DC Layout & Design Best Practices

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Agenda

- DC Best Practices
- MHE & Storage Equipment
- A/E Design Factors

Warehouse Best Practices

Warehouse Volume vs. Technology

Low Volume

- Tier 3 WMS
- Picking-paper directed
- Rider truck / cart picking
- Hand picking from flow rack, shelving or decked racking
- Discrete order picking
- 1+ storage fixture types
- Manual consolidation

Medium Volume

- Tier 2 WMS
- Radio frequency
- Pick & pass (zone route)
- 2+ storage fixture types
- Small batch picking
- Pick to light or voice directed
- Carousels
- Sliding shoe sorter

High Volume

- Tier 1 WMS
- More automation-hybrid
- Radio frequency
- Wave picking
- Higher speed conveyors
- Increased versatility
- 3+ storage fixture types
- Greater accumulation
- Cross belt & tilt tray

Storage Equipment Best Practices

1. Select storage rack based on SKU inventory profiles.
2. Select forward pick racks using 1 to 2 weeks of cubic velocity (quantity picked x product size).
3. Consider line velocity (hits, picks, or trips to product location) for material handling and placement in DC.
4. Provide effective pallet load lift-off space (3" to 6").
5. Provide minimum rack to rack flue space (12" to 18").
6. Utilize full clear height of building (~18" below lowest point).
7. Bridge cross-aisles for more storage capacity.
8. Most effective DCs have 2 to 3 rack types.

Layout Best Practices

1. ‘Spaghetti Value Mapping’ to identify opportunities to minimize travel distances and improve material flow
2. Minimize product touches / hand-offs
3. Bury columns within rack flue
4. Align racking in longest direction and along outer walls
5. Aisle length less than 250’ and no dead-end aisles
6. Consider width and number of aisles to maximize floor space
7. Match aisle width with products and trucks
8. Determine effective bay spacing
9. Receiving / Shipping on same-side of facility for best use of space
10. Plan for efficient future expansions

Identifying DC Opportunities

1. Product staged in aisle ways – dock too small
2. Only one primary rack type – typically 3 – 4 rack types
3. 72” high pallet positions with 48” high pallets – wrong type
4. Piece-pick from full pallet positions – wrong method
5. Poor cube utilization within facility – lower capacity
6. Empty or < 50% utilized pick positions – slotting
7. Operator congestion in aisle ways / pick aisles – slotting
8. Operator excessive bending during picking – slotting
9. Paper picking – lower productivity

