# P12

# Increasing Without Expanding

E212 - Facilities Planning and Design

SCHOOL OF ENGINEERING

# Warehousing Storage

Storage and warehousing resources are space, equipment and personnel.

In designing storage and warehousing systems, it is desirable to maximize:

a. Space utilization
b. Equipment utilization
c. Labor utilization
d. Material accessibility
e. Material protection

# Warehousing Storage

Example of a Storage Analysis Chart used in calculating space requirements

Date September 14, 1997 Raw Materials X

In-Process Goods _____
Company J.D.S., Inc.
Prepared by B. Hudock Sheet 1 of 1 Plant Supplies _____
Finished Goods _____

Unit Loads Quantity of Unit Loads Stores Storage

Space _____

| Description (1) | Type (2) | Capacity (3) | Size (4) | Weight (5) | Maximum (6) | Average (7) | Planned (8) | Method (9) | Specs (10) | Area $ft^2$ (11) | Ceiling Height Required ft (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Aluminum rails, three runner 288' | Bundles | 50 pcs. | 18" × 28' × 288' | 1250 lbs. | 14 | 5 | 12 | Cantilever rack | Four-arm dual rack, 4' × 12' × 6' | 192 | 24 |
| Glass, 1/4" thick, 8' × 4' sheets | Racks | 4 sheets | 8' × 4' × 4' | 400 lbs. | 20 | 13 | 15 | Pallet rack | 4' × 4' × 22' (4 levels) | 240 | 24 |
| Rubber Stripping 1/8" square | Cartons | 500 feet | 12" × 4" × 12" | 20 lbs. | 20 | 12 | 8 | Industrial Shelving | 5 level 42" × 18" shelves | 12 | 9 |

# Warehousing Storage

There are 2 major material storage philosophies:

1. Fixed (assigned) location storage
   - each individual stock-keeping unit (SKU) is stored in a specific location
   - no other SKU may be stored there, even though the location may be empty

2. Random (floating) location storage
   - any SKU may be assigned to any available storage location
   - a SKU stored in location 1 might be stored in location 2 the following month and a different SKU stored in location 1

The amount of space planned for a SKU is directly related to the method of assigning space.

# Warehousing Storage

A space standard is the volume requirement per unit load stored to include allocated space for aisles and non-usable space.

Total warehouse volume = Storage space + Aisleway space + Non-usable space

Space standard = Total warehouse volume /Total unit load quantity

# Aisle Space Requirement

Dependent on the type of material handling equipment

Recommended aisle width for various types of flow

| Type of Flow | Aisle Width (feet) |
|---|---|
| Tractors | 12 |
| 3-ton Forklift | 11 |
| 2-ton Forklift | 10 |
| 1-ton Forklift | 9 |
| Narrow aisle truck | 6 |
| Manual platform truck | 5 |
| Personnel | 3 |
| Personnel with doors opening in the aisle from one side | 6 |
| Personnel with doors opening in the aisle from two sides | 8 |

# Other Considerations (Material Handling Selection)

- Indoor vs Outdoor use
- Lift Capacity and Lift Height
- Manual vs Automated
- System requirement e.g. guidance system
- Cost

