Perspectives on Material Handling Practice

Papers in the Perspectives series have appeared in conference proceedings of the Material Handling Institute between 1992 and the present. As such they provide a point of reference as to how the industry is changing as well as insight into accepted practice during this period. In many cases the authors credited have either changed jobs or are no longer in the industry. Some companies as well have been the subject of mergers or reorganization with a new corporate identity.

DOCKLEVELERS: THE FOUNDATION OF EFFICIENT, SAFE LOADING DOCK OPERATIONS

BY

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ABSTRACT

Designing and specifying the correct equipment for a loading dock plays an important role in a facility's material handling infrastructure. The loading dock must facilitate material flow inside and traffic flow outside the building. The dockleveler is an integral part of the loading dock. The techniques presented in this paper outline the requirements necessary to select a dockleveler that meets the facility's application needs, enhances material handling productivity and increases safety. Three aspects of the loading dock - dock design, dockleveler requirements and selection

and safe dock operating practices -contribute to the effectiveness of a properly specified dockleveler.

INTRODUCTION

The loading dock is the beginning and end of manufacturing or distribution facility's operations. A properly designed and equipped loading dock will enhance the logistics infrastructure, improving the facility's competitiveness.

There are three important factors that need to be considered in planning the loading dock. These three aspects will directly affect the productivity and safety of the loading dock:

1. Dock site and design: site considerations, type of dock and dock design.
2. Dockleveler selection: dockleveler types and selection requirements.
3. Safety: building and equipment design, operating practices and maintenance issues.

Using these three aspects, this paper will demonstrate the requirements necessary in selecting a dockleveler that meets a facility's application needs, enhances material handling productivity and Increases safety.

BACKGROUND

An essential part of the loading dock, the dockleveler bridges the gap between the fixed dock height and the variable truck height to provide for the safe and efficient movement of equipment and materials in and out of trucks.

It used to be that dock layout was an afterthought in facilities planning. And after the docks were installed, they were expected to permanently cope with all changing conditions in manufacturing and distribution. Now, a number of factors are affecting the design of new docks and the upgrading of older facilities.

The deregulation of the trucking industry in the l970's resulted in a wider variety of trucks and trailers on the road. Today, loading docks have to be flexible enough to service this variety of trucks and trailers.

The plant or facility has also changed. Philosophies such as just-in-time (JIT), continuous flow manufacturing and cross docking distribution are mandating different needs for the loading dock. These in-plant processes are determining dock location.

Point-of-use receiving is becoming a necessity for facilities using JIT and continuous flow operating systems. In these approaches, receiving occurs at various locations to feed into the production process and shipping takes place at locations where the production is completed (Figure 1).

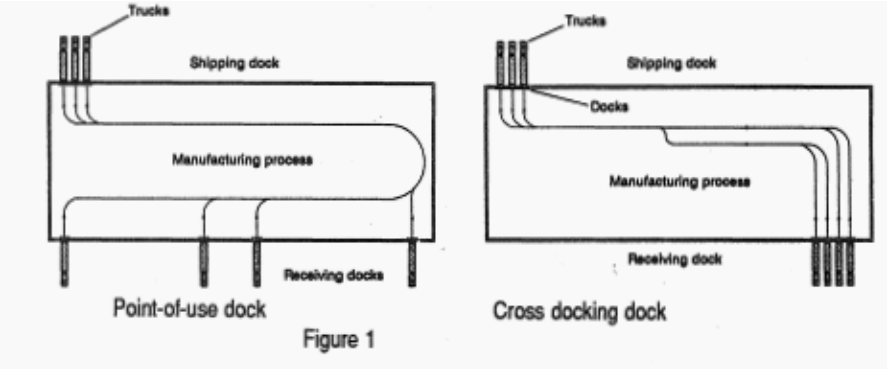


Figure 1

Cross docking--moving containers or pallet loads directly from receiving to shipping in a distribution center--is another dock planning strategy.

No longer can the loading dock be an afterthought in facility planning. Today, designing and equipping the loading dock can impact the facility's material handling process. The three factors of a properly designed and equipped loading docks will be discussed below.

LOADING DOCK SITE AND DESIGN

Since the loading dock's purpose is to facilitate the loading and unloading of trucks, it should be located to minimize in-plant traffic and facilitate safe truck movement in and out of facility grounds. Each dock and truck maneuvering area must be designed to accommodate a variety of truck sizes and types.

Site Considerations

Truck movement in and out of facility grounds and the system of directing trucks from the dock area are determined by three factors:

1. Truck access. Truck traffic should move counterclockwise around the building. To insure safety, apply these traffic design standards:
   - Specify wide angle mirrors at blind corners.
   - Post speed limits.