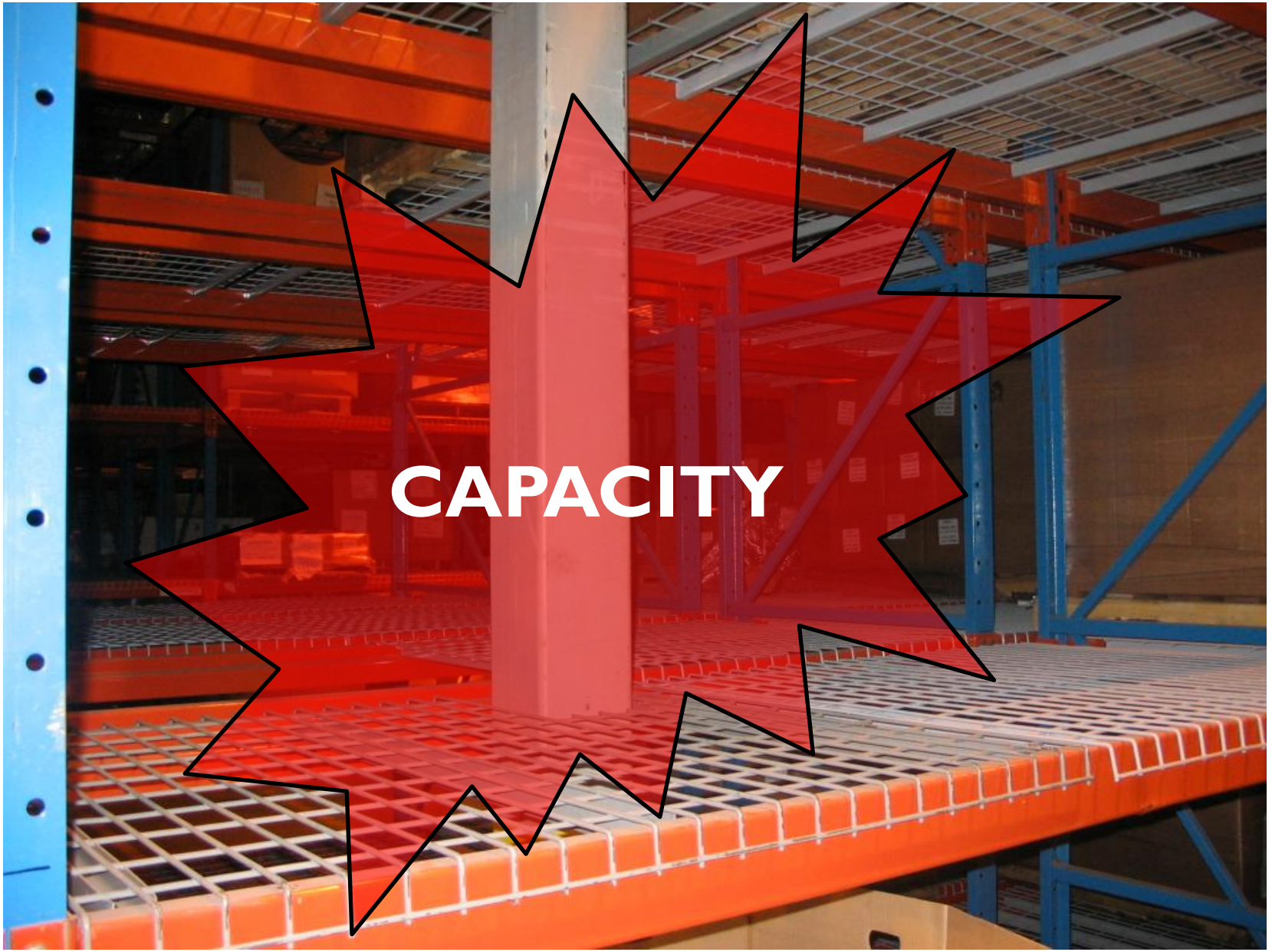

Qty. = 2
W/O CANGX402530
THIS
SIDE
UP
HEAVY
FRAGILE
HANDLE
WITH CARE
DAMAGE
ERRORS


WASTE
SPACE


SAFETY


SAFETY


SAFETY


CAPACITY


SAFETY

Storage & Pick Equipment

Bulk Floor Storage

- Least expensive deep storage; no storage equipment cost
- Provides very dense storage

CONS

- Pallets must be able to stack without damage
- Typically, limited stack height
- Same SKU per lane
- Honeycombing reduces effective storage
- Re-warehousing is required to optimize effective space use

Drive-in / Through Rack

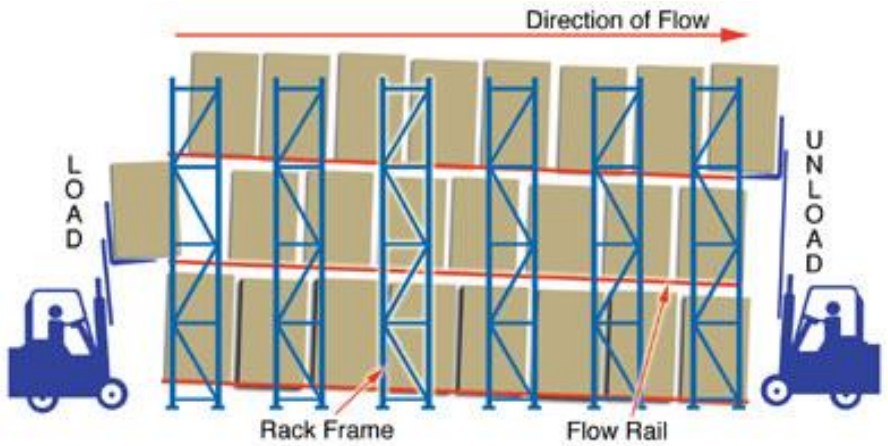
- 4+ pallets deep *x* 4 – 5 high
- Can stack higher than bulk stacks without damage

CONS

- Most miss-used rack type
- Must be single SKU per lane
- Requires standardized pallets in good condition
- Allows less overhang
- Requires good lift truck drivers
- Difficult to keep FIFO

Pallet Flow Rack

- Maintains FIFO
- Forward Picking
  - 2 – 3 pallets deep
  - Floor level only
  - Multiple floors / Module
- Reserve Storage
  - 4+ pallets deep
  - Multiple rack levels



CONS

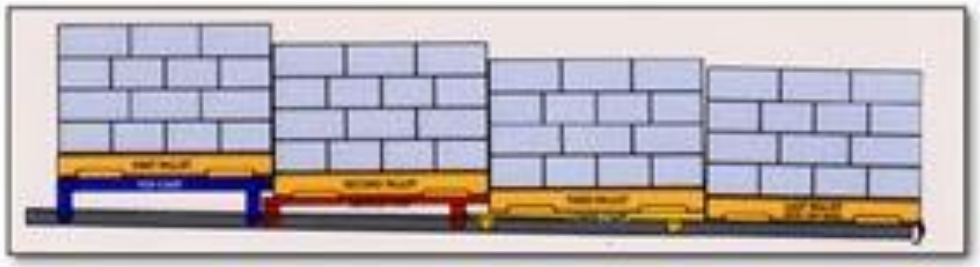
- One SKU per lane
- Slope requires headroom
- Requires front and rear access
- Pallets hung-up