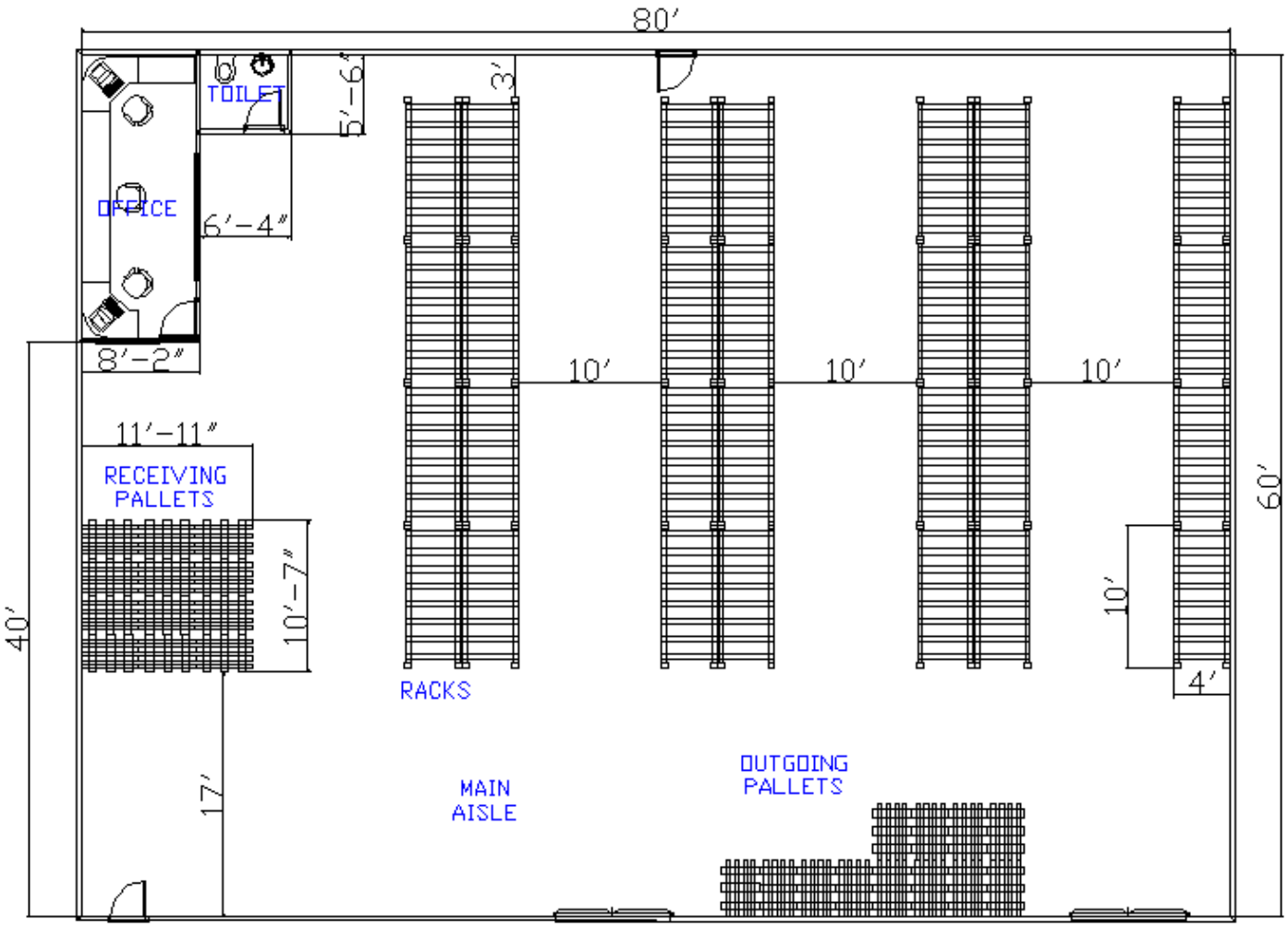
# Suggested Solution:


note: symbolic notation for foot – (ft.) or ( ’ )
symbolic notation for inch – (in.) or ( ” )

1’ = 12” (1 feet = 12 inches)

# For Existing Warehouse Layout

(205.7 cubic ft per unit load)




Use 1-ton forklift

The aisle width between racks (10’) is more than enough for the recommended width of 9’.

Main aisle width is 17’.

Total of 28 racks used.

# For Existing Warehouse Layout

Storage quantity per stack (18’ height)

= 18’ / 3.1’ = 5.8 = max 5 unit loads/stack

Number of stacks per rack

= 10’ / 3’ = 3.3 = max 3 stacks/rack

So, Total unit loads per rack = 15

Total number of racks = 28

Maximum number of unit loads that can be stored in warehouse

= 5 unit load/stack x 3 stack/rack x 28 racks

= 420 unit loads

Assumptions:

1. The office, toilet, receiving pallets area, outgoing pallet areas are non-usable space
2. Forklift can be parked at any aisle in the warehouse.
3. Storage assignment is not location-specific
4. Total horizontal clearance allowance between stacks is 1 foot for each length of rack (10 feet)

