STEEL STORAGE RACK SAFETY MANUAL

SAFETY GUIDELINES FOR LAYOUTS

A well-designed racking system optimizes the efficiency of your operation providing many years of reliable service. Please review our rack selection and specification manual to select the correct rack components.

Optional features As user of steel storage racks consider your rack environment and evaluate the benefits of additional features available that can be suited to their requirements.

Drawings are required for all large rack structures. These should include an aerial layout view of the building showing columns, loading docks, man doors, obstructions and the racking. Racking rows and aisles should be dimensioned. The elevation view drawing showing front and side profile of the racking and accessories should also show materials and capacities. All heights, widths and clearances should be dimensioned and pallet information should be displayed on the sheet showing the length, depth, height and weight of the pallet and bay.

INDOOR RACKING All racking is to be installed indoors unless otherwise specified by NAS. Outside installations require special consideration for wind and snow loads, UV and moisture corrosion.

DESIGN FEATURES

The building architect or owner should review the following issues before the racking is ordered:

a. the concrete slab is able to support the maximum column loads
b. all connections between the rack structure and the building columns and walls and the type, size and location of all rack anchors.

Lift truck operating aisle width will affect the frequency of accidental impact. Aisles equal or marginally greater than the trucks minimum turning radius may require impact resistant frame designs. The minimum clear aisle (pallet to pallet) should equal the lift truck minimum turning radius plus 6". The supplier of the lift truck should be consulted to determine the optimal size of the clear aisle. Rack layout should provide an optimum balance between lift truck ease of operation and storage density. End of row aisle clearance may vary depending on the lift truck turning radius or passing criteria. Many times the size of the pallet load changes, the type of 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 and cannot turn into a bay opening or pull a load out, because there is insufficient clearance.

Collision protection and impact damage to rack is dependant on the warehouse environment and equipment. The combination of high activity and fast moving heavy equipment increases the risk of rack damage. Energy deflecting or absorbing structural members at strategic impact locations must be designed in your rack system. 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. Please ask for our Rack Selection and Specification Manual for more information.

The bottom portions of these frames that are exposed to possible impact or collision by forklift trucks or other moving equipment should be protected by collision protective devices; or 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.

Impact resistant accessory members welded to the upright frames are the most common method of reducing impact damage. Common members are bullet nose deflectors, heavy-duty bottom horizontals, heavy-duty bottom diagonals, double front post to first beam level, and baseplates that accept larger anchors.
Potential financial loses caused by collapse of storage racks with high value products may justify additional design features that protect the racks from accidental impacts.

Heavy-duty guards with heavy-duty anchors provide protection in zones where the ends of row racks are prone to impact damage. Guard design should take into account the pallet or fork height and type of lift truck. Typically these guards are made from structural angle, minimum 1/4" thick.

The base plate design should be consistent with the compressive strength of the concrete as per information supplied by the user (owner). All columns of racks are to be furnished with such bearing plates to distribute the column load over the floor.

Anchoring recommendations
All narrow or single rows must be anchored if the height to depth ratio exceeds six to one.
The use of anchor bolts on bearing plates is recommended for reasons other than resisting overturning forces. Anchor bolts can resist accidental impact forces on the base of the columns that would otherwise result in large bending forces in the upright. When only one anchor is used on the front post, the front post can be twisted when impacted on the side opposite the anchor. The use of two anchors on the front post helps reduce this. In some cases, a third large anchor is added to the front baseplate immediately in front of the upright. The two smaller anchors in conjunction with the third larger anchor are usually effective in eliminating damage caused by medium sized impacts on the lower front post. Users should specify the quantity and size of the anchors used to resist base of column impact forces. Anchor selection should be such that the shear area of the anchor is maximized (i.e. wedge type is preferable to sleeve type).

Seismic rack must be anchored to the floor by anchors capable of resisting shear forces caused by the horizontal and vertical loads on the rack during an earthquake.

