If we load a stacker truck we can mark in the centre of gravity of both the truck and the load, and also the common centre of gravity (coloured red in the illustration). The positioning of the latter depends on the weight of the load and the load centre. When the common centre of gravity falls outside the bearing surface, the truck overturns. It the truck is loaded as shown in the figure it is very stable lengthways as there is a long distance from the common centre of gravity to the front and back edges of the bearing surface. On the other hand, the truck is less stable laterally because of the short distance to the sides of the bearing surface.





If we fit lateral stabilizers on the same truck with the same load, the truck will also be very stable laterally. The common centre of gravity is now a great distance from all sides of the bearing surface.

This is the reason why, some high lift stacker trucks are equipped with lateral stabilizers.

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poor lateral stability when it has no load.





When a reach truck has taken up a load the tion can be as shown in the illustration, wit mast in the retracted position the common of gravity is placed far back in the triangle lateral stability is no so good as a result.

With the mast in the forward position the common centre of gravity of the truck has been moved far forward and the lateral stability is good. This is a necessity when the goods are to be stacked high. However, the common centre of gravity is closer to the front edge of the bearing surface and there is an increased risk that the truck will tip forward if too heavy a load is lifted.



THE REACH TRUCK BEARING SURFACE

A reach truck is often equipped with three separately mounted wheels and therefore has a bearing surface which is triangular in shape. The centre of gravity of the truck is placed far back in order that, with the mast in the forward position, it may function as a counterbalanced truck. This means that the truck has poor lateral stability when it has no load.





When a reach truck has taken up a load the situation can be as shown in the illustration, with the mast in the retracted position the common centre of gravity is placed far back in the triangle and lateral stability is no so good as a result.

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TILTING AFFECTS THE CENTRE OF GRAVITY

The position of the common centre of gravity is affected by mast tilt, because when tilting you increase or decrease the distance between the centre of gravity of the truck and that of the load. The higher the load is lifted, the greater the effect. - As illustrated in fig 1.



Fig 1



Many high lift reach trucks have a tilting fork mechanism instead of a tilting mast, but as can be seen illustrated in fig 2, the effect is almost the same.

LATERAL STABILITY

The lateral stability of a truck changes depending on how high you have the load. You can understand this if you compare the truck with a boat and its skipper. If the skipper sits in the boat, it does not overturn so easily. However, if the skipper stands up, or for example climbs up the mast, the boat becomes very unstable. This depends on the fact that the centre of the gravity of the load (=the skipper) has moved upwards. When you lift a load with your truck, you not only move the centre of gravity of the load upwards, but also the common centre of gravity. The higher the common centre of gravity goes, the more unstable your truck becomes. This is one of the reasons why the rated lifting capacity is reduced at increased lifting heights.





Common centre of gravity





DRIVING LATERALLY ON GRADIENTS

The height of the common centre of gravity is of very great importance if you have to drive across a gradient. Never turn on a gradient.

If the load is placed low the common centre of gravity is inside the bearing surface and far from all sides, which in turn means the truck is stable (see figure to the left).

Driving on the same gradient with the load high, the common centre of gravity falls close to or outside the bearing surface (see figure to the right). If it falls outside, your truck will overturn.



THE TRUCK – A COMPROMISE

A stable forklift truck with comprehensive lifting capacity must be wide, long, heavy and have a low centre of gravity. The ideal truck in other words would be very bulky. For this reason trucks are designed for different purposes and in different sizes.

All trucks are a compromise, and you should be aware of the compromises made in respect of the type of truck you operate.



CAPACITY PLATES ON TRUCKS

The manufacturer must equip each truck with a capacity plate which provides the operator with information on the lifting capacity of the truck. It is important that you familiarise yourself with the information on the plate before you operate the truck. These plates can be of different types. Some display tables, some diagrams. They indicate the lift capacity at given load centres that can be handled safely to certain heights.

THE WEIGHT OF THE LOAD

A truck can lift a certain maximum weight of load. This information is indicated on the truck's capacity plate for the benefit of the operator. A typical (although simplified) truck capacity plate is shown below.



The maximum weight which can be lifted by this truck is 2500 kg (5500 lb), even at low lift heights and with small size loads. Remember that the weight of loads indicated on the truck's capacity plate is **maximum**. It must **never** be exceeded; and in some applications the actual loads handled should be considerably less.