# For Existing Warehouse Layout

Total storage space (based on 18 feet stack height)
= Individual rack volume x Number of racks
= 10’ x 4’ x 18’ x 28
= 20160 cubic ft. (symbolic notation: $ft.^3$)

Total warehouse space (based on 18 feet stack height)
= Length x Breadth x Height
= 80’ x 60’ x 18’
= 86400 $ft.^3$

Total non-usable space (based on 18 feet full height)
= Toilet space + Office space + Receiving & Outgoing pallets space
= (6’ 4”x 5’ 6” + 20’ x 8’ 2” + 2 x 10’ 7” x 11’ 11”) x 18’
= (6.333’x5.500’ + 20’x8.166’ + 2x10.583’x11.916’) X 18’
= (34.832’ + 163.320’ + 2 x 126.107’) X 18’
= (450.366’’) X 18’
= 8106.59 cubic ft.

# For Existing Warehouse Layout

Total space allocated to aisles

= Total warehouse space – Total available storage space – Non-usable space

= 86400 – 20160 – 8106.59

= 58133.41 cubic ft

Space Standard = Total warehouse space /Total number of unit load

= 86400 / 420

= 205.71 $ft.^3$ / unit load

The space standard of the current warehouse layout has exceeded the company's requirements of < 150 $ft.^3$ / unit load

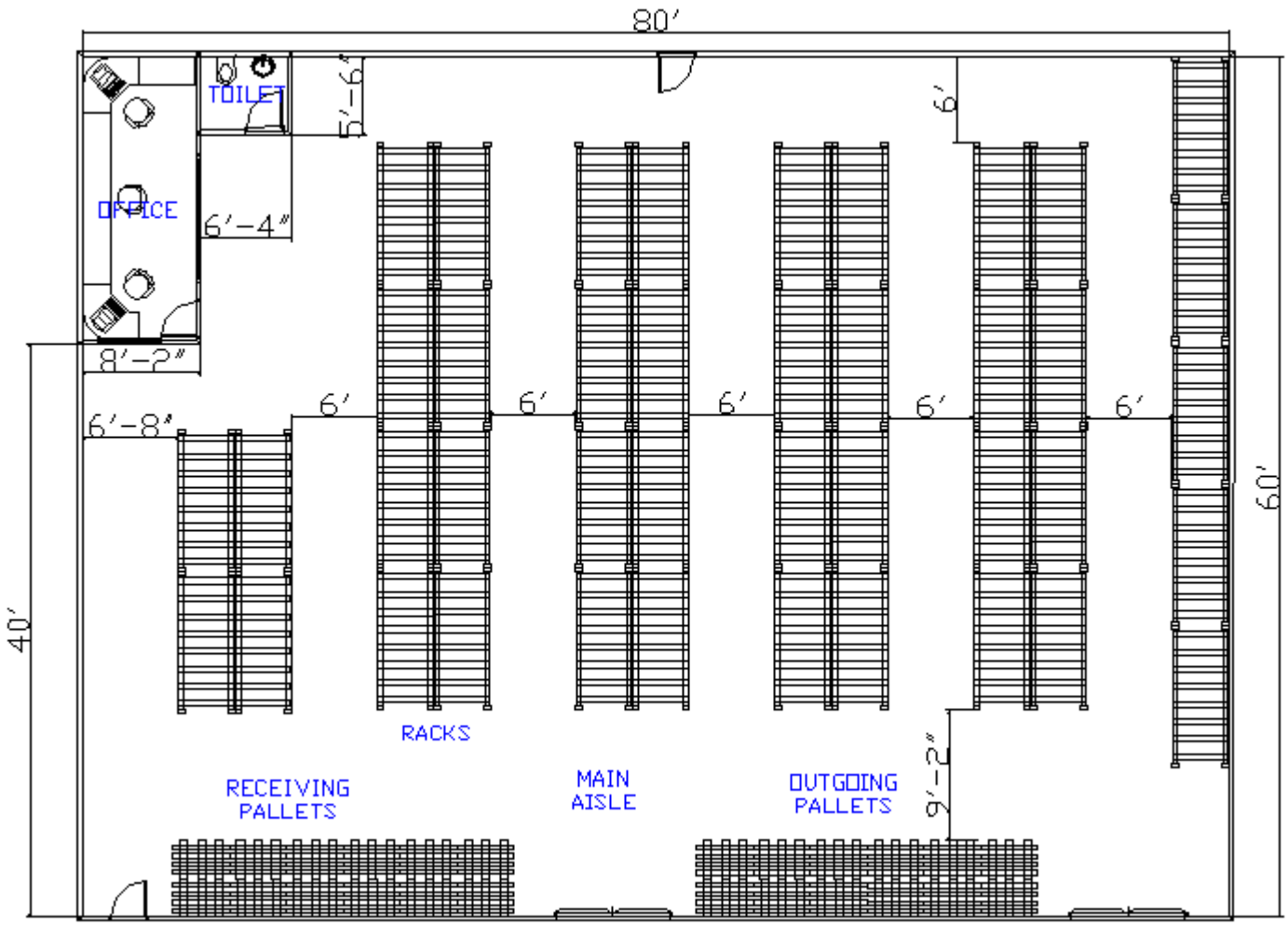
Percentage loss in space utilization due to aisles

