FE 366
PLANT AND SITE – LAYOUT
Lecture: Food Plant Design

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One of the most important operations for plant design is a living-area of process. Therefore, one mistake causes a long time problem.
IMPORTANT DESIGN CRITERIA FOR PLANT LAY-OUT

- Economical factors (piping, floors, pumping, height)
- Safety factors (hor surface, explosion, labor safety, CE rules, noise, pollution, high pressure)
- Processing/repairing factors (repairing space for machine)
- Constructional and view factor (fashion)
- Altitude factors
- Automation factors
- Standards, laws
Typical logic for food plant processing lay-out based on product safety
Preferences for product flow directions
(from Troller, Sanitation in Food Processing)

| Poor | Poor | Better | Best | Best |

-Dr. M. BAYRAM
LAYOUT STAGES

A- FIRST OPERATION FOR PLANT-LAYOUT:

A1: Select and determine Capacity
A2: Select and determine technology
A3: Select and determine energy
A4: Prepare Process flow charts
A5. Material and energy balance flow
A6. Determination of building type
A7. Re-check
A8. Determine expansion area
A9. Official laws and standarts
A10. Area determination
A11. Collect informations about area
A11. NORTH-WEST-EAST-SOUTH/WIND DIRECTION

B. SECOND OPERATION FOR PLANT-LAYOUT

B1. Site layout (Arazi yerleşim)
A- FIRST OPERATION FOR PLANT-LAYOUT:

Step A1: Select and determine Capacity → effects
- feasibility report
- economy for investment
- sizes of machineries
- building size
- plant lay-out
Procedures for plant lay-outs

Step A2: Select and determine Technology → effects
- plant area
- automation systems
- electronic control systems
- flexibility of process
- plant lay-out
Step A3: Select and determine Energy and its use →
effects
- area (e.g. Coal needs more area)
- labour
- economy
- place of plant
- plant lay-out
Step A4: Prepare Process flow charts →

A4.1. Brief flow charting (Block-diagram)

A4.2. Flow diagrams
   A4.2.i. Simplified flow-diagram
   A4.2.ii. Scaled-one view detailed flow-diagram
   A4.2.ii-a. PID Diagram (For FE467 Design II)
   A4.2.iii. Top installation (2D)
   A4.2.iv. 3D (Three dimensional) drawing
   A4.2.v. Model (Maket) preparation
A4.1. Brief flow charting (Block-diagram)

- Use simple block flow charting
- Only show main processing steps
A4.2. Flow diagrams
A4.2.i. Simplified flow-diagram

- Only show main equipment
- No scaling
- No floor installation
A4.2.ii. Scaled-one view detailed flow-diagram

- Show scaled details using one-side view
- Show all installation with real size (or scaled) on 2D drawing
- Show inlet and outlet materials, waste, by-products
- Show water, electricity cable, waste line, steam line, gas lines, compressed air lines
- Show elevations
- Show on each related floor
- Give codes to machines, lines etc.
0…: Out of process area (0.1, 0.2..)
1…: In-process (1.1, 1.2...) 
2…: Others
A4.2.ii-a-PID Diagram (For FE467 Design II)
OUTLINE
-P&ID usage for drawing
-Design of system and plant
-Determination of position of sensors, process, actuator, controller
-Giving code and name

RECOGNIZE all the piping and instrumentation symbols, CHOOSE suitable symbols and DEVELOP the piping systems and the specification of the process instrumentation, equipment, piping, valves, fittings; and their arrangement in P&ID for the bioprocess plant design.
- **TYPES of piping** and instrumentation symbols.
- **How to CHOOSE** the suitable symbols in control system?
- **How to DEVELOP** the piping systems and the specification of the process **instrumentation, equipment, piping, valves, fittings**.
- The **ARRANGEMENT in P&ID** for the bioprocess plant design.
The given input was P&ID diagram. 3D Piping routing needs to be designed for Skid Mounting as per the P&ID. Individual pipeline drawing and global BOM has been developed.
PFD

Process flow diagram

P&ID

Differences??
YOU WILL DRAW THIS FOR YOUR PROJECT (Fe 467 Design II)
The details of PID will be learned at FE 403 Food Process Control

ASC : Anti Surge Controller  TC : Temperature Controller  FC : Flow Controller
ASV : Anti Surge Valve     PC : Pressure Controller  LC : Level Controller

www.EnggCyclopedia.com
A4.2.iii. Top installation (2D)

It is very important to determine real size and place of equipments.

