01 Oct 1984

Manual of Safety Practices

Rack Manufacturers Institute

AMERICAN NATIONAL STANDARD

MANUAL OF SAFETY PRACTICES
A Code of Safety Practices for the Use of Industrial and Commercial Steel Storage Racks

RMI
RACK MANUFACTURERS INSTITUTE
RACK MANUFACTURERS INSTITUTE
1326 Freeport Road, Pittsburgh, PA 15238

MH16.2-1984

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Manual of Safety Practices— A Code of Safety Practices for the Use of Industrial and Commercial Steel Storage Racks

Sponsor

Rack Manufacturers Institute

Approved October 5, 1984

American National Standards Institute, Inc.

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Published by

RACK MANUFACTURERS INSTITUTE
1326 Freeport Road, Pittsburgh, PA 15238

Printed in the United States of America

Foreword

(This Foreward is not a part of American National Standard Manual of Safety Practices—A Code of Safety Practices for the Use of Industrial and Commercial Steel Storage Racks, MH16.2-1984.)

This standard was sponsored by the Rack Manufacturers Institute, which comprises the preponderant majority of companies which produce industrial storage racks. In the interest of improved uniformity of rack performance and enhanced public safety, the Rack Manufacturers Institute published in 1979 its first Manual of Safety Practices—A Code of Safety Practices for the Use of Industrial and Commercial Steel Storage Racks.

This standard was developed by the RMI Safety Committee. It was approved as an American National Standard by ANSI on October 5, 1984.

This standard for industrial and commercial storage racks was developed and is promulgated with the intent of offering information to parties engaged in the manufacturing, marketing, purchasing, or use of such racks.

Suggestions for improvement of this standard will be welcome. They should be sent to the Rack Manufacturers Institute, 1326 Freeport Road, Pittsburgh, PA 15238.

The following organizations recognized as having an interest in the standardization of industrial steel storage racks were contacted prior to the approval of this standard. Inclusion in this list does not necessarily imply that the organization concurred with the submittal of the proposed standard to ANSI.

American Institute of Architects
American Institute of Steel Construction
American Iron & Steel Institute
American Society of Civil Engineers
American Society of Mechanical Engineers
American Warehousemen's Association
American Welding Society
Automated Storage/Retrieval Systems
Construction Industry Manufacturers
Conveyor Equipment Manufacturers Association
Conveyor Section
Crane Manufacturers Association of America
General Services Administration
Industrial Truck Association
Institute of Industrial Engineers
International Association of Refrigerated Warehouses
International Conference of Building Officials
International Material Management Society
Material Handling Equipment Distributors Association
The Material Handling Institute, Inc.
Monorail Manufacturers Association
Motor Vehicle Manufacturers Association
National Association of Retail Grocers
National Electrical Manufacturers Association
National Fire Protection Association
National Moving & Storage Association
National Safety Council
National Wooden Pallet & Container Association
Port Authority of New York & New Jersey
Rack Manufacturers Institute
Shelving and Rack Safety Association
Shelving Manufacturers Association
Society of Manufacturing Engineers

Preface

The Rack Manufacturers Institute is comprised of companies which produce industrial steel storage racks. In the interest of improved uniformity in the evaluation of performance, the Institute publishes its first "Manual of Safety Practices—A Code of Safety Practices for the Use of Industrial and Commercial Steel Storage Racks."

This standard was developed by the Rack Manufacturers Institute, an affiliate of The Material Handling Institute, Inc., whose members were major project sponsors.

This standard was developed and is promulgated by the Rack Manufacturers Institute with the sole intent of offering information to parties engaged in the manufacturing, marketing, purchasing or use of such racking.

The Rack Manufacturers Institute and its members assume no responsibility and disclaim all liability of any kind, however arising, as a result of acceptance or use of this standard. No warranties of any kind, expressed or implied, are given to the promulgation of this standard.

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MANUAL OF SAFETY PRACTICES
A Code of Safety Practices for the Use of Individual and Commercial Steel Storage Racks

SECTION 1—SAFETY ELEMENTS DRAWN FROM THE RMI STANDARDS

1.1 Plaques

Current industry standards suggest the use of permanent plaques placed within the environment of existing racks designating load sizes and other important information. Users should consult with the rack's manufacturer to supply the applicable plaque as necessary, and this should be made as part of the plant safety program. Where rack loading is predetermined by qualified persons, and racks loaded in accordance with their requirements, plaques would not be required.

