header size, additional 20 ft (6 m) accessways may be provided to reduce the fire risk areas.

EQUIPMENT STACKING

A degree of equipment stacking is necessary to achieve a reasonable utilization of plot space, but the potential heavy fire involvement of equipment stacked in several layers must be avoided. The following restrictions apply:

1. **Maximum Height** - Avoid stacking more than three levels of equipment.
2. **Special Restrictions** - Do not locate equipment over any of the following:
 - a. Pumps or compressors handling flammable materials.
 - b. Air fin exchangers.
 - c. Heat exchangers or drums containing flammable material above 600°F (316°C) or above its autoignition temperature, whichever is lower.



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TABLE 1
ONSITE SPACING, GUIDE TO FIGURES 1A & 1B

SPACING	DISTANCE, ft (m)	REMARKS
ITEM A - Gas Compressors		
General - Where there are several large compressors in a unit, it is usually economical for operation and maintenance to locate them in one area. Associated intercoolers, knockout drums, etc., may be located in the compressor area and need not comply with the 25 ft (7.5 m) spacing to non-associated equipment, provided that they do not restrict access for firefighting and maintenance (generally, spacing of 10 to 15 ft (3 to 4.5 m) is sufficient). Access for firefighting must be available on at least two sides. Compressor orientation should consider the possibility of massive mechanical failure in relation to surrounding equipment. Compressors handling inert gases or air may be spaced closer than is shown for gas compressors, unless they are in a service critical to plant operations such as main plant instrument and industrial air systems.		
Basic	25 (7.5)	Protects high investment compressor equipment from fires involving other equipment and vice-versa. Small steam or electric motor driven compressors [below 200 hp (150 kW) drivers] may be treated as pumps for spacing and location purposes.
From A (Gas Compressors) From B (Drivers Other Than Steam or Motor)	As required for operations and maintenance	Provide access for operation and maintenance. Compressors may be grouped in the same risk area.
From W (Onsite Pipebands)	15 (4.5)	Additional spacing (above the basic spacing for onsite pipebands) is intended to protect piping from potentially large compressor fires. Pipebands do not pose a significant risk to compressors and reduced spacing (below the basic spacing for compressors) is appropriate. Where the compressor is equipped with provisions for automatic shutdown, isolation and blowdown in the event of a fire, spacing can be reduced to 10 ft (3 m).
ITEM B - Drivers Other Than Steam Or Motor		
Basic	35 (10.5)	Provides spacing between equipment handling hydrocarbons from sources of ignition on gas turbines, diesel or gas engines. Steam or motor drivers require maintenance spacing only.
From M (Fired heaters)	25 (7.5)	Minimizes damage to driver in case of fired heater fire.
From W (Onsite Pipebands)	15 (4.5)	Additional spacing (above the basic spacing for onsite pipebands) is intended to protect piping from potentially large fires involving drivers. Pipebands do not pose a significant risk to drivers and reduced spacing (below the basic spacing for drivers) is appropriate. Where the driver is equipped with provisions for automatic shutdown, isolation and blowdown in the event of a fire, spacing can be reduced to 10 ft (3 m).
ITEM C - Central And Multi-Unit Control Houses		
General - Location should be next to a roadway. The spacing guidelines on this Table are intended to minimize the exposure of central and multi-unit control houses to fires. Additional spacing beyond that given on this Table may be required depending on blast resistance. Refer to Section XV-H for additional information.		
Basic	100 (30)	Provides space between equipment with vapor release or fire risk potential and important centralized or multi-unit control houses. Additional distance may be required depending upon type of construction and the location of the boundaries of Potential Explosion Domains. See Section XV-H for details.
From W (Onsite Pipebands)	25 (7.5)	Pipebands pose a lower fire risk than general process equipment, provided that there are no large concentrations of valves, flanges or other potential release sources within a horizontal radius of 100 ft (30 m) of control center. Where pipebands are part of a Potential Explosion Domain, additional spacing may be required. Refer to Section XV-H for details.