During installation and holes on floor can be determined using this drawing.
A4.2.iv. 3D (Three dimensional) drawing

Using 3D, determine employee numbers!!!
A4.2.v. Model (Maket) preparation

It is very important for scenario.
It is very important to find alternative solutions
(inlet, outlet, passing, reaching, labor positions)
A5. Material and energy balance flow

- Prepare a flow diagram and show all material and energy balance (inlet-outlet)
A6. Determination of building type

A6.1. One floor:  e.g. Pre-fabric, steel or concrete

Usability:
- fast building
- investment cost is lower than multifloor
- Flexible building (it can be changed to other processes)

Based on energy usage:
- In general, if area cost is less (due to pumping cost), building construction time is limited, building construction labor cost is low $\Rightarrow$ use one-floor
- Use for liquid product processing (milk, fruit juice etc.). Because, if multi-floor is used, pumping energy cost will increase due to elevation
A6.2. Multi floor

- Concrete or steel (depend on price of these materials in countries, e.g. Concrete in Türkiye, Steel in Canada)
- It is preferred if:
  - area cost is expensive
  - building construction labor cost is low

- In general; it is used for solid food production or solid-liquid food production (floor, semolina, bulgur). In order to decrease transportation cost by using potential energy.
- It is generally not flexible for other production.
- Drawing is important to determine the holes on the floor for pipe passing.
A7. Re-check

• After the preparation above items, again re-check the project (e.g. Itmes A4.2, A4.3 etc)
A8. Determine expansion area

- For the next planning for the expansion of production line, determine areas. It depends on capacity, economy offer-supply-demand etc. (~20-30% extra area)

A9. Official laws and standards

- Obtain all standards for area, construction, waste, energy utilizations, gas line, seismic activities, floor limits etc.
- Collect area drawing, status, zone properties, geographic properties, elevation, next plan for government
- Also, obtain Railway plans, roads, gas lines, water lines, waste lines, etc.
A10. Area determination

• Decide the area after previous evaluations.

A11. NORTH-WEST-EAST-SOUTH/WIND DIRECTION

• Determine north-west-east-south positions for area/site.
• Determine wind direction to prevent dust, odor, smoke.
B. SECOND OPERATION FOR PLANT-LAYOUT

B1. Site layout (Arazi yerleşim)

• Main criteria for the site lay out is the short-way for raw material, product, by-products, waste, energy supply to decrease transfer costs.

• Second one; if in the next time, there is another investment plan on the same site.

• Third one; planning for administration building, process building, energy building and other buildings (stock, security etc.)

• Break a space between buildings and wall/limit/boarder of the field!!! (according to law)

• Put steam generator near to gas inlet, cooling tower (according to wind) near to water supply line, trafo near to electricity network (but, break space between wall of field)
Factors to prepare site lay-out

1. Raw material inlet-outlet, transportations, wind, elevation (excavation etc.)
2. Relation with other support buildings (energy, steam, water, waste treatment etc.)
3. Relation with energy construction, equipment, wire-networki automation lines etc.
4. Waste-water and waste disposal
5. Relation with process administration office and control
6. Road, standarts, railway, gas line, elavtion of area (important for fresh and waste water flow potentially), altitude of place (pressure, boiling points etc.)
7. Cold storage (north, underground etc.), product storage position
(i) Whether a sloping or level site is required
(ii) Access to the location – are roads suitable and is a rail link required?
(iii) Has the land or site been contaminated and what is the underlying geology?
(iv) Will planning permission be granted?
(v) At what level is the water table and what is drainage like?
(vi) What utilities are available – water, gas, electricity, etc.
(vii) Security, in particular access and boundaries.
Environmental impact

(i) Waste disposal
(ii) Potential hazards to local community
(iii) Pollution – gas, liquid and solid
(iv) Noise levels – day and night
(v) Effect of the facility on the use of local raw materials
(vi) Transportation infrastructure