= [Total space due to aisles / Total warehouse space] x 100%

= [58131.77 / 86400] x 100%

= 67.28%

# New Proposed Warehouse Layout
## (<150 cubic feet per unit load)




Use narrow aisle truck

The aisle width between racks will be based on the recommended value of 6’

Main aisle width is 9’ - 2” instead of 17’.

Total of 41racks used.

# New Proposed Warehouse Layout

Existing rack design will still be used.
Storage quantity per stack (18’ height)
= 18’ / 3.1’ = 5.8 = max 5 unit loads/stack
Number of stacks per rack
= 10’ / 3’ = 3.3 = max 3 stacks/rack
So, Total unit loads per rack = 15

Total number of racks for new layout = 41
Maximum number of unit loads that can be stored in warehouse
= 15 x 41 racks
= 615 unit loads

Assumptions:
1. The office, toilet, receiving pallets area, outgoing pallet areas are non-usable space
2. The narrow aisle truck is within the specifications and can be parked at any spaces.
3. Storage assignment is not location-specific
4. Total horizontal clearance allowance between stacks is 1 foot for whole length of rack (10 feet)

# New Proposed Warehouse Layout

Total storage space (based on 18 feet stack height)
= Individual rack volume x Number of racks
= 10’ x 4’ x 18’ x 41
= 29520 $ft.^3$

Total warehouse space (based on 18 feet stack height)
= Length x Breadth x Height
= 80’ x 60’ x 18’
= 86400 $ft.^3$

Total non-usable space (based on 18 feet full height)
= Toilet space + Office space + Receiving & Outgoing pallets space
= (6’ 4”x 5’ 6” + 20’ x 8’ 2” + 2 x 10’ 7” x 11’ 11”) x 18’
= (6.333’x5.500’ + 20’x8.166’ + 2x10.583’x11.916’) X 18’
= (34.832’ + 163.320’ + 2 x 126.107’) X 18’
= (450.366’’) X 18’
= 8106.59 cubic ft.

# New Proposed Warehouse Layout

Total space allocated to aisles

= Total warehouse space – Total available storage space – Non-usable space

= 86400 – 29520 – 8106.59

= 48773.41 cubic ft

Percentage loss in space utilization due to aisles

= [Total space due to aisles / Total warehouse space] x 100%

= [48773.41 / 86400] x 100%

= 56.45%.

Space Standard = Total warehouse space /Total number of unit load

= 86400 / 615

= 140.49 ft.$^3$/ unit load

The space standard of the proposed new layout will meet the corporate requirements of < 150 cubic ft / unit load

# New Proposed Warehouse Layout

Layout factors that support fulfilling of space standard:

Layout factors that support fulfilling of space standard:

1. Use of narrow-aisle truck in place of forklift, resulting in lower loss in space utilization
2. Minimal or no wasted spaces
3. Increasing the number of storage racks within the same space, leading to higher capacity

Note that these factors are inter-related.

# Learning Objectives

- Determine warehouse storage efficiency by understanding and assessing Space Standard.
- Determine the storage area profiling based on storage capacity required and types of unit load.
- Achieve increased warehouse storage capacity through facilities re-layout, without the needs of floor area expansion.