1.2 Drawings And Installation Drawings

Installation instructions and drawings, when furnished with each rack, should be available for designation of layouts, size limitations, permissible configurations, distances, deviations and style. These drawings are available to your safety inspector to assure good installation and maintenance as prescribed by the manufacturer.

1.3 Collision Protection

For resistance to minor impacts, the bottom portions of those frames which are exposed to possible impact or collision by forklift trucks or other moving equipment should (1) include collision protective devices; or (2) be designed to maintain their full design load at the usual allowable stresses even if the carrying capacity of an exposed column is reduced by damage to one half that of an undamaged column; or (3) be designed to maintain their full design load capacity at 50 per cent increased allowable stresses even if a damaged exposed column has lost all carrying capacity; or (4) be shown by test to be capable of standing without collapse even if a damaged exposed column has lost all carrying capacity. Upon such damage, the pertinent portions of the rack shall be unloaded immediately by the user and the damaged portion shall be repaired adequately or replaced.

1.4 Base Plates And Anchoring

All columns of racks are to be furnished with bearing plates. The purpose of the bearing plate is to provide for the transfer of column loads to the floor. The base plate design should be consistent with the compressive strength of the concrete as supplied by the user (owner).

Certain racks such as movable shelf racks and stacker racks must be anchored to the floor by anchors capable of resisting shear forces caused by the horizontal and vertical loads on the rack and the strength of the building.

1.5 Rack Tolerances

The following section gives a short synopsis of some important design constraints.

1.5a Vertical Constraints The vertical tolerance requirements for racks should be such that the rack is installed with a maximum tolerance from the vertical of 1 inch in every 10 feet of height.

1.5b Stability Of Upright Frames

There are a great many important details dealing with the stability of the upright frames in the specifications. They include such things as slenderness limitations, allowable unbraced lengths, and various allowable stresses and design characteristics. However, a rack is designed for stability, using a factor known as "Height to Depth Ratio." "Height to Depth Ratio" should not exceed 6 to 1 measuring to the top of the topmost load. If the ratio exceeds 6 to 1 the constraint can be overcome with proper anchoring or external bracing of the rack structure.

1.5c Bracing Factors

Diagonal bracing configurations vary in overall rack design and the adequacy of a given configuration can only be determined by reference to the engineering specifications.

1.5d Beam And Shelf Connections

Except for movable shelf type racks, rack beams should have connection devices (or may be bolted in such a way as) to withstand an upward force of 1,000 pounds per connection without failure or disengagement. In movable shelf racks only, the top shelf or shelves (every 12 feet in the system) need to have the constraint of being able to withstand an upward force of 1,000 pounds. In the case of movable shelves on a movable shelf rack, all that is required is that some connection be made on all 4 corners so as to eliminate forward or rearward displacement.

1.5e Rack Beam Deflection

At working load (excluding impact) the deflection should not exceed 1/180th of the span measured with respect to the ends of the beam.

1.5f Impact Tolerances

Constraints are applied in the design of racks with regard to impact tolerance. These tolerances are related to the unit load. Reference should be made to the manufacturer.

1.5g Moving Forces And Overturning

It is important that all maximum dynamic forces as applied by the moving equipment manufacturer be considered in the design constraints of the rack. Consideration should be given to the overturning factor in the design of the racks including the factor of wind loads and earthquakes.

1.5h Building Connections

When racks are connected to roofs where roof deflections may occur, horizontal or nearly horizontal connections are recommended. Care should be taken to assure that the roof can then deflect vertically to the full extent of expected building deflection without exerting damaging forces on the rack.

Section Two

Setting Up and Installing Racks

Before installation begins, all applicable drawings and instructions should be reviewed. This includes building drawings as well as those supplied by the rack manufacturer.

Next, the rack location should be determined and the floor chalked with the outline of each row. At this time, building column locations should be verified as they apply to the installation plan. Most simple pallet rack installations do not require the use of a transit.

Installation of racks with critical alignment, plumbness, aisle straightness and other such considerations should begin with a thorough floor layout and elevation gridding using an optical transit or laser surveying device. Such racks include flow racks, racks serviced by narrow aisle trucks or stackers, and racks installed on floors that are substantially out of level.