- Prohibit parking in areas of poor vision.
- Separate pedestrian and vehicle traffic.
- Design roadways for employees that are separate from truck traffic

2. Waiting/staging areas. Unless the facility is designed for peak loads, it should have a waiting area--adjacent to the dock and large enough to handle the anticipated number of vehicles. When trailers will be handled by yard jockeys (tractors designed to handle trailers on site) a trailer parking area is a necessity. Waiting and parking areas must not interfere with the space needed for maneuvering to and from the dock.

3. Loading/maneuvering areas. The loading area for each dock position--the space where the tractor/trailer combination will be parked during loading and unloading--should extend at least 65' in front of the dock and at least 3' on each side of the dock.

The dock's maneuvering space--the area needed to back the largest truck and trailer up to the dock--should extend a minimum of 70' outward from the loading area. If traffic flow around the facility is counter-clockwise, the maneuvering area should extend outward at least 120' from the dock. This recommendation assumes a 65' tractor/trailer combination; shorter trucks will need proportionally less space.

Type of Dock

Security needs, traffic control, safety, worker comfort, space availability and climate are the major factors in determining what type of loading dock will be built. There are four main types of docks:

1. Enclosed docks offer optimal protection from the weather and afford good security (Figure 2). Enclosed docks require proper ventilation to control the build-up of truck exhaust. Also, since there is no wall at the edge of the dock, concrete posts with safety chains or another type of barrier should be installed to hinder forklifts from accidentally driving or backing off the dock.

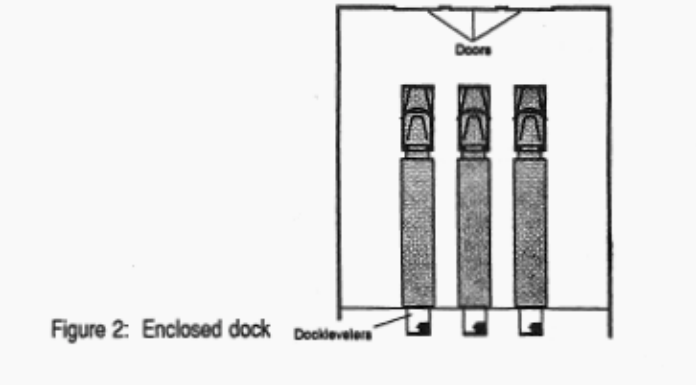
1. 

Figure 2: Enclosed dock

2. Open docks offer minimal protection from the weather and may compromise safety in climates where snow and ice can build up on the dock (Figure 3). On an open dock, sufficient space between loading ramps and the building wall has to be provided to allow forklift maneuvering. Concrete posts and safety chains, or other barriers, are necessary to reduce the risk of forklifts driving off the dock.

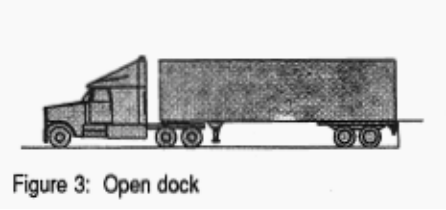


Figure 3: Open dock

3. Sawtooth docks are used when there is limited truck maneuvering space (Figure 4). A sawtooth dock requires more linear wall space per dock position than the normal perpendicular design. They also require that the driveway is level at the dock or the trailer floor will tilt with respect to the dock.

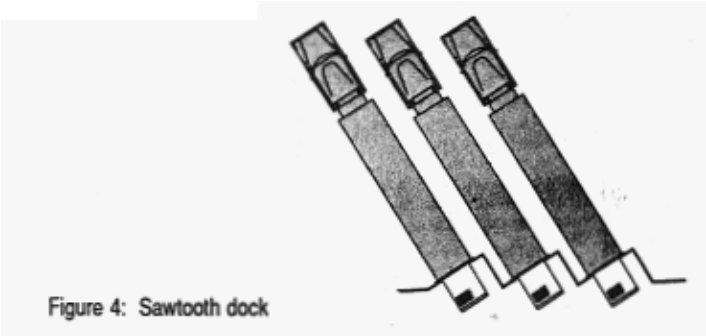


Figure 4: Sawtooth dock

4. Dock piers are useful if the building lacks enough wall space to handle the appropriate number of dock positions or if the building and process layout do not lend themselves to permitting dock positions along the building perimeter (Figure 5). The dock pier can be a closed or open design. It must also be large enough to safely handle forklift traffic maneuvering on the dock.

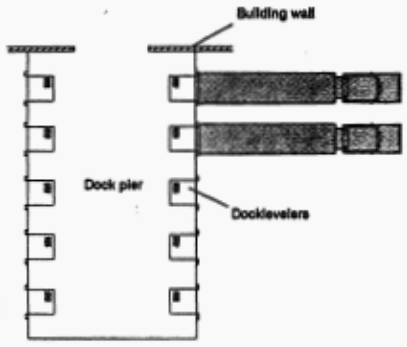


Figure 5: Dock piers

Driveway slope

Recent trends in warehouse and industrial plant construction have eliminated basements and dock-level buildings in many areas. If the plant floor is at grade, or has a low grade, the loading dock is created by depressing the driveway approach towards the building so that the trailer bed will be at about the same height as the dock (Figure 6).