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Stability of Upright Frames
The 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 depth can be increased with back-to-back, cross-aisle or wall bracing of the rack frames.

Single or back-to-back rows of 3 pallet wide bays can be prone to collapse. When the front post of a single run of rack is disabled, the structure has a natural tendency to collapse forward into the aisle.

The width of the bay (beam length) affects the amount of damage received by the frames adjacent to the pallets. Occasional impacts will occur if the pallet or lift truck straddles come too close to the frame.

Proper clearances for beam loading must be provided to allow for efficient and safe pallet loading. Pallet load to column of min. 3 inches and load to load of min. 3 inches or more is recommended. Insufficient clearance may result in impacts causing damage to the rack and to the materials stored. Inadequate clearances result in 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 occur.

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 not be less than two inches.

The back-to-back clearance of loads in adjacent rows will not only be dictated by the overhang but also by local fire regulations. 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 inches back-to-back (8" total), but must be determined by local codes and underwriter's requirements. Possible impact of loads on 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.

RACK BEAM DEFLECTION
The amount of allowable beam deflection is not only based on the working standard (length of beam divided by 180), but the operational appearance of the beam "smile" or deflection measured with respect to the ends of the beam.

To prevent beam disengagement you must allow adequate vertical clearance (including liftoff) between the top of load and bottom of next beam level. The distance between the top pallet to the building truss is dictated by the sprinkler system and local fire codes.

Beam safety clips All rack beam connectors should have safety spring clips, safety pins or bolts to withstand an upward force of 1,000 pounds per connection without failure or disengagement.

A lower beam level installed close to floor level (usually 12" from the floor) will reduce the incidence of upright damage. Lateral impacts on the upright post are minimized by the protection and support offered by the beams. Lower beams insure proper skid location. Prevents damage to frames caused by skids located too far into the aisle being accidentally driven into and pushed into the frame.

BEAM IMPACT
Method of loading has a large effect on whether the racks are subject to impact damage:
Hand stacking or picking presents the least hazard.
Turret truck with man-aboard operator rarely causes damage.
Narrow-aisle reach or straddle trucks cause greater damage, because the operator has trouble viewing the fork and beam height.
Counter balance trucks have a lot of inertia and often cause damage in reverse as well as forward directions.

Load retainers, front-to-rear supports may be required when pallets of varying size are to be stored, or when the chance of pallet "fall through" exists. 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 and wire mesh decks should be provided on all over the aisle storage**.

The proper size and grade of bolt must be specified to be SAE grade 5 or greater when the manufacturer does not provide the bolts.

Dead end aisles cannot exceed 30 feet in length without tunnel bays to provide exits for pedestrians.

Good Lighting down every rack aisle improves picking rates, rack entry, pallet placement and aids in reducing rack damage.

Expected life versus required life of the racking should be considered when evaluating the cost of potential damage reducing features. If the rack is expected to be in use for a long time, then it has the potential to receive more impact and be excessively damaged before its use is complete.

The legal liabilities of a collapse caused by damage must be considered may be severe if the product is hazardous, or if unprotected workers or shoppers are stationed nearby.

INSTALLATION SAFETY GUIDELINES

Trained professional Installers with the knowledge and experience of rack assembly are required for proper installation. Improper assembled rack can pose a safety hazard to your employees or merchandise. If you require rack assembly, please contact us for your nearest professional authorized installation service center. We cannot provide warranty coverage for any rack installation that has been installed by anyone other than an approved installation contractor or inspected and approved by an authorized NAS professional.

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

Deviation by the Installer from the manufacturer's drawings and instructions should be approved by the manufacturer and noted on all drawings.

Changes to the configuration (moving beam levels) should only be allowed with written approval from an authorized person who will document and inspect the changes having access to this standard and the new maximum bay loads.

Major changes to the configuration of the storage racks should trigger a request for configuration drawings that meet the requirements of this standard.

SETTING UP AND INSTALLING RACKS
Before installation begins, all applicable (plan, elevation and building) drawings and instructions should be reviewed. The installer should have a meeting with the supplier/designer and customer to go over the outstanding issues.