Push Back Rack

- 2 – 5+ pallets deep
- Can be back-to-back
- One SKU per location

CONS

- Requires headroom due to slope
- Cost can be an issue
- Maintenance
- Pallets hung-up

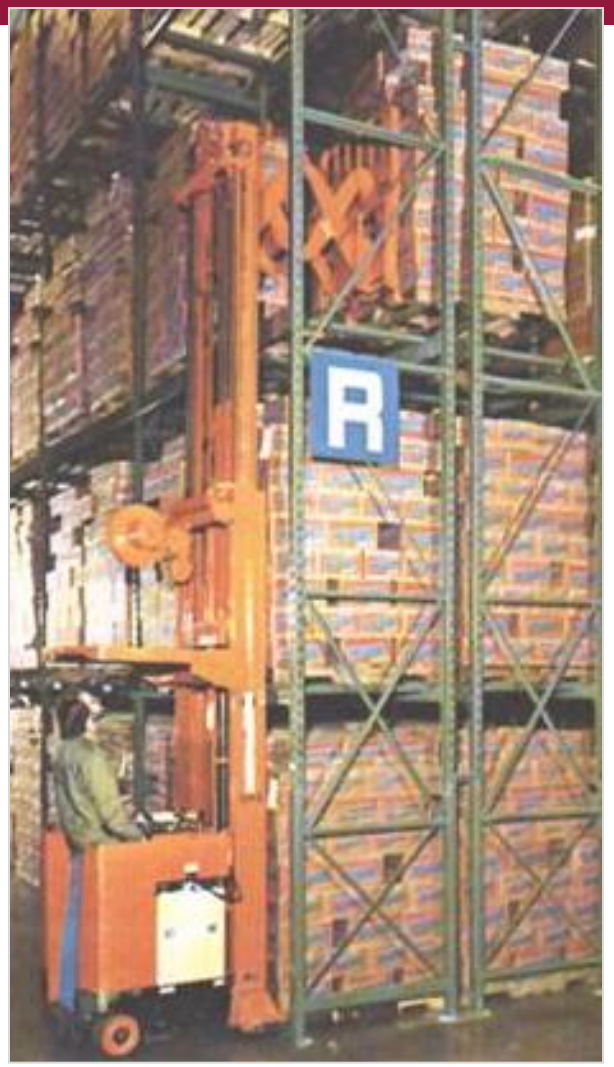


Double Deep Pallet Rack

- 5 to 10 pallets / SKU
- Provides greater density than selective, fewer aisles

CONS

- Requires deep reach truck
- Both pallets in a slot should be the same, less flexibility



Single Deep Pallet Rack

- 1 to 5 pallets / SKU
- Most used in industry
- Access to every pallet
- Very flexible
- Deck for flexibility