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TABLE 1 (Cont)
ONSITE SPACING, GUIDE TO FIGURES 1A & 1B

SPACING	DISTANCE, ft (m)	REMARKS
ITEM D - Single-Unit Control Houses		
General - Location should be at unit battery limits, next to a roadway. Single unit control houses are rarely used on new construction, but may be present in existing, older plants. The spacing guidelines on this Table are intended to minimize the exposure of single-unit control houses to fires. Additional spacing beyond that given on this Table may be required depending on blast resistance. Refer to Section XV-H for additional information.		
Basic	50 (15)	Provides space between equipment with vapor release or fire risk potential and single-unit control houses. Since the control house is associated with a single unit, less space is required than for central or multi-unit control houses. Additional distance may be required depending upon type of construction and the location of the boundaries of Potential Explosion Domains. NOTE: In no case shall a unit control house be located less than 100 ft (30 m) from the nearest boundary of a Potential Explosion Domain associated with a process unit not controlled by the control house. See Section XV-H for details.
From W (Onsite Pipebands)	15 (4.5)	Pipebands pose a lower fire risk than general process equipment, provided that there are no large concentrations of valves, flanges or other potential release sources within a horizontal radius of 50 ft (15 m) of control house. Where pipebands are part of a Potential Explosion Domain, additional spacing may be required. Refer to Section XV-H for details.
ITEM E - Air Fin Coolers And Plate Heat Exchangers		
General - Air fin exchangers, with their extensive heat transfer surfaces, are highly vulnerable to failure under fire exposure. A preferred location for air fins is at the opposite side of fractionating towers, away from fired heaters. They should not be located over any of the following: 1. Pumps or compressors handling flammable materials. 2. Drums or heat exchangers containing flammable materials, unless they are part of the same process unit as the air fin cooler. 3. Any drums or heat exchangers containing flammable materials above 600°F (316°C) or above their autoignition temperature, whichever is lower. 4. Preferably, air fins should not be located over or within 10 ft (3 m) horizontally of major pipebands except when a better layout is not available, because of the maintenance difficulties that are introduced, in addition to the fire involvement hazard. If they are so located, then the following requirements must be applied: a. There should be at least 8 ft (2.5 m) of head room between the lowest part of the air fin cooler and the top of the pipe rack. b. Flanges, valves and extraneous manifolds not associated with the air fin cooler should not be located directly below the air cooler or within 10 ft (3 m) horizontally beyond it in all directions. c. Normal horizontal spacing requirements from both the air fin cooler and the pipeband to adjacent equipment must be met. d. Access must be provided for mobile equipment for removal and replacement of motors and air fin units. e. Supports for the air cooler and pipeband must be fireproofed in accordance with the requirements of IP 14-3-1. For gasketed plate exchangers, the following precautions are recommended to ensure a safe and reliable plate heat exchanger unit. 1. Spacing requirements for air cooled heat exchangers should be applied to plate exchangers handling flammable fluids. 2. If in flammable service and located less than 20 ft (6 m) horizontally from equipment with a high potential of fire (IP 14-3-1), plate exchanger should be fireproofed. 3. See ER&E Report No. EE.47E.87, Fire Safety of Plate Heat Exchangers, for additional information.		
Basic	10 (3)	Minimizes damage to air fins, since they are more vulnerable to damage from fire exposure than shell and tube exchangers.
From T (Main Equipment Structures)	As required	Air discharged from air fins should not create operating or maintenance problems on other equipment, in structures.

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TABLE 1 (Cont)
ONSITE SPACING, GUIDE TO FIGURES 1A & 1B