2.2 Proper Erection And Plumbness
Racks MUST be erected strictly in accordance with the manufacturer's instructions. Deviations from these instructions could seriously impair the safety of the rack.

2.3 Clean Aisles
Aisles should be kept clean and clear of all materials and debris during installation. Many accidents involving racks occur during installation, so safe working conditions are most important during installation. Aisles and the area under racks should be swept clean before any moving vehicles are allowed to operate around the racks.

2.4 Clearance And Load Size
Proper clearances around loads must be provided for safe operation. Insufficient clearance may result in impacts causing damage to the rack and to materials stored.

2.4.1 Horizontal Clearances In The Direction Parallel To The Aisle Should Be As Follows:
Load to column—3 inches or more is recommended.
Load to load—3 inches or more is recommended.

2.4.2 Horizontal Clearances In The Direction Perpendicular To The Aisle Are Governed By Two Factors
One has to do with the load position. If front to rear supports are not provided under the pallet, then the pallet must overhang the front and rear beams to prevent falling through. The overhang should be not less than two inches.

The other consideration has to do with back-to-back clearance of loads in adjacent rows. Many times this clearance will be dictated by fire regulations, in which case this back-to-back clearance is called a flue space and is provided to allow heat to rise and set off sprinklers installed in this space. In such instances, the minimum clearance is usually four (8 inches back-to-back), but must be determined by local codes and underwriter's requirements. Possible impact of loads with sprinklers must also be considered. In the absence of fire protection considerations, a minimum back-to-back clearance between loads of four inches should be provided.

2.5 To Anchor Or Not To Anchor
The practice of anchoring racks is recommended in all cases and is essential if the height to depth ratio exceeds six to one. However, lower racks whose exact location is not critical may be installed without anchoring. When racks are to be anchored, careful consideration should be given to proper installation of the anchors. Holes for anchors cannot be drilled immediately adjacent to each other as the concrete will crack between holes. This means that if holes are drilled in the wrong place, a correction cannot always be made by drilling a new hole several inches away.

2.6 Deviation By The Installer
All deviations from the manufacturer's drawings and instructions should be approved by the manufacturer. Deviations should be noted on all drawings.

2.7 Uprights At Aisle Intersections
These uprights are more likely to be struck by moving vehicles. This problem sometimes can be minimized by special markings on these uprights to make them more visible. An alternate practice is to install guards on the uprights. The rack manufacturer can supply guards.

2.8 Load Retainers, Front-To-Rear Supports
Front-to-rear supports may be required when pallets of varying size are to be stored, or when the chance of pallet "fall through" needs to be reduced. If front-to-rear supports are to be used, consideration should be given as to whether they need to be fastened in place. If normal operation causes the supports to shift in position, or if the potential exists for them to present a safety hazard by falling from the rack, then they should be fastened to the rack. Front-to-rear supports should be provided on all "over the aisle storage."

Section Three

Beware of Rack Hazards

The following consists of a group of 14 of the most commonly experienced rack hazards found in conjunction with rack installations. An attempt is made here to clarify these hazards and to recommend some of the corrections that can be made to eliminate the hazards. By referring directly to these hazards, we get into the most important characteristic of safe operation of rack systems, which involves the concept of "preventative maintenance." A program of self-inspection by a rack user would relieve a great many potential accidents through an organized system of review for hazards.

3.1 Mis-Alignment Of Racks

Hazard Description—Racks can be mis-aligned by being out of plumb in the vertical, the horizontal, or not corrected for the slope of floors. Various size racks improperly butted up against one another with protrusions in the aisle is a common alignment problem. Racks improperly connected together can cause whole groups of mis-alignments. This hazard would then affect safety in moving pallets or movable shelves in and out of the rack. Mis-alignment is particularly a predominant hazard in drive-in structures. Too often the front frame is anchored out of alignment of one bay and spreading support rails in the adjacent bay, which could contribute to pallet fall-through. Many times permanent deformation of the rack is caused by fork truck and stacker interference caused by mis-alignment of racks.

Solution—Most mis-alignment hazards can be safely eliminated by adherence to the manufacturer's installation drawings and specifications. All connections should be checked to make sure they are on the proper levels; all plumbing should be done on the vertical plane to make sure that the rack is properly aligned from front to back. Also, shimming and plumbing should be done on the horizontal plane to make sure the rack is level.