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Limit (mg l(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOD</td>
<td>300</td>
</tr>
<tr>
<td>Suspended solids</td>
<td>300</td>
</tr>
<tr>
<td>Total dissolved solids</td>
<td>500</td>
</tr>
<tr>
<td>Total phosphorus</td>
<td>10</td>
</tr>
<tr>
<td>Total nitrogen</td>
<td>40</td>
</tr>
<tr>
<td>Oil and grease</td>
<td>100</td>
</tr>
</tbody>
</table>
ROAD
RAILWAY
TIPİK KAMYON VE OTOBÜSLERİN ÖLÇÜLERİ, Dönüş Yarı ÇAPLARI
Bkz. Yazılı Kaynak

1. Caddy-Tenteli Kamyonet
2. Tenteli kamyon
3. Tenteli kamyon
4. Unimog-kamyonet
5. 2 dingilli kamyon
6. 3 dingilli kamyon
7. 4 dingilli kamyon
8. Yarı römorklu kamyon, Uzunluğu = 15 m
9. Treylerli kamyon, Uzunluğu = 15 m
10. Tandem römorklu Kamyon, Uzunluğu = 15 m, Genişlik = 2,50 m
11. Yarı römorklu damperli kamyon
12. Boşatma kantları
13. Devrime kantları kamyon
14. Çöp kamyonu
15. Beton romaj arabası Uzunluğu = 11,8 m
16. Merdiven arabası: Uzunluğu = 11,50 m
17. Standart hedi-otobüs
18. Yüksek tavanlı uzun yol otobüsü
19. Standart korkulu otobüs genişliği = 2,50 m
18 m. uzunluğundaki kamyonun için optimal avlu derinliği için Şekil 1' e bakınız. Bu şartlarda giriş için gerekli derinlik 35 m'dir. En uzun kamyon bile bu durumda rahatlıkla giriş çıkabilir. Belirtir bir termin planına göre çalışan araçların kolaylıkla yüksek indirme ve bindirme işlemlerini sağlanabilmesi için planlanmanın yapılması önemlidir. Bu şartlar yerine getirilmediği halde, 10×15 derece eğimli çarkı rampalar en uygun çözümü sunmaktadır (Bzk. Şekil 3,5-6).

Bir kamyon ve trelerinin dönüş yarı capı takr. 12,0 metredir. Yan yana duran iki kamyon arasındaki en az mesafesi rampa değiştirileğinde en az 1,50 m, yüksek ambarı en az 3 m olmalıdır.
AĞIR VASITALAR

PARK ETME VE DÖNEMEÇ

Ağır vasıtalardan büyükliklerinin farklılıkların nedeniyle sabit zemin için işaretlemesi amaca uygun değildir. Ağır vasıtalardan yer gereklerini esas ölçer, araçın seyahatine, yere park ailesi olarak, ağır vasıta ve zemin şekillerinden seçilmiş tarzına göre seçilir. Özellikle derinlikçe dönerde seyir eden vasıtin arka tekerlerinin zincir eğrisi göz önünde bulundurulmalıdır. Trafikten ruhsat verilen büyük taşıtlar için dönüş çapı: dış dönüş yan çapı 12 m, ruhsatlı çok sayıdaki ağır vasıtalardan yeterli dönüş dairesinin dış dönüş yan çapı ise 10 m olmalıdır (Bkz. S. 425)

| Park yerleri Garahtar Akaryakıt İstasyonları |

<table>
<thead>
<tr>
<th>Taşıt türü (a)</th>
<th>Park yan genişliği (b)</th>
<th>Serbest bölge (c)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kamyon ZZ1 10,00</td>
<td>3,00</td>
<td>14,00</td>
</tr>
<tr>
<td>Kamyon 12,00</td>
<td>3,95</td>
<td>13,10</td>
</tr>
<tr>
<td>Tek kamyon</td>
<td>3,85</td>
<td>12,80</td>
</tr>
<tr>
<td>Yan römorklu kamyon 15,00</td>
<td>3,95</td>
<td>15,00</td>
</tr>
</tbody>
</table>

1. Tek üst dilimle
2. Sıra dizilim
3. Sekizgen durumunda dönüş mekanı
4. Çok dur ortada dönüş çakısı
5. Geçit

Diğer övalarları (Bkz. Şekil 12-14)
Dönemeçlerin tarzi, büyüklüğü ve biçimleri her bir bölgenin kullanılmasına ve şarap üzerindeki göçmenin uygulandığı binaların, bunlar için en doğru seçimi için gelen bir öneride bulunmak zorur. Dönemeç teşpitinde, iftai ve çop taşımacılığı gereksinimleri göz önünde bulundurulmalıdır. Bu tür taşımına kurulum, çop aralıklarının uzun mesafeli veya yollarla girilmesi ve dolmak结构调整ında dolaylı bakımsız yollarla çalışmalı reddetmektedir.