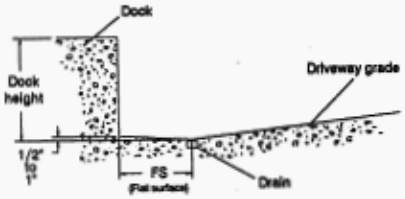


Figure 6: Depressed driveway

A 3% driveway grade is recommended, a 6% grade is practical, and a grade of 10% is the maximum. Grades approaching this limit will make truck departure difficult during winter ice and snow conditions. Severely sloping driveways also force loading the trailer "uphill," placing additional burden on the loading equipment and causing loads to "topple".

If the loading dock is located at the edge of the building, the depressed driveway presents another problem. The angle of the driveway approach causes the top of the truck to extend beyond the floor of the truck. If the building wall is essentially flush with the dock face, the top of the truck will contact the building before the bed of the truck contacts the bumper (Figure 7). This results in damage to the truck, building or both. The solution is to extend the dock face, set back the building wall or change the angle or contour of the driveway approach.

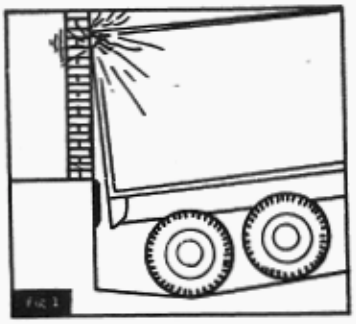


Figure 7

Dock design

The dock design should strive for the least possible height difference between the dock and the trailer bed. The two most important aspects in designing the loading dock are truck dimensions and dock height.

1. Truck dimensions. The loading dock design must be able to accommodate the variety of trucks and trailers expected at the dock. Truck dimensions important to designing and equipping the loading dock are overall height, width, truck or trailer bed height and rear-axle setting.

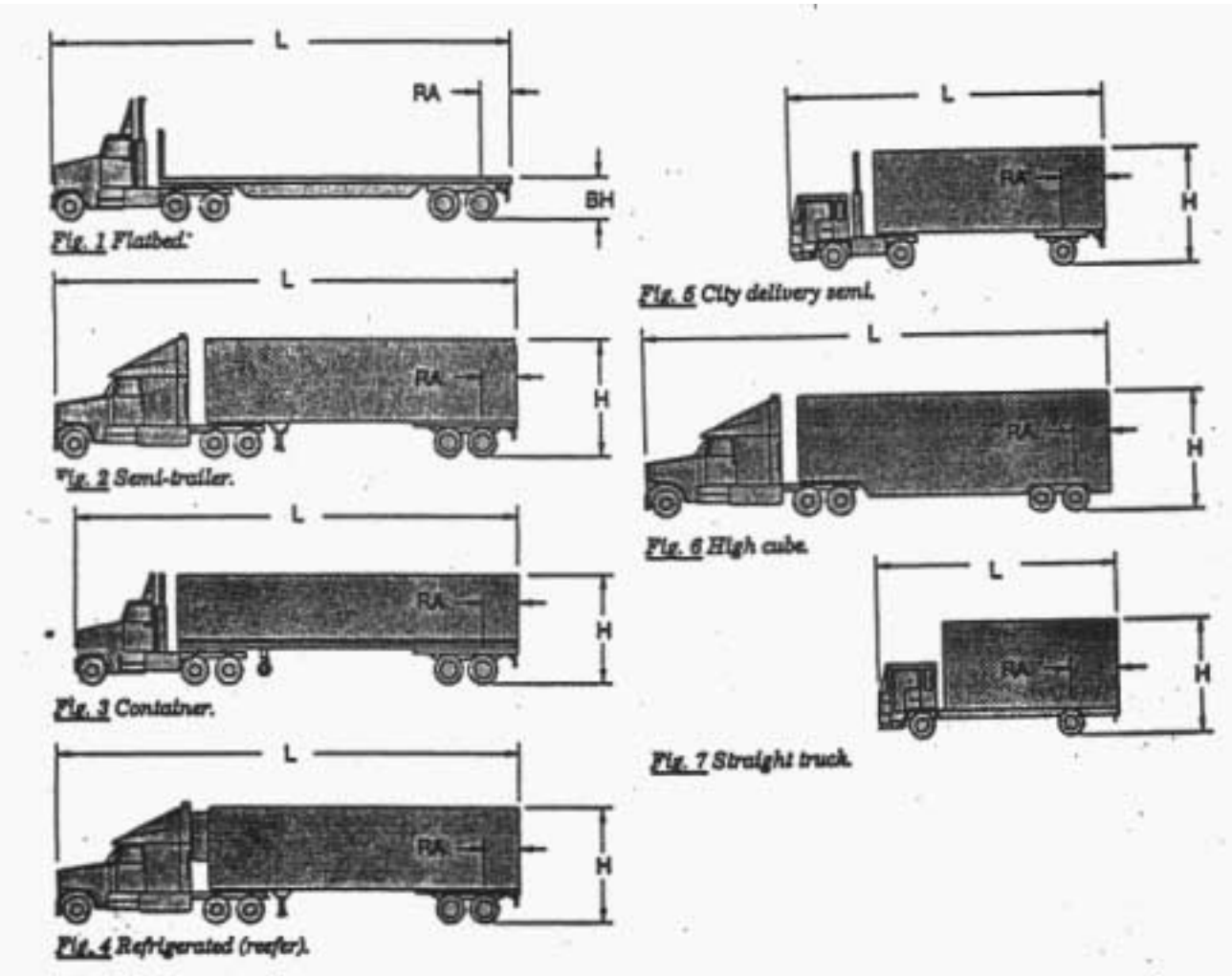
   The trend in truck sizes is toward longer and wider trailers with lower beds to allow increased cargo volume. Trailers with lower - only 36" high - beds are known as "high cube" trailers, for their increased cubic foot capacities. These trailers are increasingly common, particularly at automotive and other assembly plants using the JIT operating concept.