3.2 Improper Beam Installation

Hazard Description—Improper beam installation can be a serious hazard and could adversely affect shelf capacities and eccentricity of column loading. Each manufacturer designates a style of beam to column connection, either tabbed, slotted, bolted, or clipped with locking clips. Each beam to column connection should be checked to make sure it is consistent with the manufacturer's connection style and should be consistent with the installation instructions. This should eliminate most beam installation problems. However, the hazard itself, if undetected, could lead to permanent deformation of the connection and could lead to ultimate failure of the beam.

Solution—The solution to improper beam installation is a periodic inspection of all beam connections, that the initial installation be verified to be consistent with the manufacturer's instruction, and any requirement for special repair of beam connections be referred to the manufacturer. This will insure that it is within the constraints of the rack design.

3.3 Inadequate Clearances

Hazard Description—Inadequate clearances involve improper openings for handling equipment and inadequate load-to-load dimensions at various levels. This hazard causes a great deal of abuse and a great many problems in the proper safe use of rack systems. Improper and unsafe clearances are based on the user's desire to put loads too close together, one upon the other, and to make the aisles smaller to over-utilize floor space. The result is that material is easily dislodged from one load to the other and collision of loaded pallets, trucks, and materials occurs.

Solution—Set up the rack for proper clearance as outlined by the manufacturer. Make sure that when a pallet is lifted out from a set of beams or from a bay level there is enough room to move it to properly clear the front and back beams so that it can be withdrawn safely; also, the truck radii for entrance and exit, where applicable, are designed in the aisle layout.

3.4 Improper Aisle Width

Hazard Description—Many times the size of the pallet load changes, the type of the fork truck changes, and parts project out into the aisle causing an improper sized aisle. This improper sized aisle constitutes a very serious hazard in that you are operating with material handling equipment that is not designed for that aisle. This presents a serious hazard in that you cannot turn into a bay opening, and you cannot clearly pull a load out of an opening because you do not have clearance behind you.

Solution—Refer to the original drawings of the manufacturer's designs and the original layouts of the racks at installation and verify the consistency of the pallet load to the beam spacing to the aisle width; also, determine what size the aisle was designed to accommodate the particular material handling equipment and insure adequate load-to-load dimensions. If it is necessary to change the rack positioning for new material handling equipment, this should be done.

Section Three (Cont.)

3.5 Aisle Guards, Frame Guards, And Column Guards

Hazard Description—Damaged rack columns due to high-speed material handling equipment is one of the greatest hazards to rack installation. Collisions occur with columns due to many reasons, including careless operation of the truck, improper clearance, and improper size of the aisle.

Solution—To minimize the collision problem, use aisle guards. An aisle guard can either be a device that is secured to the column to take up and strengthen the column or it can be a sacrificial type of structure that would protect the column, particularly at important traffic areas, therefore reducing the probability of a rack failure.

3.6 Dislodgement Of Accessories

Hazard Description—Many rack installations are supplied with a number of accessories such as front-to-rear supports; decking materials, including straight decks, grid decks, ledges of all kinds and cradles of all kinds. Dislodgement of these accessories by material handling equipment causing improper connection represents one of the serious hazards in a rack installation.

Solution—Have a professional maintenance program that requires the checking of fasteners and verifying that all loose accessories, cradles, and materials are indeed on the rack structures in the way prescribed by the manufacturer.

3.7 Spillage Of Goods, Overloading

Hazard Description—If unstable loads are stored, items may fall behind the racks, fall in the section next to them where there is clearance and are protruding into the aisle. Many pallets are overloaded with bulk material that hangs over and is easily dislodged when a piece of handling equipment picks up a pallet. The spillage of this material causes loss of the materials, but in many cases it indirectly causes damage to the rack system. It causes unnecessary collision, or in the case of such things as chemicals or oils, can cause severe damage to the racks.

Solution—In bulk storage racks, care should be taken to insure that the loads are intact and in some way bound up, either by a piece of plastic wrap, or by the use of bins, or ledging materials. Periodic inspection of the rack should be made to see that there are no miscellaneous packages hanging out that will be dislodged when that load is removed from that rack. Spilled material should be picked up at once.

3.8 Floor Obstructions, Debris

Hazard Description—Floor obstructions and litter in aisles and around the rack constitute a serious hazard. Accidents with personnel and damage to the rack occur many times if the debris in the aisle is hazardous *material* or corrosive material.