Dönemeçler, donmuş çekici (Bzk. Şekil 4-5), donmuş dairesi ve donmuş çemberi (Şekil 6-9) olarak düzenlenmiştir. Donmuş çapların manevra ve çevrerleri kolaylaştıran donmuş dairesi ve çemberleri kullanılabılır.

Dönemeçlerin çoğu nedeniyle sol yana doğru asimetrik olarak düzenlenmeldir (Bzk. Şekil 6-9). Dönemeçler dış tarafında taşların römarkt ve troyleri için serbest bölge oluşturulmalıdır. Dönemeç çaplarının dış taraf bitkilerle yeşilendirilerek (Bzk. Şekil 8). Dönemeç çaplarının (Bzk. Şekil 1) kamyonlar için uygundur. Eğer, garaj önderi ile yasa uyumlu birlikte kullanılması, yol genişliğinin 6 m'den fazla olması gerekmek.
Closing area and distance on the site

• According to countries standards: 40-60% of the whole area can be closed. Remain should be open.
• According to countries standards: Put 5-10 m of distance around the land. In front of the land, it maybe 20-30 m.
ENTRANCE AND EXIT TO THE SITE

- IMPORTANT POINTS:
  - Use only ONE Entrance/Exit from same place (due to better control and cost of security)
  - No personal and visitor cars and personal service cannot be entrance the plant site due to security and safety.
ELEVATED FIELD
(EXCAVATION)

INDUSTRIAL ZONE
PLANT AREA VIEW

GROUND WORK

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1. Raw material inlet-outlet and transportations

- At inlet;
  - control of inlet of raw material → view point is important → control by manager, quality control dept., logistic office, boss (building & offices should be placed based on view point for truck, railways, vagoon etc.)
  - No cross-flow

Trafic jam
- Discharging/loading mechanisms for raw materials and products (rampa, pneumatic transfer, platform, elevations, pump etc.)
(e.g. For wheat → tireme, lift, special discharge truck, vagoon etc.)

Figure 9. Pneumatic conveyor.
Dark arrows show flow of seed. Dotted arrows show airflow.

Airlock. From the airlock, the seeds drop into the discharge pipe and are conveyed to the discharge cyclone.
- In general, raw material and product loading and discharging points should be near/or/on railway, road or ship area.

- In developed countries, bulk transfers are made using ships in sea, river or channels, and railways. → cheap and easy transport
2. Relation with other support buildings (energy, steam, water, waste treatment etc.)

- **Steam generator** should be found in **separate building** (chimney position is important, the direction of wind should be though due to smoke and gas pollution, process building should be before smoke-chimney.)

- **Water supply**
- **Waste water supply**
- **Energy supply** (trafo)
- **Cooling tower** (important for dirtness to road, corrosion to building and metals etc. No other building should be made near the cooling tower to prevent its wind. Because **tower needs wind to cool water**. The high of tower building is important to supply water by less pump power. Sun position should be evaluated to supply shadow position.)
3. Relation with energy construction, equipment, wire-network, automation lines etc.

- Energy wire-line, network, telephone wire, electricity, camera lines, should be parallel to road. Not cross to building. Spaces between wires and road should be evaluated.
- Between pipes (of wire, in USA wire installed in pipe) ~ 25 mm
- Between steam pipes, hot water: >25 mm
- Water pipe (to prevent freezing) → install inside the soil (h:20 cm)
- Wire, camera wire, internet wire, telephone wire → install to into sand (no concrete over)
- Steam line → into soil or open channel with isolation. The high of pipe on air >5-7 m install, over to over to prevent wide space.
4. Waste-water and waste disposal

- Obtain laws, standards and future plans from government
- Closed pipe should be used
- Waste water treatment building should be far from process building. But, it should be placed near to main discharge channel.
- Pipes should be parallel to roads.
- Slope for pipe and channel should be calculated to prevent plugging.
- Aeration in pipe/channel should be made to prevent gas formation and explosion.
- Channel floe slope should be calculated for Rain water channel (45 mm-150 mm elevation/1 m long)
5. Relation with process administration office and control

- View-point and control points important
- Stairs:
  Inclined stairs (important for labour and control, if it has high slope, peoples will tire).