   Currently, more than half of the trailers being produced are 102" wide. Figure 8 and Table 1 display common truck and trailer designs and their associated dimensions. However, trailer and bed heights will vary by as much as 6" from their loaded to unloaded conditions, and sometimes more when air suspension systems are used.

Type of Vehicle	Typical Truck Dimensions				
	Overall Length "L"	Truck Bed Height "BH"	Rear Axle "RA"	Overall Height "H"	Overall Width "W"
Flatbed	55' - 70'	48" - 60"	48" - 144"	--	96" - 102"
Semi-trailer, Road	55' - 70'	48" - 52"	48" - 144"	12' - 14'	96" - 102"
Container	55' - 70'	56" - 62"	36" - 48"	12' - 14'	96"
Refrigerated	40' - 55'	50" - 60"	48" - 60"	12' - 14'	96" - 102
Semi-trailer, City	30' - 35'	44" - 48"	36" - 48"	11' - 13'	96"
High Cube	55' - 70'	36" - 42"	48" - 144"	13' - 14'	102"
Straight Truck	15' - 35'	36" - 48"	27" - 144"	11' - 12'	96"

Table 1: Typical truck dimensions

2. To determine the best dock height, an analysis of the bed heights of the trucks that will use the dock must be made to determine an average height. As a general guideline, most trucks will require a dock height between 46” and 52”. Figure 8 is below.



Suggested dock heights for level docks are given below:

Truck Type	Dock Height
Flat Bed	52”
Semi-Trailer	48”
City Delivery Semi-Trailer	46”

Container	55”
Refrigerated	52”
High Cube	40”
Straight Truck	44”

DOCKLEVELER SELECTION

The most important equipment for a safe, efficient loading dock is a dockleveler. The dockleveler must bridge the gap between the dock and the trailer, be able to compensate for the tilt of an unevenly loaded trailer, and float up and down with the trailer suspension during loading.

Dockleveler types

There are four main types of docklevelers: edge-of-dock; front-of-dock, vertical storing; and, recessed (Figure 9).

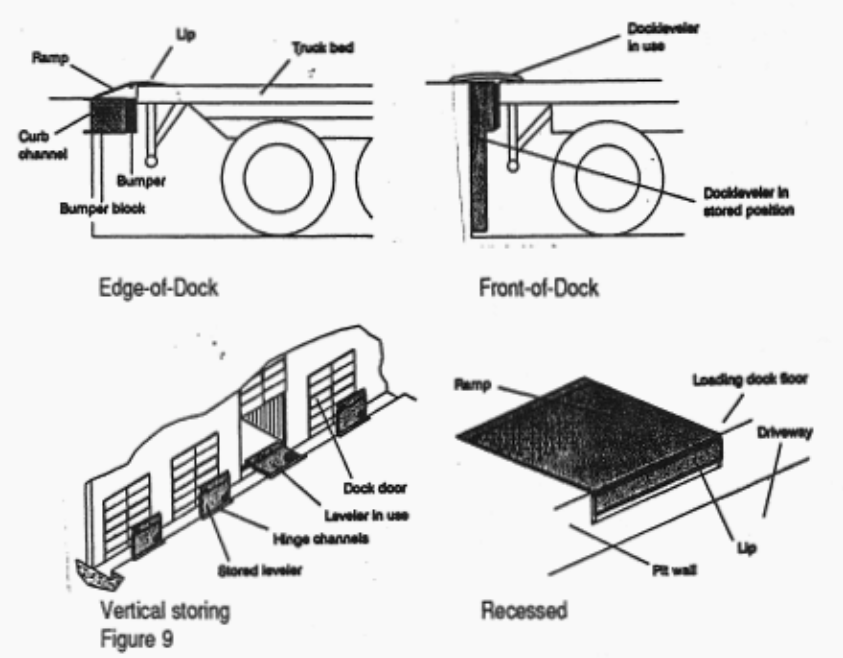


Figure 9

1. Edge-of-Dock (EOD) dockleveler. The least expensive type of dockleveler, the EOD fills the need for a permanent, adjustable dockleveler for docks wher4e a narrow range of

truck and trailer heights will be served. It is installed on a steel channel embedded in the front of the loading dock.