CON

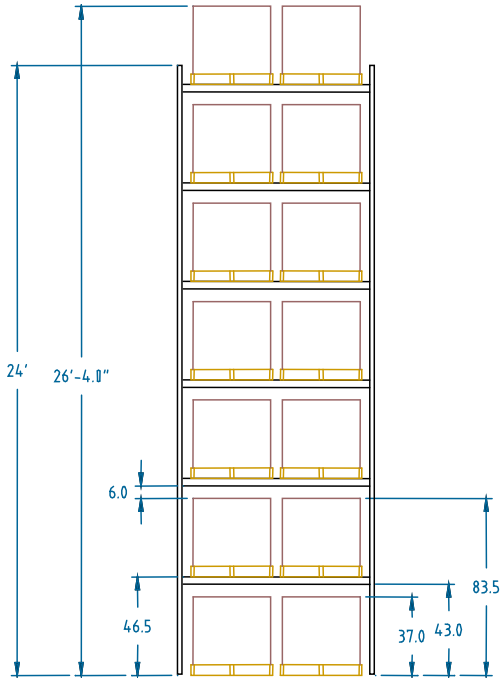
- Requires the most aisles

Decked Pallet Rack

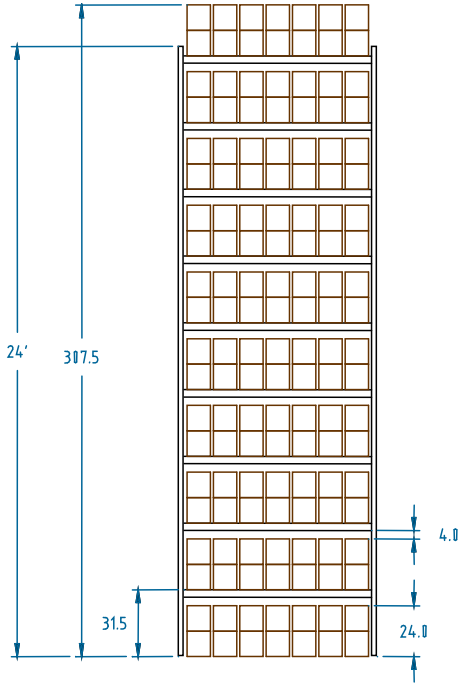
- 0.25 to 1 pallets / SKU
- 36”-42” location depth
- Various location heights
- Increase SKU positions
- Access to every position
- Very flexible
- Handle with order picker

CON

- Requires the most aisles
- More location consolidation



Partial Rack



Decked Rack

Wide-Span High-Bay Shelving

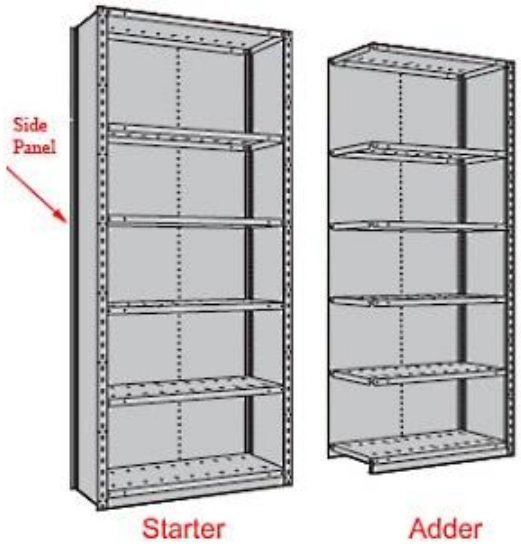
- 8 -16 cu ft / SKU
- 18”-24” location depth
- Various location heights
- Increase SKU positions
- Access to each position
- Very flexible
- Handle with order picker

CON

- Requires the aisles

High-Bay Steel Shelving

- 4 -16 cu ft / SKU
- 12”-24” location depth
- Various location heights
- 8’ to 24’+ bay height
- Access to each position
- Very flexible
- Handle with order picker

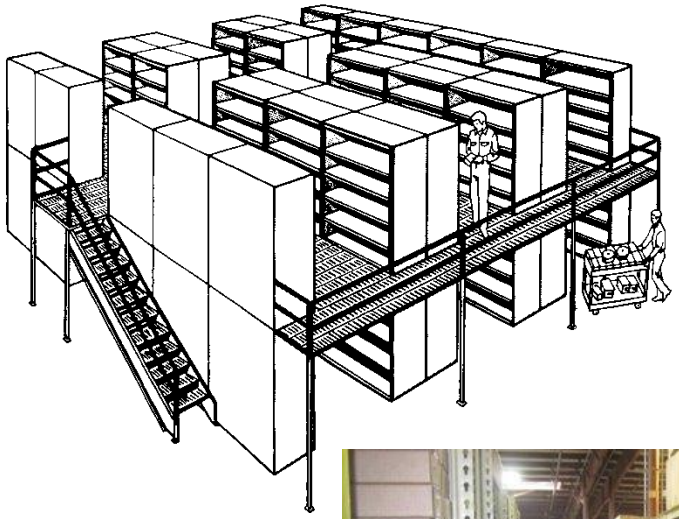


CON

- Requires the aisles
- Less durable

Shelving Mezzanine

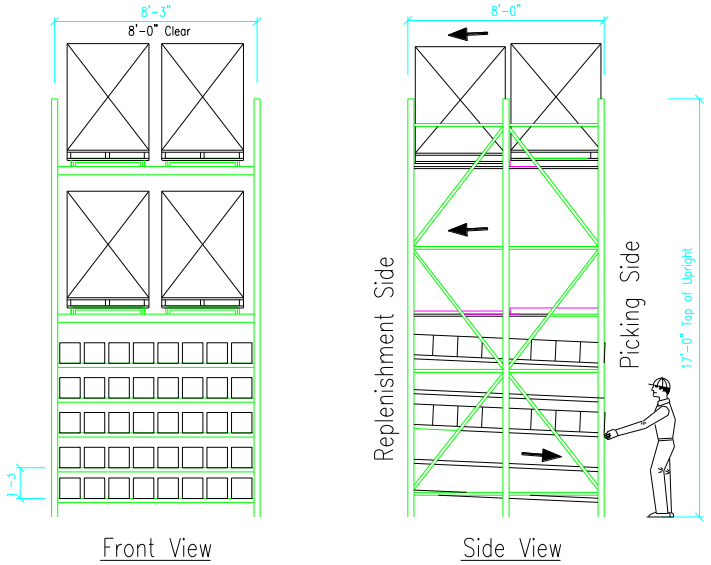
- 4 -16 cu ft / SKU
- 12”-24” location depth
- Various location heights
- 8’ to 9’ bay height
- Access to each position
- Pick cart or conveyor