Height of guard bar: 85 cm
Width of stair: 1-1.2 m

Vertical stairs (Gemici merdiveni):
- for silo-tank
- space between wall of tank= 22.5 cm
- use safety circle-bar (D=122.5 cm)
Small silo-tank

Big tank-silo

Safety circle
CRITICAL POINTS FOR PROCESSING AREA
Roof angle: \(>30^\circ\)  

If it is possible \(\rightarrow\) no windows

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**Electricity, wire channel**

**Piping channel-lines**

**Wall smooth, flat and cleanable**

**Sandwich panell wall can be used**

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**Discharge water channel**

Floor should be hard, smooth and no slip surface for labors. (epoxy, ceramic, acid proof)  
If there is vibration and high heavy machine, this area should be constructed specially.
Inside the building → **positive pressure** should be supplied (use air duct and fans)
(to prevent insect inlet, dust inlet, m.o. İnlet, air control)

**Lighting** is very important
The door site/position of processing building is not cross to/front of wind.
WC/SHOWER/ENTRANCE OF PERSONEL AND HYGENIC CONDITIONS

- WC/SHOWER SHOULD BE POSITIONED WHERE NO CROSS CONTAMINATION (NO DIRECT OPENING INTO PROCESSING LINE)
- PUT AN ENTRANCE SEPARATELY FOR PERSONAL
- CREATE A HYGENIC CORIDOR!!!

Hygiene corridor
- No direct entrance to process area
- WC for lady/gentleman
- Showers
- Hygiene lavatories
- Disinfectance
- Doors to person
Other buildings

- first-aid building
- administration building (no noise, vibration) Manager should see inlet.
- Repair-building
- Lab.
- Security
- Cafe
- WC/Bath
- Kitchen
- Silo/storage building (dark, south position in North of Ecuvator, North on south ecuvator)
- Park area

Cafe, first-aid, resting house should be far from entrance of plant. Green area should be supplied.
Roads/Entrance

All around the site of plant must have to get roads. Railway should be found in the inlet of site

Plant site  
Rail way  

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Space between buildings

\[ W = \frac{(h_1)}{2} \]

Min. 9 m.
## Lighting parameters

<table>
<thead>
<tr>
<th>Process line</th>
<th>Lux.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-classification unit</td>
<td>500</td>
</tr>
<tr>
<td>Color sorting apron</td>
<td>1000-2000</td>
</tr>
<tr>
<td>Separation apron-color</td>
<td>500-1000</td>
</tr>
<tr>
<td>Cutting (by hand)</td>
<td>1000</td>
</tr>
<tr>
<td>Final classification</td>
<td>1000</td>
</tr>
<tr>
<td>Bottling-filling</td>
<td>1000</td>
</tr>
<tr>
<td>Thermometer-indicator area</td>
<td>500</td>
</tr>
<tr>
<td>Labeling area</td>
<td>300</td>
</tr>
<tr>
<td>Storage area</td>
<td></td>
</tr>
<tr>
<td>inactive</td>
<td>50</td>
</tr>
<tr>
<td>active</td>
<td>300</td>
</tr>
<tr>
<td>Office</td>
<td></td>
</tr>
<tr>
<td>active</td>
<td>1500</td>
</tr>
<tr>
<td>kitchen</td>
<td>700</td>
</tr>
<tr>
<td>dining room</td>
<td>1500-2000</td>
</tr>
<tr>
<td>wc-shower</td>
<td>300</td>
</tr>
<tr>
<td>file stock</td>
<td>300</td>
</tr>
</tbody>
</table>
## Areas (approximately)