Solution—See that there is a "janitorial" program around the racks on a fixed schedule to eliminate the problem of dirty aisles and miscellaneous material in the area.

3.9 Handling Equipment Deficiencies

Hazard Description—All racks generally have some form of handling equipment related to them, including fork trucks, side-loaders, hand trucks, and there are people operating these trucks. The condition of these trucks and the way they are handled can directly affect the safety of the rack and the rack structures. Some of the moving equipment deficiencies include defective forks, forks out of alignment, inexperienced operators, and poorly maintained equipment. Poorly maintained equipment includes bad wheels or hydraulic units. Most rack manufacturers see this as a very serious hazard.

Solution—The industrial truck manufacturers have developed a good program of accident prevention and maintenance of the equipment. If the trucks are properly maintained and the operators are trained and skilled, then the problem of destruction to the rack and the safety of the rack is minimal. Again a direct solution would be a fixed program of equipment maintenance and inspection, together with a significant operators training program.

3.10 Pallets On The Floor

Hazard Description—Many times there are not enough openings in the rack for the material that is subject to storage. The aisles become filled with pallet loads of material. The pallets on the floor then become a serious hazard to the safe operation of the racking system.

Solution—The elimination of the pallets on the floor is the simple and obvious solution. Short of that, a special program for the clearing of each aisle before the picking from that aisle would be necessary in order to make the system as safe as possible.

3.11 Damaged Racks

Hazard Description—Most damaged racks are due to collision of continuous battering over the years by trucks and handling equipment. In some cases, these damaged racks could end up as a rack failure. The battering could accumulate *in magnitude* and eventually reduce the overall structural capacity of the rack.

Solution—The damaged racks should be replaced. As soon as a damage occurs, the column twisted or distorted, the rack should be unloaded and the rack section removed and replaced with a new upright section. The damage might be a tip-off that a guard is necessary at that spot.

3.12 Deteriorated Racks—Rust, Acid, Salt Corrosion

Hazard Description—Many racks are set up in highly corrosive atmospheres, many racks are set up out-of-doors. Some racks are set up near heat treating areas or areas where there is acid and salt corrosion in the atmosphere. These racks deteriorate over a long period of time and rusting takes place, reducing the rack capacities.

Solution—Inspection and maintenance is the best preventative measure we have. This is the only thing that can solve this problem. When the system is bolted, care should be used to see that plated bolts are used. When rust appears, the racks should be wire-brushed and coated with a corrosion-resistant coating, such as an epoxy or some suitable corrosion protection material. Corroded racks in service should be removed if there is any indication that the connections are impaired.

3.13 Beam Spreading

Hazard Description—Beam spreading is the result of overloading a set of beams, causing deformation at the connection and pulling away from the upright column. This is usually caused by shocking, overloading, and represents a potential for serious damage to the rack structure and possible collapse.

Solution—A routine inspection program is called for. To verify this condition, remove all damaged beams, replace them with proper beams and re-align the rack using manufacturer's instructions.

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Section Four

Maintaining Your Racks for Safety

4.1 Inspection Program: Planned Maintenance
Inspection programs will vary in accordance with the size of each rack installation and the use to which it is intended. Visual inspection should be made on a timely basis to insure the integrity of the racks. Personnel should be encouraged and expected to report any damage to racks at the time of occurrence.

4.2 The Damaged, Dented, Buckled, Or Bent Rack
Because of the various types of rack construction, repair of damaged parts will vary. Advice on the proper means to correct damage should be checked with the rack manufacturer. In most cases, buckled or severely bent rack components should be replaced. Moderate damage, such as denting, or slightly skewing upright columns can be corrected by adding bracing or splices or simply heating the member and returning it to the vertical. More care should be taken with dimpled or buckled beams. In most cases, replacement is called for. Since 90% of rack damage occurs between the floor and first horizontal beam, most damage can be seen from floor level.

4.3 Rust Prevention And Painting
Rust prevention or touch-up painting becomes of importance depending upon use. Any high moisture or cooler application calls for careful attention to paint conditions, and is normally an operation that is readily performed by maintenance personnel, although it requires checking out all components from floor to ceiling, at a lesser frequency than damage checks.

4.4 Tightening The Lags, Connecting Bolts
Racks that are lagged at time of installation should be tightened in accordance with torque data supplied by most manufacturers, and the same criteria must be used when tightening connecting bolts as the security of the entire system is dependent upon proper fastening methods. Random checking should be used to ensure there has been no loosening of lags or connections.