Your will notice that the higher the truck is capable of raising the load, the less weight it is permitted to lift. Accordingly, up to 3.3 m (130 in), it can raise 2500 kg (5500 lb) at 500 mm (20-in) load centre.

Above 3.3 m (130 in) and up to 4.2 m (165 in), it can only safely raise 2450 kg (5400 lb) and above 4.2 m, up to its maximum lift height of 4.9 m (193 in), it can only raise 2360 kg (5200 lb) at 500 (20 in load centre).

You will also notice that each height shown on the capacity plate — the permitted weight is shown at 500 mm (20 in), 600 mm (24 in) and 750 mm (30 in). As the load centre increases, the permitted weight decreases.

CENTRE OF GRAVITY CAPACITY DIAGRAM

The permitted load can even be shown in the form of a centre of gravity diagram, which gives the lifting capacity of the truck for different load centres.



You can read from this diagram that the truck can lift 1500 kg with a 500 mm load centre.

Note! If you have a load centre of less than 500 mm, the truck does not have a greater lifting capacity than that given for 500 mm.

This means that you may not handle more than 1500 kg with the truck to which this diagram applies, even if the load is very close to the fork heels.

CAPACITY PLATES FOR ATTACHMENTS

If your truck has an attachment fitted, there must be a capacity plate giving the following information.

- The weight of the attachment
- The distance from the truck/attachment connection point to the attachment centre of gravity position
- In the case of a portable crane jib the maximum lifting capacity at each slinging point

WARNING: Do not exceed the permitted capacity for the combined truck/attachment.

Forces on the truck

CENTRIFUGAL FORCE

If you fasten a piece of string to an object and swing it around in the air, the string will be fully extended. Centrifugal force causes the object to try to fly outwards. If you release the piece of string the object will fly off. If you use a rubber band instead of a piece of string, the rubber band will be stretched more and more the faster the object swings around because the centrifugal force is greater at increased speed. If you double the speed the centrifugal force increases fourfold.



Even your truck experiences centrifugal forces when you drive around a corner. However, you have no piece of string to keep the truck from flying off, you depend on the frictional forces of the tyres to do this for you. If the centrifugal force becomes too great, which happens when you drive too fast in a corner, the tyres lose their grip (the string breaks) and the truck skids and overturns.



LIVE FORCE

All objects in motion possess a certain kinetic energy. The amount of this energy depends on the mass and velocity of the object. The kinetic energy increases, if the mass or velocity increases. The object is said to have a live force.

If you travel in a car that suddenly brakes sharply, you are thrown forwards due to the live force in your body. When you brake your truck the load will continue forwards for the same reason. If the load is unstable or you brake too hard, the load will fall off the forks. **The live force is** greater for heavy objects and increases the faster you go.



THE INERTIA OF THE LOAD

When you start a loaded truck you must remember that the load has a certain inertia (the load strives to remain where it was). A sudden start, especially in/reverse, can result in losing the load. The heavier the object is the greater the inertia is. If you first kick a ball and then kick a stone you will feel the difference.





UNEVEN SURFACES

A truck is not a "racing car" and therefore is not designed like one. A truck lacks all suspension, which means that it will bounce if driven at high speed over uneven surfaces.

This bouncing effect can result in the truck completely losing its steering capacity.



When a truck is driven too fast in a corner that has an uneven surface, the bouncing effect means that the tyres lose contact with the surface. When this happens certifugal force takes over and the truck skids.



SHOCK EFFECT

Careless driving on uneven surfaces exposes the truck to very great stresses. The electronic and hydraulic systems are particularly sensitive, but even parts such as the lifting chains can be damaged by large shock forces.

An uneven surface has an adverse effect on truck performance and also creates a risk of damage to both the truck and the load.

Materials Handling and Packing

MATERIALS HANDLING

In short, materials handling comprises all transportation, handling, storage and packing of goods. Handling never increases the value of the goods, but only leads to costs. Materials handling costs as a percentage of total costs have greatly increased since the turn of the century due to the specialization and centralization of industry and increased international trade.

Today, these costs account for more than 50% of the total cost to the consumer for many products.