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.

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.

Proper erection and plumbness For ease of operation and uniformity of loading all frames should be leveled with shims. With the use of a carpentry level, the rack should be shimmed vertically and horizontally to within 1/8 inch for every 10 ft. The baseplates must have firm contact with the slab or else the opposite post will be overloaded and the rack may rock out of plumb when loaded.

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.

All beam connectors require factory supplied safety pins to prevent accidental disengagement. Make certain that the beam connector is fully seated and the safety pin is fully engaged with the column holes.

Anchoring recommendations
All narrow or single rows must be anchored if the height to depth ratio exceeds six to one.

The use of anchor bolts on bearing plates is recommended for reasons other than only resisting overturning forces. Anchor bolts can resist accidental impact forces on the base of the columns that would otherwise result in large bending forces in the upright. When only one anchor is used on the front post, the front post can be twisted when impacted on the side opposite the anchor. The use of two anchors on the front post helps reduce this. In some cases, a third large anchor is added to the front baseplate, immediately in front of the upright. The two smaller anchors in conjunction with the third larger anchor are usually effective in eliminating damage caused by medium sized impacts on the lower front post. Users should specify the quantity and size of the anchors used to resist base of column impact forces. Anchor selection should be such that the shear area of the anchor is maximized (i.e. wedge type is preferable to sleeve type). Holes for anchors cannot be drilled immediately adjacent to each other, as the concrete will crack between holes.

When installing anchors, the hole drilled must be the proper depth and diameter, but it is recommended that the hole be drilled deeper than required so that the anchor can be submersed into the floor, if the layout of the racking is revised in the future.

The proper size and grade of bolt must be specified to be SAE grade 5 or greater when the manufacturer does not provide the bolts, otherwise there is a risk the bolt may fail due to lack of strength.

Bolts and anchors must be properly tightened to the minimum recommended torque specified by the manufacturer, drawings or industry standard. Inadequate tightening can make the anchor ineffective.

Seismic Rack must be anchored to the floor by anchors capable of resisting shear forces caused by the horizontal and vertical loads on the rack.

USER INSTALLATION OR RELOCATION

In addition to the above professional installation guidelines the following should be considered

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

Employee safety must be evaluated when self-installation is considered. Installation of pallet rack usually requires erectors to have full four-point safety harnesses and other related safety equipment. This standard recommends that users **not install** rack if their staff is **not qualified** to do rack erection.

Mixing racking components from different manufactures is not recommended. Not all racking systems fit together properly. Consult the manufacturer of the racking to ensure that the new racking does fit with your old racking system. All NAS rack components are designed to work together. Be cautious when introducing new to existing components. Many manufacturers offer compatible parts but with design differences. The differences may affect the overall performance and safety of the rack structure. Since NAS has no control over the design and manufacturing of these components, any warranties or guarantees are made void if non-NAS parts are used with NAS parts.

Changing Bay configuration Adding, deleting or changing your beam levels alters the bay capacity of the rack structure. Before adjusting the rack layout, please contact your NAS representative for new bay capacities or obtain new installation drawings.

Rack Modification Do not modify, drill, cut or weld any rack components. Such modifications may decrease the load caring capacity of the weakened component.

Rack inspection

Installation errors can cause significant safety problems. If the user opts for self-installation, a trained rack professional should inspect the installation.

SAFE OPERATING

Load capacity charts and other important information pertaining to the racking installation should be posted in the storage area where they are clearly visible to lift truck operators and safety personnel. Signs should state the maximum pallet load including double stacking and the total load per bay. The information can be obtained from the installation or elevation drawings, and should be secured in a safe location for future reference. Users should consult with the rack's manufacturer to supply the applicable signs as necessary, and this should be made part of the plant safety program.