<table>
<thead>
<tr>
<th>Area</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administration office</td>
<td>10 m²/person</td>
</tr>
<tr>
<td>Repair office/building Lab.</td>
<td>20 m²/technical person</td>
</tr>
<tr>
<td>Lab.</td>
<td>20 &quot; &quot; (also depends on equipment size)</td>
</tr>
<tr>
<td>Cafe</td>
<td>1 m²/person</td>
</tr>
<tr>
<td></td>
<td>3.5 m²/kitchen person</td>
</tr>
<tr>
<td>First-aid</td>
<td>0.1-0.15 m²/labor</td>
</tr>
<tr>
<td>Garage/repair</td>
<td>100 m²/vehicle</td>
</tr>
<tr>
<td>Plant main-road</td>
<td>10 m width</td>
</tr>
<tr>
<td>Plant other road</td>
<td>7.5 m width</td>
</tr>
<tr>
<td>Walking road</td>
<td>1.2 m width (for 10 person/1 min pass)</td>
</tr>
<tr>
<td>Road Corner</td>
<td>90° return corner (dia. 11 m)</td>
</tr>
<tr>
<td></td>
<td>T-cross (dia. 7.5 m)</td>
</tr>
<tr>
<td></td>
<td>Small road (dia. 4 m)</td>
</tr>
<tr>
<td>Min. Railway circle</td>
<td>56 m (inside circle diameter)</td>
</tr>
<tr>
<td>Cooling tower</td>
<td>0.04 m²/kWh (mechanic suction)</td>
</tr>
<tr>
<td></td>
<td>0.008 m²/kWh (natural suction)</td>
</tr>
</tbody>
</table>
The OSHA (in USA) has standards for hazardous materials that give the minimum distances between containers and the distance between these items and the property line, public roads, and buildings.

### Clearances for Preliminary Layout

<table>
<thead>
<tr>
<th>Clearance, Ft.*</th>
<th>H</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main roads to battery limits (BL)</td>
<td>30</td>
<td>18</td>
</tr>
<tr>
<td>Secondary roads, accessways to BL</td>
<td>25</td>
<td>16</td>
</tr>
<tr>
<td>Railroads to BL</td>
<td>50</td>
<td>23</td>
</tr>
<tr>
<td>Main pipe rack (accessway under)</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>Secondary pipe rack</td>
<td><strong>10</strong></td>
<td>12</td>
</tr>
<tr>
<td>All other overhead piping</td>
<td>—</td>
<td>7</td>
</tr>
<tr>
<td>Clearance between:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small pump bases, &lt; 25 hp</td>
<td>2½</td>
<td>12</td>
</tr>
<tr>
<td>Large pump bases, &gt; 25 hp</td>
<td>3</td>
<td>14</td>
</tr>
<tr>
<td>Compressors and nearest equipment</td>
<td>10</td>
<td>†</td>
</tr>
<tr>
<td>Adjacent vertical vessels</td>
<td><strong>10</strong></td>
<td>—</td>
</tr>
<tr>
<td>Adjacent horiz. vessels, &lt; 10-ft. dia</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Adjacent horiz. vessels, &gt; 10-ft. dia</td>
<td>8</td>
<td>—</td>
</tr>
<tr>
<td>Adjacent horiz. heat exchangers</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Shell of fired heater and nearest equipment</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Control houses and reactor or main equipment structures</td>
<td>30</td>
<td></td>
</tr>
</tbody>
</table>

* H = Horizontal, 0 = Overhead
† As needed for maintenance

Some correlations (limiting factors) for plant layout

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Space for security</th>
<th>Space on equipment and both sides</th>
<th>Building constructional and processing start-up space</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crusher, mill, centrifuge</td>
<td>Both side</td>
<td>Horztl. 2m+1</td>
<td>Working road 5m</td>
</tr>
<tr>
<td>Dryer</td>
<td>1.5 m+1</td>
<td>2m+1</td>
<td>wall of building 2.5 m</td>
</tr>
<tr>
<td>Tower etc.</td>
<td>1.5 m</td>
<td></td>
<td>Near to column 3m</td>
</tr>
<tr>
<td>Boiler, steam oven</td>
<td>15 m to dangerous area</td>
<td>1.5 m</td>
<td>2 x width of boiler</td>
</tr>
</tbody>
</table>
Kettle/jacketed heat exchanger
15 m to dangerous place
1.5 m
3m+1
4m for working area
40 m²/30 m³ volume kettle