It is recommended that EOD use be limited to carrying only lightly loaded forklifts traveling at low speeds or pallet jacks, and that it serve only trucks and trailers with very stiff suspensions. The EOD dockleveler can be manually lifted into the truck, with the help of counterbalancing springs, or hydraulically activated. In either operation, it returns to the stored position as the truck pulls away from the dock.

2. Front-of-Dock (FOD) dockleveler. The FOD is a completely self-contained dockleveler, including built-in bumpers, and is bolted directly to the front of the dock. Because it requires no pit or special concrete work for installation and is easily removed for relocation, it is ideal for use at a leased building. However, the FOD dockleveler, similar to the EOD, has a limited vertical range of service and capabilities.

3. Vertical storing dockleveler. The vertical storing dockleveler is well suited for docks that need thorough environmental control, cleanliness or security.

   Rather than being installed in individual pits, the vertical storing dockleveler uses a continuous pit that is parallel with the building wall. The dockleveler's ramp pivots on hinges installed on the step down wall. Vertical storing docklevelers can service trailers 6" above and below dock.

4. Recessed dockleveler. The recessed dockleveler is installed in a pit formed at each dock position. A recessed dockleveler has the greatest operating range above and below the dock, improves the efficiency of the loading equipment by providing low ramp grades throughout its operating range, provides the best access to a range of trailer and truck sizes, is available in the highest load capacities, and its construction provides it long service life.

Depending on dock length, recessed docklevelers can service trailers as much as 18" above and below dock.

Dockleveler selection requirements

The dockleveler should never be used outside its vertical operating range or load carrying capacity. It must also be compatible with loading equipment to be used on the dock and tolerant of the weather conditions at the dock. To ensure an adequate dockleveler for all expected operating conditions, the selection process should thoroughly evaluate the following:

- Required dockleveler load capacity.
- Range of trailer bed heights to be served.
- Comparison of the required dockleveler working range with the maximum grade capabilities of loading equipment.
- Loading equipment operating speeds.
- Loading equipment ground clearances.
- Weather conditions at the facility.
- Dock slope.

Dockleveler selection is based on the required operating characteristics of the dockleveler. There are six characteristics that need to be evaluated in the selection process.

1. Required load capacity.
   Use the following procedure to evaluate the required American National Standards Institute (ANSI) (see Appendix) rated capacity for the dockleveler.

   Step 1: Determine the Gross Vehicle Weight (GVW) of the largest forklift that will be used on the dockleveler. The GVW includes the weight of the forklift plus the weight of the maximum anticipated load.

   Step 2: Multiply the GVW by 1.50 to determine the ANSI capacity rating, unless Steps 3 or 4 below require further adjustments. This multiplier makes allowances for operating conditions normally encountered but not included in the ANSI test loading standard.

   Step 3: Multiply the ANSI capacity rating obtained in Step 2 by 1.40 if one of the following conditions is anticipated. If two or more the following conditions are anticipated, multiply the ANSI rating by 1.70.
   Condition 1: More than eight trucks per day will be served at each dock position.
   Condition 2: The forklift will drive onto the dockleveler at an angle other than straight ahead.
   Condition 3: The forklift will be outfitted with front end attachments or fork side shifters.
   Condition 4: Three-wheeled forklifts will be used on the loading dock.
   Condition 5: The expected forklift speeds will exceed four miles per hour.'

   The following is an example of load capacity determination:

   - Forklift weight = 7,000 lbs.
   - Forklift load = 3,000 lbs.
   - Ten trucks per day will be serviced
   - Three-wheeled forklifts will be used

- Forklift speeds are expected to exceed 4 MPH

Solution:
GVW = 7,000 + 3,000 = 10,000 lbs.
Required ANSI capacity:
10,000 x 1.5 x 1.7 = 25,500 lbs.
(Typical forklift weights are given in Table 2)

Capacity (lbs)	Weights, (empty)	
	Gas/LP	Electric
3,000	5,500 - 6,500	6,500 - 7,500
4,000	6,500 - 7,500	7,700 - 8,500
5,000	8,500 - 9,500	9,700 - 11,000
6,000	10,000 - 11,000	12,000 - 13,000
7,000	12,500 - 13,500	14,500 - 15,500
8,000	13,000 - 14,000	14,000 - 15,000
9,000	15,000 - 17,000	16,000 - 18,000
10,000	17,000 - 19,000	18,000 - 20,000