Beam Overloading could result by using your rack in any manner other than originally configured and could lead to rack collapse and injury. Beams should not deflect (Bend in the center) more than the L/180 where L = the distance of the beam. If this does occur the beam load should be decreased. After a beam is completely unloaded, and does not return to its normal horizontal state, the beam has been deformed and must be replaced. Depending on the sectional properties of the beam, it may yield or deform before it reaches the above maximum allowable deflection. Should your load weights, size or configuration change, confirm that they do not exceed the manufacturer's maximum allowable load for the pair of beams.

Beam Spreading is the result of overloading one or both of the beams, causing the beam to rotate and spread outward which also causes the beam bracket to pull away from the upright column. This is usually caused by point loading or overloading, and represents a potential for serious damage to the rack structure and possible collapse. We recommend the use of safety bars or wire mesh decks to prevent pallets from falling between beams if incorrectly positioned or moved.

Dislodgement of Accessories by material handling equipment causing improper connection represents one of the most serious hazards. Many rack installations are supplied with a number of accessories such as front-to-rear supports, decking materials, including straight decks, grid decks, ledges and cradles of all kinds, which form an integral part for the safety of the racking structure.

Safety Pins are also an integral part of the security of the beam installation and if missing should only be replaced with a safety clip supplied or approved by the manufacturer of the rack. Beams should not be used if a safety-pin-spring-clip is bent in a manner that prohibits the pin from reliably performing its function. Alternatively, the beam can be bolted to the upright.

Spillage of Goods occurs if unstable loads are stored. Items may fall behind the racks or in the section next to them where there is clearance and may protrude into the aisle. Many pallets are overloaded with bulk material that hangs over, which is easily dislodged when a piece of handling equipment picks up a pallet. Spillage not only causes loss of material, but it can also cause severe damage to the rack system, especially if chemicals or oils are stored.

Floor Obstructions, debris and litter in aisles and around the rack are a serious hazard and many times responsible for personnel accidents and damage to racking.

Pallets on the Floor were often placed there, because there was not enough room in the rack for the material to be stored. Aisles filled with pallets are a serious hazard to the safe operation of the racking system. Initiate a regular program to remove pallets or any obstructions from the path of lift trucks.

Damaged Pallets, broken or cracked boards, protruding nails or other deficiencies can jam palletized loads between rails, carts or rollers. Use only pallets of correct size and in good working condition.

Most damage to rack installations occur due to high-speed material handling, careless operation of lift trucks, improper clearances and improper size of the aisle.

Impact damage to uprights is typically at the floor level of the front post, the bottom horizontal and the bottom diagonal. The bottom diagonal is usually a compression member and any damage to it will cripple its ability to perform as such. The front post is also a compression member and must therefore be free of any significant damage. When rack row ends are exposed to loading docks or main aisles and other high activity areas, the lowest pallet height of the exposed frame is prone to damage.

Inexperienced operators are a serious hazard and lift truck operator training in accordance with CSA B335 should be mandatory, however competence and experience are still factors to be considered. Greater amounts of damage will occur in workplaces where the staff turnover is such that the lift truck operators have little experience or training. 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 minimized. Again, the solution is a program of regular equipment maintenance and inspection together with a significant operator-training program.

Handling Equipment such as fork trucks, side-loaders and hand trucks are generally related to the storage racking. The condition of these trucks and the way they are handled can directly affect the safety of the rack structure. Some of the moving equipment deficiencies include poorly maintained equipment and defective forks, forks out of alignment, bad wheels or hydraulic units etc.

Lift trucks are to be equipped with protective devices to prevent the operator from being crushed by the storage racking, loads and other objects. The operator should also be restrained or otherwise protected from falling off any equipment, man-aboard or stock pickers.

Never climb on racks when picking orders or adjusting levels, a slip or fall may result in serious injury.

Immediate damage reporting to the supervisor should be mandatory and include any noticed dents, kinks, misalignment of racks or otherwise damaged racking components.

MAINTENANCE

A planned maintenance inspection program 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 regular basis to insure the integrity of the racks. Personnel should be trained and qualified to assess racking for damage and if necessary, unload the damaged rack and replace or repair damaged components immediately.