4.5 Cleanliness And Good Lighting
Cleanliness and proper lighting are keys to a well-run warehousing operation. A well-maintained and clean storage area are musts in any phase of the food industry and good housekeeping should be prevalent in all storage operations. Proper lighting facilitates rack entry and pallet placement and aids in reducing rack damage.

Glossary of Terms

AISC Standards
American Institute of Steel Construction Standards or authoritative guides.

AISI Standards
American Iron and Steel Institute Standards or authoritative guides.

Aisle Guide
A restrictive barrier used to direct or limit movement in an aisle, generally side or lateral movement.

Anchoring
Lagging or fastening methods used to secure columns, beams, ties to floor, walls, ceilings, etc.

Anchoring Post
Hitching post. Post used to tie down or restrict movement.

Axial Forces
Forces, or loads, acting on geometric axis of columns, beams, etc.

Base Plate
Pad used to support a column and transfer column load to floor or ground.

Beam Connection
Device used to fasten shelf beam to column, wall, etc.

Beam Deflection
The downward distortion of a beam or support caused by a load or force.

Bracing
Restrictive supports used to limit movement in racks, uprights, shelves, etc.

Buckling
The failure or collapse of a column, beam, etc., generally caused by an added force.

Concentrated Load
A load or force restricted to a point or position as opposed to one generally distributed.

Connection Locking Device
A pin or bolt used to restrict movement in a connection, as in a beam or shelf pad.

Decking
Solid or perforated material used on shelves, load beams, or walkways to support loads of variable sizes.

Deflection
Distortion of column beam, tie, etc., caused by a load or force.

Dynamic Forces
A force related to motion. A moving force.

Earthquake Zone
An area or region with a history of earthquake occurrence, generally of slight, moderate, severe, etc., magnitude as Zone 1, Zone 2, Zone 3.

Frame Load
The load or force acting on or applied to an upright, shelf, set of beams, etc.

Horizontal Clearance
The clearance along side of or behind a load, as opposed to vertical clearance, or headroom.

Impact
The striking of one object against another. A load striking a beam or rack member.

Industrial Steel Storage Rack
A series of steel supports or beams connected together to form an assembly used to store industrial goods or material. See Page 1 of Standard Nomenclature.

Lateral Member
A tie running from front to rear, as in a shelf.

Live Load
Load being moved in or out of a rack system. Pallet load as opposed to dead load or weight of actual rack members.

Moment
The product of a load and its perpendicular distance from an axis.

Movable Shelf Rack
A type of rack where the shelves are removable and replaceable in multiple locations in the section opening.

Pallet Clearance
Clearance or unused space at sides, rear, and above loaded pallet.

Picking
Selection and removal of material from a pallet or from an unpalletized area.

Plaques
A sign or display board listing maximum loads or loading conditions.

Plumbness
The closeness of an upright or column to being vertical.

Rack Beam
A horizontal load-support member in a rack system.

Rack Column
A vertical load-support member in a rack system. A post.

Rack Standards
Authoritative guides, or directives, used in the manufacture, sales, and use of storage rack systems and components.

Retrieval Device
Any device or mechanism used to select and pickup stored material from a storage rack system. May be a manually operated fork truck or a completely computer-controlled mechanism.

Safety Factor
Extra capacity designed into a system to cover unusual or extra demands on the system.

Section Opening
The opening, or span, between two adjacent upright frames; a rack bay.

Shear
The tendency to deform or fracture from one body sliding against another.

Side Sway
The end-to-end movement at the top of a rack system caused by external forces.

Skid
Steel or wood, movable unit load.

Slave Pallet
A pallet used in an automated rack system.

Stacker Racks
Racks used in an automated, generally high-rise system.

Transverse Member
A tie or diagonal member in an upright frame. A tie or pallet support in a shelf.

Uniformly Distributed Load
A load, as on a shelf, or pair of load beams, supported by all, or nearly all of the shelf or beam supporting surfaces.

Unit Load
One composite load placed on a pair of load beams.

Upright Frame
The vertically supporting assembly in a rack system. Generally consisting of 2 or more columns tied together with bracing members.

Wind Load
The added force on a rack system caused by wind force.

Wooden Pallet
A movable load support made out of wood.