Horizontal heat exchanger
1.5 m+1
2 m from kovan
1.5 from side

Silo tank
15 m to dangerous area
space 3m
between two tank
½ of tank diameter

Pump
from motor side=2m
other side =1.5 m

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<table>
<thead>
<tr>
<th>Component</th>
<th>Width</th>
<th>Height</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filter</td>
<td>-</td>
<td>1.5 m+1</td>
<td>-</td>
</tr>
<tr>
<td>Compressor</td>
<td>-</td>
<td>1.5 m+1</td>
<td>3 m+1, for series system</td>
</tr>
</tbody>
</table>

For series system, the space between two compressors is 2 x width of compressor.
Criticals for plant-layouts

- Always ask 5W-1H (why, where, what, when, who, how→ to find alternatives; how install? Another where?)
- Prepare alternative plans/project to find the best.
- Discuss with the others? Experts.
- Prepare 2D projects (top, left, oblique)
- Make a scale model (3D) and discuss scenario (inlet-otlet of raw-processed products, labors, maintenance etc.)
- Prepare 3D drawing
- Make
  - correlation and use suitability techniques
  - correlation chart (used for limiting factors)
  - process flow chart&cost charting
  - possibility analysis (2D-3D)
  - ordering- step-by-step analysis
Coloring in drawing
(In general)

- Roads: Black
- Electric motor: Orange
- Pump, compressor, equipment, machine: Black
- Metal apparatus (air conditioning): Gray
- Consol-support: Black
- Concrete: Brown-yellow mix
- Platform and metal roads: Silver, gray
- Heat exchanger
  - Isolated: White
  - No isolated: Gray
Piping

Process lines/pipe: red
Steam: yellow
LPG/Natural gas: yellow
Water: Green
Chilled water: blue
Chemical water (CIP): orange
Pressurized air line: white

Showing piping – cable – network system
HINTS

• Groups all same machines in the plant area (to supply good control and maintenance, piping easy)

• EVERYTIME, FIRSTLY SOLVE PROBLEMS ON DESK, PREPARE PROJECT AND THEN-FINALLY APPLY IN PLANT.-→ TO BE ENGINEER!!!
DRAWING

• By hand or CAD programs (Autocad, Solid Edge, Cathia)
• 2D (top for installation, left for processing flow chart and determine elevation) or 3D
• Use scale as 1/50, 1/100, 1/1000 etc.
• Always show North-East-South-West positions.
Some important detail drawings (You need them!!)

• Drawing for machines (top, left etc.)
• Drawing for holes (important for multifloors; semolina, flour)
• Drawing for electricity, cables, automation lines
• Drawing for steam lines
• Drawing for gas lines
• Drawing for water lines
• Drawing for air lines
• Drawing for waste water lines
• Drawing for hygenic consideration (inlet-outlet scenario)
• Don’t forget expansion area in the drawings!!!
Elevation
If there is no special reason for elevating equipment, it should be placed on the ground level. The superstructure to support an elevated piece of equipment is expensive. It can also be a hazard should there be an earthquake, fire, or explosion. Then it might collapse and destroy the equipment it is supporting as well as that nearby.

Other pieces may have to be elevated to enable the system to operate. A steam jet ejector with an intercondenser that is used to produce a vacuum must be located above a 34 ft (10 m) barometric leg. Condensate receivers and holding tanks frequently must be located high enough to provide an adequate net positive suction head (NPSH) for the pump below. For many pumps an NPSH of at least 14 ft (4.2 m) H2O is desirable. Others can operate when the NPSH is only 6 ft (2 m) H2O.
Railroads, Roadways, and Pipe Racks
The main purpose of railroads is to provide an inexpensive means for obtaining raw materials and for shipping products. This means that they should be close to raw material and/or product storage. Buildings and loading docks should be set back 8 ft (2.4 m) from the center of the railroad track. Spurs and switches should be laid out with a 100 ft. (30 m) radius.