Table 2: Typical forklift weights

2. Service height range.
Use Chart 1 to correlate the required dockleveler capacity with serviceable trailer bed heights for the four types of docklevelers - EOD, FOD, vertically storing and recessed. To find the operating envelopes of the various docklevelers follow these steps:

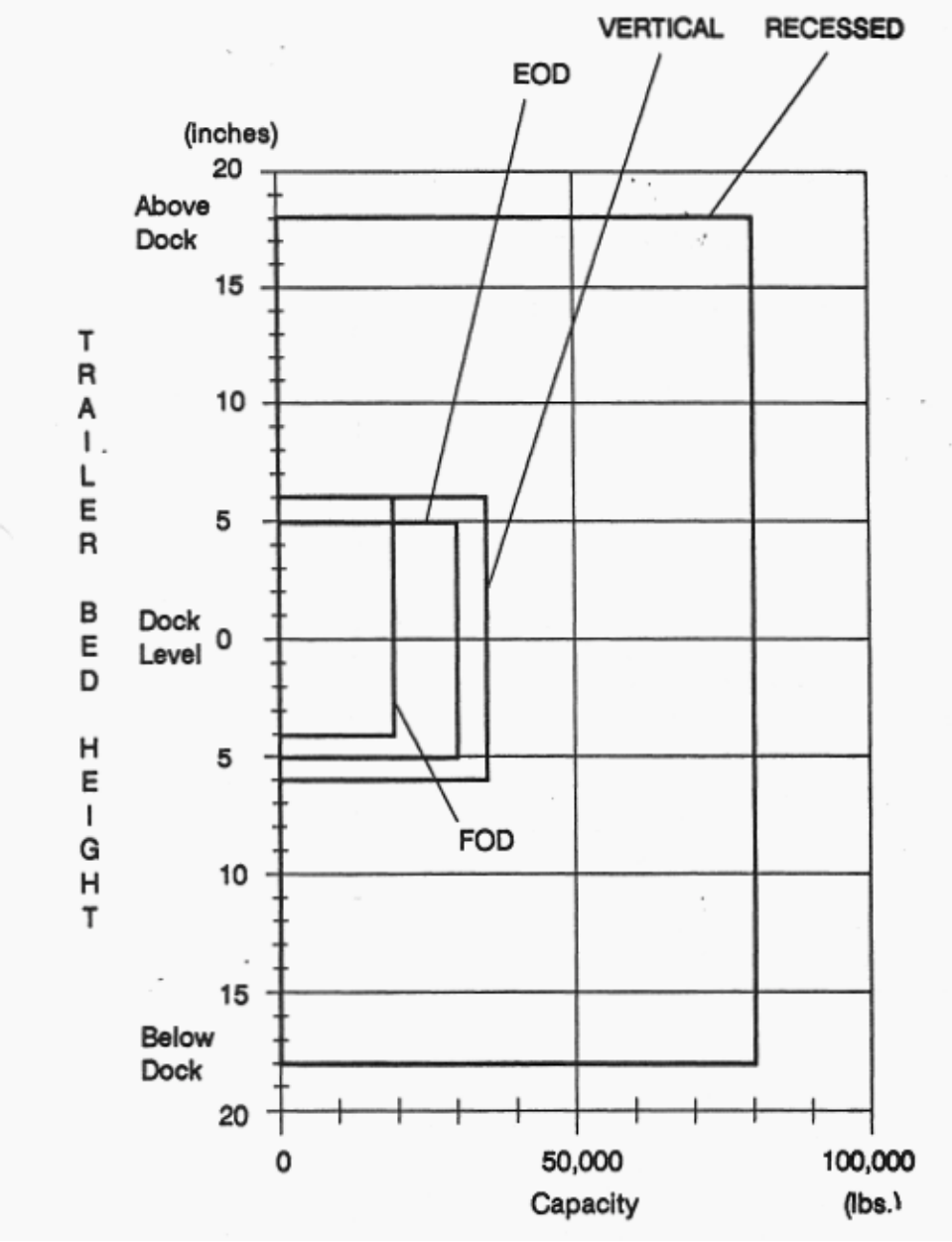
Step 1: After determining the required ANSI dockleveler load capacity, locate that value on the horizontal axis of the chart and draw a vertical line upward from the value.

Step 2: The initial dock height and anticipated truck bed heights that will be served above and below this dock will determine the dock's required working range. Locate these upper and lower limits on the chart and draw horizontal lines through them.

Step 3: These three lines and the vertical axis on the chart define a box - the required operating envelope. The dockleveler types whose operating envelopes entirely cover the required operating envelope have capacities and working ranges that qualify them for further considerations, the others are screened out.
An example of this screening:

- Required dockleveler capacity = 25,000 lbs.
- Required working range of 5½" above dock to 4" below dock.