KEY AREAS TO LOOK FOR:
Damaged or corroded posts
Damaged braces
Damaged beams
All beam brackets are properly engaged and safety pins installed
Loads not to exceed specified loading capacities
No dents, kinks or otherwise damaged components
All racks plum, level, square
No shifted or missing safety bars
All components properly tightened
No sheared anchors and
All anchors secured properly, no loosening of lags or connectors

A priority system should be used when inspecting rack. Each item noted during inspection should be categorized as one of the following: a) immediate danger – unload
and put out of service, b) problem – requires repair or revision, c) bad practice –instruct operators.

A qualified and trained inspector should occasionally do rack inspections. Identification of damaged uprights that are in danger of bucking can be difficult to asses for persons without structural engineering training.

All operators should be encouraged and expected to report any damage to racks at the time of occurrence.

Upright frame damage is very common. Typical damage is to the lower front post, bottom diagonal and bottom horizontal braces. The bottom diagonal is usually a compression member and any damage to it will cripple its ability to perform as such. The front post is also a compression member and must therefore be free of any significant damage. Most damaged rack columns are due to high-speed material handling, which is one of the greatest hazards to rack installations. Collisions with columns occur due to many reasons, included careless operation of the trucks, improper clearances and improper size of the aisle. Continuous battering over the years by trucks and handling equipment could eventually reduce the overall structural capacity of the rack and result in rack failure. Damage might be a tip-off that guarding is necessary at that spot. If a column is twisted or distorted, the rack should be unloaded and rack sections removed and replaced with a NEW upright section immediately.

If repair is contemplated because of the various types of rack construction, repair of damaged parts will vary. Moderate damage to endframes under 12 ft. 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 position. Advice on the proper means to correct damage should be checked with the rack manufacturer. In most cases, buckled or severely bent rack endframes SHOULD BE REPLACED.

Repair of damaged storage rack should only be done if replacement is excessively expensive. High uprights with many beam levels are difficult to replace because the stored product must be moved and all beams must be removed and reinstalled. When repair involves operations such as cutting and welding, only persons qualified and trained to manufacture rack to this standard should be allowed to do the repairs. In some environments it is not possible to repair uprights because the use of welding equipment is not feasible or allowable. Contact NAS representatives for repair and the correct repair kit.

With buckled or dimpled beams more care should be taken. Beams should be replaced in most cases. A minor amount of abuse to the bracket will not generally affect the capacity of the beam, however kinking of the beam section will greatly reduce its capacity. A beam should not be used if it is bent in a manner that indicates it has been overloaded.

Tightening anchors and connecting bolts in accordance with torque data supplied by the manufacturer is necessary from time to time. The same criteria must be used when tightening connecting bolts as the security of the entire system is dependent upon proper fastening methods.

Rust prevention and touch up painting becomes of importance depending upon use. Any high moisture or cooler application calls for careful attention to paint conditions. This is normally an operation performed by maintenance personnel, although it requires checking all components from floor to ceiling, but at a less frequency as damage checks.

Good lighting down every rack aisle improves picking rates, rack entry, pallet placement and aids in reducing rack damage.

High maintenance standards can result in significant long-term savings. When damage is left in place, lift truck operators can make the logical deductions that damage is not a safety concern and caution is not a priority. When this message is received, the rate of damage accelerates and the facility soon requires a re-racking program at considerable cost.

NAS disclaims any responsibility for injuries or damages, which may result from the interpretation and implementation of the above safety practices, since the actual operations and conditions are beyond NAS control. It is assumed that only trained, experienced and knowledgeable personnel with proper equipment will be engaged in the design, installation, maintenance and operation of the rack system.

It is emphasized that NAS is the manufacturer of steel storage equipment and is not engaged in the specific use of its products. The opinions express intended to help and guide how the rack components should be installed and used. The expertise and skill of the installer and operator determines the quality and longevity of the rack structure.