All roadways that are used frequently should be blacktopped. They should be 20 ft (6 m) wide to allow two-way traffic. All turns should have a minimum inner radius of curvature of 20 ft (6 m) and a minimum outer radius of 40 ft (12 m) to provide adequate turning room for large trucks.
Planning for Future Expansion and Improvements
In the last chapter the design of equipment for proposed future expansions was discussed. Obviously, if the equipment has been overdesigned to meet the anticipated future expansion, no extra space needs to be provided. If, however, additional equipment will be required, space should be allocated for it. The net result will be an increase in the initial cost of construction and some increase in material transfer costs, because the transfer lines will be longer. Robertson cited a cost increase of 3% in the initial cost of building a plant if the linear distance between all parts was increased 25%. With such a small increase in costs, even when an expansion is not planned it is usually wise to allow plenty of space between units. This will permit the plant engineers to install improvements in the future to increase yields, eliminate bottlenecks, and improve the stability of the process. These improvements cannot be anticipated where extra space will be needed.
Warehouse
The engineer must decide whether warehouses should be at ground level or at dock level. The latter facilitates loading trains and trucks, but costs 1520% more than one placed on the ground. It is usually difficult to justify the added expense of a dock-high warehouse. To size the amount of space needed for a warehouse, it must be determined how much is to be stored in what size containers. The container sizes that will be used are obtained from the scope. Liquids are generally stored in bulk containers. No more than a week’s supply of liquid stored in drums should be planned. Solids, on the other hand, are frequently stored in smaller containers or in a pile on the ground. Having decided what is to be stored in a warehouse, the engineer can now approximately size it. For instance, suppose he has decided to store the product in 50lb (23 kg) bags. These are usually stored on pallets that contain 5 bags on each of 8 rows. This means each pallet contains 2,000 pounds (900 kg) of material. If a fork-lift truck is used, these can be stacked 3 pallets high, in rows about 3 deep. If they are stacked higher they tend to be unstable. The standard pallet sizes are given in Table 6-6. The most common size is 40 x 48 in (107 x 122 cm). The rows must be 1 ft (0.3 m) apart in order to permit fork lifts to operate properly. This information is used to size a plant in the example below.
Automatic storage and retrieving equipment can substantially cut down on storage space and the number of operators needed. It is especially useful where there is a large variety of products.
<table>
<thead>
<tr>
<th>Inches</th>
<th>Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 x 32</td>
<td>48 x 60</td>
</tr>
<tr>
<td>32 x 40</td>
<td>48 x 72</td>
</tr>
<tr>
<td>36 x 42</td>
<td>36 x 36</td>
</tr>
<tr>
<td>32 x 48</td>
<td>42 x 42</td>
</tr>
<tr>
<td>36 x 48</td>
<td>48 x 48</td>
</tr>
<tr>
<td>40 x 48*</td>
<td></td>
</tr>
</tbody>
</table>
Control Rooms
The control center(s) and the electrical switching room are always located in an enclosed building. It is important that both of these services be maintained so that the plant can be shut down in an orderly manner in the case of an emergency. Therefore these buildings must be built so that should an external explosion occur the room will not collapse and destroy the control center and switching center. To avoid this, either the structure must have 3-4 ft (1-1.2 m) thick walls, or the roof must be supported independently of the walls. The Humble Oil and Refining Co. has specified that the building withstand a 400 psf (2,000 kg / m²) external explosive force. To keep any flammable or explosive vapors from entering the building, it is frequently slightly pressurized. This prevents the possibility of an internal explosion.
1- Flow diagram/Side view

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-Dr. M. BAYRAM
2- P&ID Diagram
3- 2D- Top view of site-layout including building and facilities etc. (should be scaled. show all dimensions)
4- 2D- Top view of process line/building details (show all floors) (should be scaled, show all dimensions)
5- Optional-3D drawing or simulation
VERY IMPORTANT:
IN YOUR DESIGN PROJECT PRESENTATION AND REPORT:
The followings should be submitted.
- P&ID Diagram (YOU WILL DRAW THIS FOR YOUR PROJECT
(Fe 467 Design II) The details of PID will be learned at FE 403
Food Process Control

1- Flow diagram/Side view (Scaled!!!)

2- 2D- Top view of site-layout including building and facilities etc.
(should be scaled, show all dimensions) (Scaled!!!)

3- 2D- Top view of process line/building details (show all floors)
(should be scaled, show all dimensions) (Scaled!!!)

4- 3D drawing or simulation (Scaled!!!)
CASE STUDY 
(IN-CLASS WORKSHOP)

• PREPARE AN IDEAL PLANT LAYOUT
  – Pasteurized milk line
    • Step 1: Flowchart
    • Step 2: Side-view Flowdiagram (by showing steam/water etc. Lines)
    • Top view (Site and Plant layout)