Chart 1



Solution: After constructing the required operating envelope, it can be seen that recessed and vertical docklevelers are the only candidates with capacities and operating ranges that exceed the required envelope and are qualified for further evaluation.

3. Loading equipment grade capabilities.
The next step is selecting a dockleveler length that results in a grade within the grade capabilities of the loading equipment. Table 3 shows loading equipment and their maximum grade capabilities. The equipment grade capabilities cited in this table should be used only as a guide, contact loading equipment manufacturers for actual specifications.

Use Table 4 to determine the minimum dockleveler length necessary using the truck to dock height differential and appropriate loading equipment as guidelines. For height differentials or loading equipment not shown in the table, the minimum dockleveler length can be calculated with the following formula:

ML = (DTD)/(MGC)

ML = Minimum dockleveler length
DTD = Dock to Truck Height Differential
MGC = Maximum Equipment Grade Capability

4. Loading equipment operating speeds.
The selected dockleveler type and length should be checked against the speeds of the loading equipment. If high speed, 4 mph or more, forklift traffic will be used, avoid FOD and EOD docklevelers.

In warehouse applications, where loading/unloading will be done at high speeds, strive for a low grade, in the range of 3 - 5%, calculated as height differential divided by dockleveler length. Grades in this range minimize dockleveler and forklift stresses, lessen impacts on the materials being handled and reduce the risk of toppling loads.

5. Loading equipment ground clearances.
For a forklift or pallet jack to move freely and safely over a dockleveler, it must have sufficient ground clearance. There are three ground clearances that affect the ability of loading equipment to drive on, over and off a dockleveler.

- Front grade clearance
- Under clearance
- Rear grade clearance

Table 3

Loading Equipment Maximum Grade Capabilities

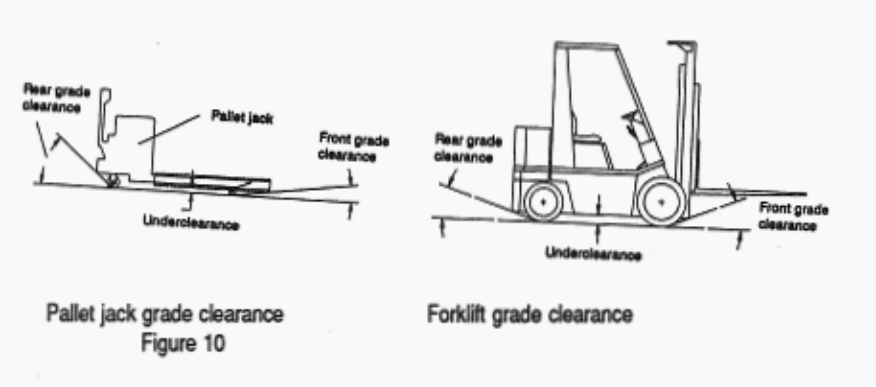
Type of Equipment	Max. Recommended Grade
Hand Operated Pallet Jack	3%
Electric Pallet Jack	7%
Electric Fork Truck	10%
Gas Fork Truck	15%

Table 4

Minimum dockleveler length

Capacity (lbs)	Weights, (empty)	
	Gas/LP	Electric
3,000	5,500 - 6,500	6,500 - 7,500
4,000	6,500 - 7,500	7,700 - 8,500
5,000	8,500 - 9,500	9,700 - 11,000
6,000	10,000 - 11,000	12,000 - 13,000
7,000	12,500 - 13,500	14,500 - 15,500
8,000	13,000 - 14,000	14,000 - 15,000
9,000	15,000 - 17,000	16,000 - 18,000
10,000	17,000 - 19,000	18,000 - 20,000

Checking clearances is especially important when pallet jacks will be operated on vertical, EOD or FOD docklevelers (Figure 10). Clearance is, in general, less of a concern when pallet jacks are used on recessed levelers.



Pallet jack grade clearance

Forklift grade clearance

Figure 10

6. Weather conditions.
   If snow and freezing temperatures are routinely expected at the facility, avoid selecting the FOD and EOD docklevelers. These models are not sheltered from the weather and will experience ice and snow buildups.

LOADING DOCK SAFETY

Loading docks, particularly high traffic docks, must be designed with the best available safety features and equipment. While safety has been an integral part of this paper, this section examines specific building design, operational and maintenance factors that contribute to improved dock safety.

Loading dock safety is important for several reasons:

- It protects and enhances employee health.
- It supports high plant productivity.
- It reduces exposure to financial loss and insurance costs for everyone involved in designing, equipping, building and operating the facility.

Possibilities to improve loading dock safety are established in the facility planning stage. There are three steps that will increase safety:

1. Locate docks to minimize cross traffic interference.
2. Design docks for ease-of-entrance into and out of the trailer. Locate staging/storing areas out of the dock area.
3. Provide adequate lighting.
4. Install barriers at docks to protect against forklifts accidentally driving off an empty dock.