CON

- Requires the aisles

Carton Flow Rack



Carton Flow Rack

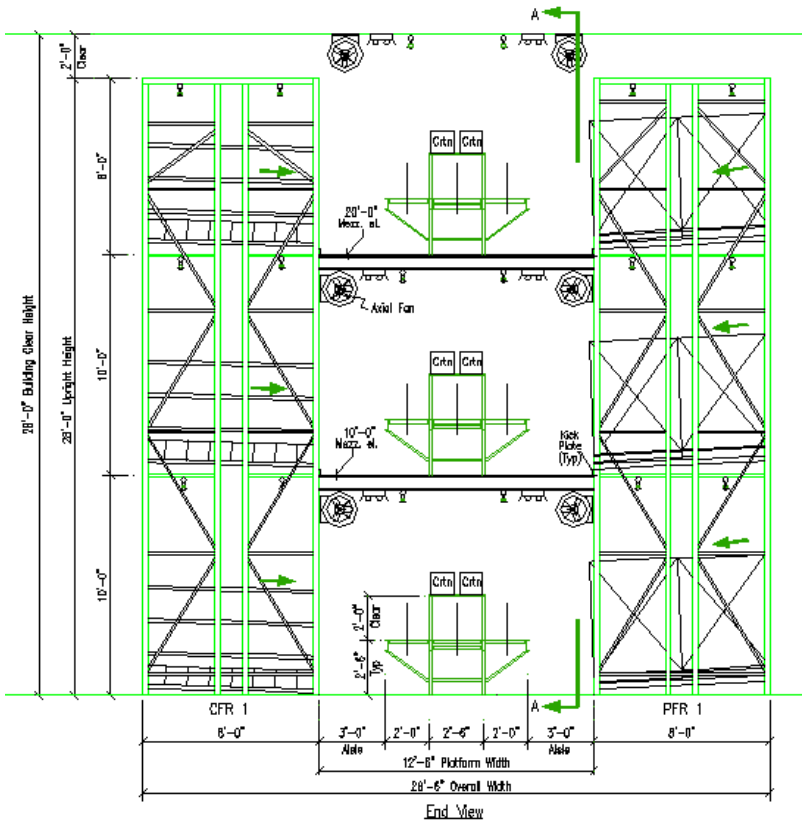
- Replenish from back aisle
- Typically 3' to 12' deep
- Often integrate Pick-to-Light
- Medium cube / day movement
- Fast lines / day movement

Carton Flow – Push Back Above

- Good use of vertical space

3 Level Pick Module

Combining pallet and carton flow rack within a 3-level pick module is a common order fulfillment practice. For example:



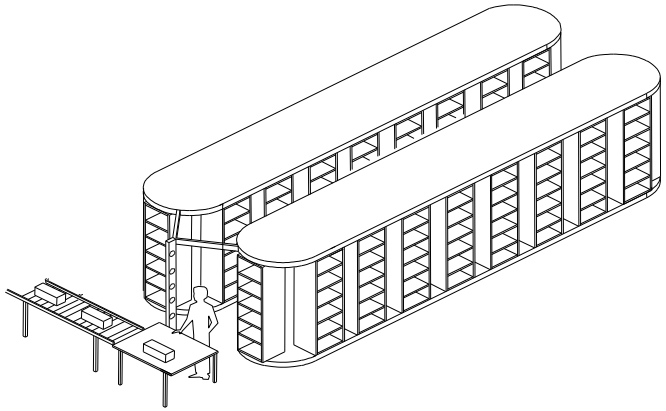
2 Aisle Module

1 Aisle Module

Horizontal Carousels

Horizontal Carousel

- Part-to-operator technology
- Low cube / day movement
- Medium lines / day movement
- Handles various item dims / weight



Warehouse A/E Design Best Practices

A/E Best Practice Areas

1. Architectural Design
2. Structural Considerations
3. Floor Slabs
4. Lighting
5. Fire Protection
6. Sustainability
7. Security

Architectural Design

Getting Started-Due Diligence-Bridging Documents

1. Develop conceptual site plan and floor plan that reflects the results of the logistical analysis.
2. Establish the basics – people, hours, conditioned areas, traffic volume.
3. Conduct project code review and pre-application meetings with Building and Fire Departments.
4. What are the "drivers' of the project.
5. Development architectural covenants and/or landlord requirements.
6. Owner preferences – preliminary outline specifications.
7. Survey and geotechnical analysis.