SPACING	DISTANCE, ft (m)	REMARKS
ITEM F - Cooling Towers		
Basic	50 (15) or 100 (30)	Provides spacing for vapors to disperse. Discharge of vapors can be anticipated from exchanger leakage unless a water disengaging drum is installed upstream. Equipment that does not represent a source of ignition and is lower than the cooling tower may be spaced 50 ft (15 m) away, and equipment that represents a potential source of ignition or is higher than the tower should be spaced 100 ft (30 m) away. Spacing and location should also be selected to minimize corrosion, ice formation and visibility problems that may result from impingement of the cooling tower exhaust plume on adjacent high structures.
ITEM G - Process Vessels Below 600°F (316°C) And Below Autoignition		
Basic	5 (1.5)	Primarily to provide access for operation and maintenance. Also allows some access for firefighting. For very large vessels, such as crude desalters, consider providing a low toe-wall around the vessel a minimum of 10 ft (3m) from the vessel walls. The area inside the toe wall should be graded to drain to one or more sealed catch basins located near the toe-wall. No other equipment should be installed within the toe-wall.
ITEM H - Electrical Unit Load Centers Or Unit Substations		
General - 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 the edge of the unit.		
Basic	50 (15)	To meet electrical area classification requirements and to protect electrical equipment from fires in the process area. Greater spacing may be required under certain conditions, per IP 16-6-1 . Greater spacing may also be required for substation buildings depending on blast resistance, criticality of substation, and location of the boundaries of Potential Explosion Domains. See Section XV-H for details.
From W (Onsite Pipebands)	15 (4.5)	Pipebands pose a lower fire risk than general process equipment, provided that there are no large concentrations of valves, flanges or other potential release sources within a horizontal radius of 50 ft (15 m) of the load center or substation. Where pipebands are part of a Potential Explosion Domain, additional spacing to substation buildings may be required depending on blast resistance and criticality of substation. Refer to Section XV-H for details.
ITEM I - Critical Electrical Switch Racks		
General - Critical electrical switch racks consist of electrical supply or control equipment for an individual piece of equipment or small group of equipment the loss of which would interfere with the function of an emergency system, or would result in downtime exceeding a week duration. Reduced spacing may be considered for non-critical switch racks based on a case-by-case evaluation. All switch racks, whether they are considered critical or not, must meet the applicable electrical area classification requirements. Refer to IP 16-1-1 for additional information.		
Basic	50 (15)	To meet electrical area classification requirements and to protect electrical equipment from fire in the process area.. Greater spacing may be required under certain conditions per IP 16-6-1 . For non-critical radially fed switch racks containing only motor controllers (no associated power transformer or power distribution gear) the spacing may be decreased to 15 ft (4.5 m) from potential release sources other than fired heaters and to 25 ft (7.5 m) from fired heaters. The applicable electrical area classification requirements must be met if reduced spacings are used .
From W (Onsite Pipebands)	25 (7.5)	Pipebands pose a lower fire risk than general process equipment, provided that there are no large concentrations of valves, flanges or other potential release sources within a horizontal radius of 50 ft (15 m) of the switchrack.



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TABLE 1 (Cont)
ONSITE SPACING, GUIDE TO FIGURES 1A & 1B

SPACING	DISTANCE, ft (m)	REMARKS
ITEM J - Emergency Valves For Shut-Off, Isolation, Water Sprays, Etc.		
General - Refer to Section XV-F and IP 3-7-1 for information regarding the location of Emergency Shutoff and Isolation Valves for various services. Refer to IP 3-2-3 for information regarding the location of actuation valves for water spray and deluge systems.		
ITEM K - Exchangers Handling Flammable Materials Above 600°F (316°C) Or Above Autoignition		
General - The following spacing requirements apply to any exchanger processing flammable materials at an inlet temperature above 600°F (316°C) or above the autoignition temperature, whichever is lower, on either side.		
Basic	15 (4.5)	Provides some access for firefighting and minimizes damage to other equipment. Probability of fire is greater than with exchangers operating below 600°F (316°C) or below autoignition, since auto-ignition is likely if leakage of process fluids occurs.
From K, L (Other heat exchangers regardless of temperature)	15 (4.5)	Exchangers that are interconnected by a common process stream may be spaced 3 ft (1m) apart regardless of operating temperature.
From M (Fired Heaters)	25 (7.5)	Allows reduced spacing considering auto-ignition is likely to occur upon exchanger leakage regardless of fired heater ignition source.
ITEM L - Exchangers Handling Flammable Or Combustible Materials Below 600°F (316°C) And Below Autoignition		
Basic	5 (1.5)	Provides access for operation and maintenance.
From K, (Exchangers operating above 600°F (316°C) or above autoignition temperature)	15 (4.5)	Exchangers that are interconnected by a common process stream may be spaced 3 ft (1 m) apart regardless of operating temperature.
From L (Exchangers operating below 600°F (316°C) and below autoignition temperature)	3(1.5)	Exchangers that operate below both 600°F (316°C) and autoignition temperature may be spaced 3 ft (1.5 m) apart even if they are not interconnected by a common process stream.
ITEM M - Fired Heaters		
General - Since fired heaters are a constant source of ignition, their location must be carefully selected. Where practical they should be located on the upwind side of a unit, near battery limits, with consideration given to the effects of adjacent units as well as the equipment in the same unit. The top of a fired heater stack should be at least 10 ft (3 m) higher than any equipment within a horizontal distance of 50 ft (15 m) and at least 10 ft (3 m) higher than any working platform that is regularly used by operating or maintenance personnel (once per day or more), and is within a horizontal distance of 100 ft (30 m).		
Basic	50 (15)	Separates equipment handling flammable material from a constant source of ignition. Spacing also minimizes damage to other equipment in case of a fired heater fire.
From G (Process Vessels Below 600°F(316°C) and below AIT)	50 (15)	As an exception, fuel gas knockout drums should be spaced as close as possible to their respective fired heaters, subject to a minimum of 10 ft (3 m).