Ensuring continued loading dock safety is established in the operator training and maintenance stage. The most Important aspects of operating and maintaining docklevelers in order to increase safety are:

1. Keep the loading dock area clear of debris.
2. Never clean or work in the dockleveler pit unless the dockleveler's maintenance strut is in place.
3. Maintain the dockleveler with regularly scheduled adjustments, lubrication and pit cleaning.
4. Practice safe dockleveler operating standards.

- Never use loading vehicles to "drive down" the dockleveler.
- Never try to extend the dockleveler lip by hand.
- Always remove the dockleveler lip from the trailer bed and store the dockleveler before the truck departs.

A final note on safety at the loading dock. No loading dock can truly be safe without ensuring that all vehicles are restrained during loading or unloading. According to OSHA regulations, all trucks at the loading dock must be restrained to prevent trailer creep and unexpected truck departure, which can result in a serious accident.

There are three types of trailer restraints available--wheel chocks, trailer restraints and the Auto-Chock™. Wheel chocks are not an effective safety device. Trailer restraints have been accepted by most industries as the most effective and efficient means of restraining the trailer. The Auto-Chock is a hydraulically-powered, steel wheel chock that does not depend on the trailer's ICC bar to safely restrain the trailer. No matter what restraining device is used, the most important factor to a safe loading dock is to restrain all trailers.

CONCLUSION

Loading dock design and equipment can dramatically improve a facility's material handling productivity and safety. Specifying the correct dockleveler is a key element in an effective loading dock.

This paper analyzed the three aspects that significantly affect the loading dock: design, dockleveler selection and requirements and safe operating practices. Using these aspects, it outlined the requirements necessary for selecting the correct dockleveler for an application.

Applying the techniques shown, it is possible to plan, design and equip a loading dock that will meet a facility's application needs, enhance material handling productivity and increase safety.

Appendix A

CAPACITY DESIGN STANDARDS

A dockleveler is expected to withstand stresses, which are complex and highly variable. Even on side-by-side docks, similar docklevelers will experience very different use patterns and forces.

Many loading factors contribute to the stresses a dockleveler experiences.

- Gross Vehicle Weight of the forklift.
- Traffic intensity.
- Forklift speeds.
- Forklift wheel patterns and wheel load distribution.
- Ramp and lip inclines.
- Forklift maneuvering on the ramp.
- Load lifting by the forklift while on the ramp, such as during slip sheet operations.
- Sideways tilt of the truck, caused by driveway conditions or uneven loading combined with a soft truck suspension.
- Unloading, particularly from a trailer below dock level, causing additional strain on the lip and lip hinge.
- The use of forklift front end attachments, such as clamps, carpet rams and fork side shifters.

Capacity Standards

In an attempt to rate the load carrying capacities of various docklevelers, two recognized national standards have been created.

1. Commercial Standard CS 202-56, issued by the United States Department of Commerce on April 10, 1956, is commonly called CS 202.
2. ANSI/ASME MH14. 1-1984, issued by The American Society of Mechanical Engineers on November 15, 1984, is commonly called ANSI.

Both of these standards express their dockleveler ratings as the Gross Vehicle Weight (the eight of forklift plus the weight of its load) the dockleveler can support. Despite using the same Gross Vehicle Weight basis, the ratings are not equivalent.

The CS 202 standard is a static loading test and does not account for dynamic forces. It is further divided into Class A and Class B loadings. A Class A loading determines the weight a dockleveler can support in the stored position- -i.e. on its dock level supports or its lip saddles.

A Class B loading is measured with the dockleveler lip extended and resting on a trailer bed for support.

These are the current interpretations of the CS 202 standard, which was written when the dockleveler industry was in its infancy and the equipment had completely different features and designs compared to modern equipment. For example, the hinged lip dockleveler was developed after CS 202 was written.

The ANSI standard, on the other hand, is a rating the includes the effects of dynamic factors and is based on performance tests that include Gross Vehicle Weight, ramp incline, forklift speed and a minimum dockleveler lift of 500,000 cycles or forklift rollovers.

Because of the more severe loading conditions imposed by the ANSI tests, its ratings are typically lower than CS 202 ratings. For example, a 20,000 lb. ANSI rating would be somewhat equivalent to a 25,000 lb. CS 202 rating.

The user should be cautioned, however, that since actual plant and warehouse loading conditions are usually more sever than those specified in the ANSI standard, the ANSI rating cannot be directly applied to determining the GVW capacity of the dockleveler. In reality, actual ramp grades will be different lip support on the trailer bed may be at the forward edge rather than laying flat on the trailer, and so on. Thus, a forklift with a GVW of 10,000 lbs. may actually require an ANSI rating of 15,000-25,000 lbs.