Architectural Design (cont.)

Getting Started (continued)

8. Expectation for your budget and schedule and share them with the design team.
9. Schematics for Architectural, Structural, HVAC, Plumbing, Electrical, Refrigeration.
10. Options for areas of uncertainty or to better evaluate design alternatives.
11. Clearly establish who is the point of contact and who is the decision maker on the project.
12. Insurance carrier requirements (including FM Global).

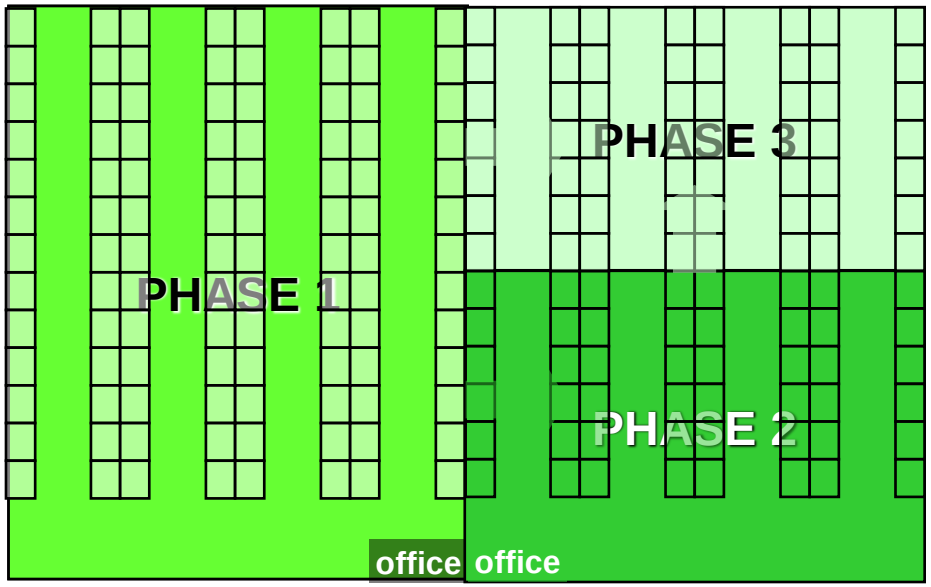
Architectural Design (cont.)

Important Tips

1. Get drawings from material handling and storage providers before turning the conceptual layout into an architectural background.
2. Devote special attention to the design of the shipping and receiving dock doors and dock equipment… they are the valves into and out of your facility.
3. Consider your exit strategy should you need to sell the facility in the future and design accordingly.
4. Always plan for expansion but let the expansion pay for itself wherever possible.

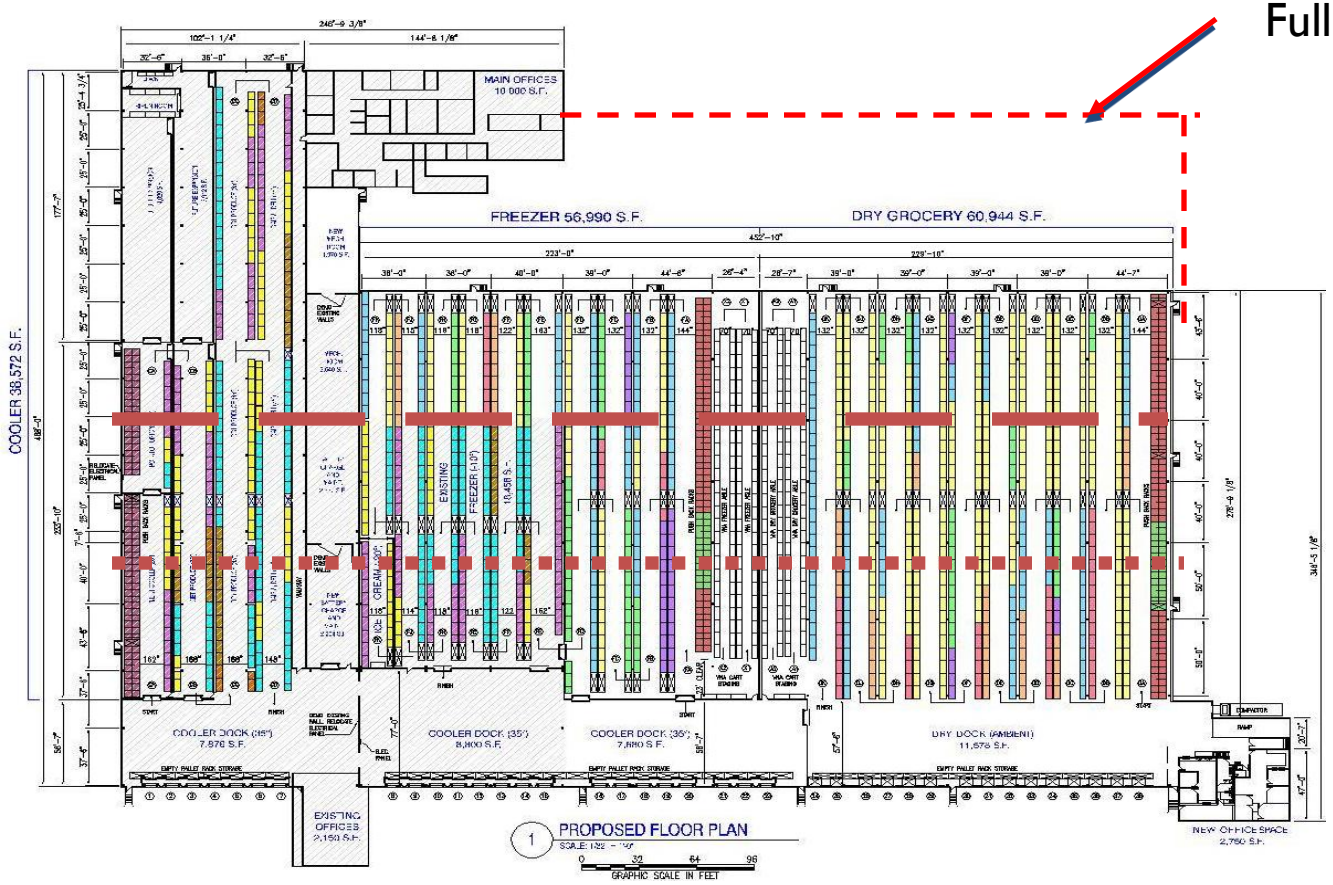
Plan for Expansion

1. Consider full build-out plan and place obstacles like structural bracing accordingly.
2. Locate maintenance, battery charging, office and other support areas convenient in phase one and at full build-out.
3. Avoid isolating large roof top equipment with expansions that may require crane access in the future.
4. Minimize internal walls.
5. Watch the roofline.
6. Option of convertible freezers.



Plan for Expansion

Example - Ridge line runs long way on building, but set at mid point of full build out, not phase one.



Structural Considerations

Structural Systems

- Conventional Steel
- Pre-Engineered Metal Building
- Tilt-up or Precast Members/Walls

Structural Considerations (cont.)

Foundations v. Bay size comparison

Bay size	Found. Size	sf	Concrete mat'l	Rebar	Eqpt	Labor & OH	Steel Assembly	ASSEMBLY TOTAL	$/SF
40x40	6x6x1.33	1600	321.67	36.00	150.00	400.00	8,216.00	$ **9,123.67**	$ **5.70**
40x40 HC	7x7x2	1600	553.70	98.00	150.00	450.00	8,248.00	$ **9,499.70**	$ **5.94**
40x50	7x7x1.33	2000	401.71	36.00	150.00	400.00	10,060.00	$ **11,047.71**	$ **5.52**
40x50 HC	8x8x2	2000	692.59	98.00	150.00	450.00	10,560.00	$ **11,950.59**	$ **5.98**
50x50	7.5x7.5x1.33	2500	446.25	49.00	150.00	400.00	12,675.00	$ **13,720.25**	$ **5.49**
50x50 HC	8.5x8.5x2	2500	768.75	194.00	150.00	450.00	13,100.00	$ **14,662.75**	$ **5.87**
40x60	7.5x7.5x1.33	2400	446.25	49.00	150.00	400.00	12,632.00	$ **13,677.25**	$ **5.70**
40x60 HC	8.5x8.5x2	2400	768.75	194.00	150.00	450.00			
50x60	8x8x1.33	3000	493.75	63.00	150.00	400.00			
50x60 HC	9x9x2	3000	850.00	206.00	150.00	475.00			
60x60	8.5x8.5x1.33	3600	545.00	97.00	150.00	425.00			
60x60 HC	9.5x9.5x2	3600	936.25	244.00	150.00	475.00			

HC=Greater than 26' clear height

Assumes 1 foundation per bay, no allowance for line footer at end bays.

Unit Costs based on 100,000 SF or larger building

No GC OH&P

Structural Considerations (cont.)

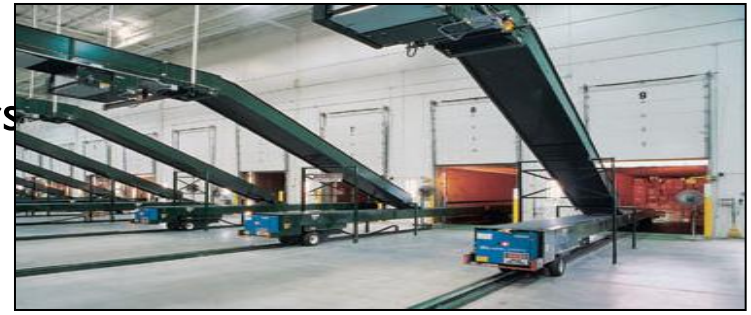
Column Spacing

- **Typical economical bay spacing is 40 to 60 feet.**
- **Average steel weight (joists + girders) for:**
  - 40 x 40 bay (1,600 sf) = 2.5 to 3.1 psf
  - 50 x 60 bay (3,000 sf) = 3.3 to 4.3 psf *(based on total load of 35 psf to 50 psf)*
  - Approximately 35% more steel weight

Optimize column spacing based on rack layout. Less columns almost always means more flexibility.

Structural Considerations (cont.)

1. Moment Frames – welded beam and column connections.
2. X or K diagonal bracing locations.
3. Don't place on expansion walls.
4. Locate to maximize useable space.
5. Roof supported conveyors may require special joists.
6. Anticipate future roof supported conveyors or equipment.
7. In Seismic Zone 4 – Supplemental bracing is required for ductwork, pipe, conveyors, etc.

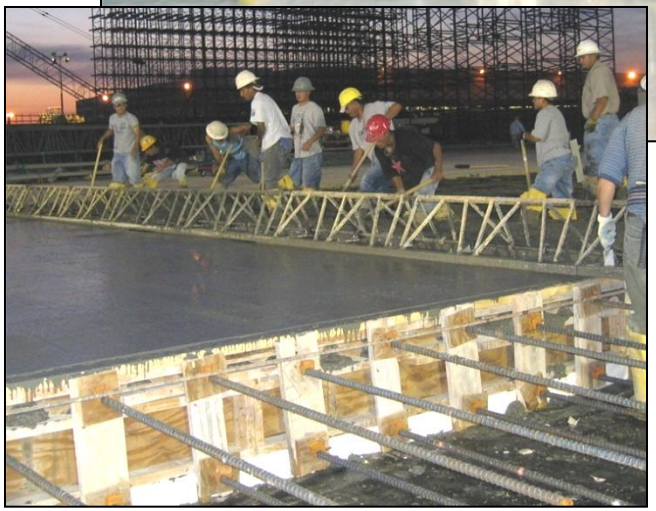


Floor Slabs

1. The floor slab is one of the most important features in a DC.
2. Floor joints are typically spaced every 15’ but can be extended to 50-100’ with shrink compensating concrete ($2-$3 premium). Joints can be unprotected or armored…filled or not filled.
3. Floor flatness and levelness are specified by Ff and Fl numbers. Typical values of 25/25 can readily be obtained with a modern laser screed.
4. Depending on loads, slab thickness can be between 7 and 12 inches.
5. Under floor heating system depending on temperatures (glycol, vent tube, electrical grid)

Floor Slabs (Cont.)

1. ‘Super-Flat’ floors may be required for tall very narrow aisle wheeled vehicles.
2. Concrete floors can be non-reinforced, or reinforced with steel rebar, steel fibers, or other fibers.
3. Wearing surface can be treated with special finishes to improve durability (trap-rock, hardeners).
4. Some proprietary floor systems include separate wear topping layer.
5. Cantilevered racking may require a thicker floor because of additional point loading.



Lighting

1. Daylight harvesting using skylights, side windows and/or clear stories.
2. LED lighting will battle fluorescents for warehousing usage. HID will be the thing of the past.
3. Wireless Controls vs. Hardwired.
4. LEED Certification will become required practice vs. owner driven, (Cal Green Code).

Fire Protection

Fire Protection Alternatives

1. Smoke Vents and Separation
2. Classification of Product-High Hazard
3. Early Suppression Fast Response (ESFR) - Depending on hazard classification, can usually avoid in-rack sprinklers. Wet pipe applications.
4. Cooler/Freezer Systems-Quell System
    - Licensed Contractors
    - Special Software
    - Not Code Approved Yet-Special Review

Sustainability

Elements

1. Fuel Cells
2. Solar Panels
3. Wind Turbines
4. Sky Lights
5. Water Reuse
6. Heat Reuse
7. Use of Recyclable (concrete, steel) and Renewable Materials (Wood)
8. Innovation Initiatives
9. Friendlier Refrigeration Gas (Ammonia, CO2)

Security

1. CPTED-Crime Prevention Through Environmental Design-Using the Environment to add in Crime Prevention.
2. Hiding Holes In Warehouses-place to steal.
3. Locker Areas- Where is the best place to locate.
4. Proper Ventilation- Doors open- uncontrolled access.
5. 3rd Party Monitoring-Redundancy to Phone Line-Cell Phone in case phone line is cut and 24 hour monitoring.

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