DEVELOPMENT IN HANDLING

There has been considerable development in the materials handling field, as in manufacturing, and in the early 50's the results of this development really came to the fore. Since then, there has been rapid expansion. Earlier transport movements were carried out manually with the aid of trolleys and barrows. Loading and unloading often took place with goods being inched up onto lorry platforms and railway wagons with the aid of levers and planks. It was heavy work, which demanded great physical effort and involved many risks.

Rising labour costs made it imperative that materials handling methods should be more efficient. The advent of forklift trucks was a major factor in further development and led, among other things, to better packing methods.



Stacking and Storage

PALLET RACKING

The most common stacking method is the use of pallet racking. These can either be in single or double rows. The distance between the racks (aisle width) can vary, depending on the type of truck used.

Pallet racking is a flexible storage method, where all stored units can be handled independently of one another. This method involves more space and greater investment than bulk stacking. On the other hand, the stacking height can be greater, from 4 to 9 metres.

Pallets racking is preferred in warehouses and stores which have a wide range of goods and where a hich degree of accessibility is required.





FREE STANDING STACKING

Free standing stacking means that the loads are stacked on top of one another. This can be, as with pallet racking, in single or double rows. Only the top load of each stack is accessible. This type of stacking means that the packing of the loads at the bottom of the stack must withstand great weights. Therefore, the stacking height is often limited. Furthermore, the loads must be of regular shape and stable, if they are to avoid the risk of toppling over. Great demands are also placed on precision and care when stacking.

BULK STACKING

This method of stacking requires the least space. However, it can only be used where there is a large number of similar loads. The goods must be positioned so that the truck can come in between the rows without difficulty. Always follow the local regulations in respect of stack height, aisles etc.

Bulk stacking means poor load accessibility and therefore it is difficult to use the first-in first-out principle. For this reason rules are often laid down as to how incoming and outgoing goods are to be handled in warehouses using bulk stacking, in order to ensure correct rotation of stock.



Packing

UNIT LOADS

The unit load is easy to handle and can be transported unopened from the supplier to the end user.

A unit load should be suitable for both truck and pallet handling.

STANDARD PACKING

The main object of packing is to provide protection for the goods and to facilitate handling. Good packing must be able to withstand handling by trucks and other materials handling equipment. This has involved a long standardization process regarding design and dimensions.

A large number of different types of pallets and packing are used depending on requirements and conditions. Some of the most common types are presented below.





TIMBER PALLETS

Timber pallets are commonly used in a wide range of industries and services, forming an essential part of many mechanical handling systems in factories, distribution, warehouse and the like.

The most common size in use in the UK is 1000 x 1200 mm, two- and four- way entry.

THE EUR PALLET

The EUR (European Pallet) is becoming more and more common. Most European countries use an agreed pallet dimension of 800 x 1200 mm, and to increase flexibility in transit, they also use a HALF PALLET, 800 x 600 mm.



TWO- AND FOUR- WAY PALLETS

The four-way entry pallet can be handled from alls four sides. A pallet which can olny be handled from two sides is called a two-way entry pallet.

Pallets are available in wood, plastic, sheet metal, fibre board and paper board.







PALLET COLLARS

Folding pallet collars are often used, especially for long distance transport, to retain goods on the pallet. Stable and stackable transport packing is achieved by placing a lid on the collars. The collars must be bound together to make them more secure and special collar tensioners are available. Collars are foldable which means they can easily be returned.

PALLET SUPPORTS

There are a number of other methods to support goods on pallets, besides pallet collars. Here we have a method which uses collapsible sides.



PALLET CONVERTER

A pallet converter is a metal frame fitted to a normal wooden pallet: allows stacking of crushable loads.

Note: These types are sometimes designed to be "collapsible" so as to occupy less space when being returned empty or stored.





POST PALLET

A post pallet is of metal (deck may be of wood) with stacking feet. Can be fitted with mesh sides, with one side detachable or hinged.

SHEET METAL BOXES OR CORNER POST PALLETS

There are many different types of boxes made of sheet metal. Many have pallet feet in the corners instead of the normal runners, as on timber pallets.





WIRE NETTING CONTAINER

Wire netting containers allow one to see the goods which are being transported, which is not the case when using pallet collars.

ROLL PALLET

A roll pallet or a roll cage comprises a deck with wheels and castors and with side guards to retain the loads. Widely used in order picking and distribution of consumer goods.





SLIPSHEET

For long journeys when maximum use should be made of the loading space, the pallet can be replaced by a paper or plastic sheet (slipsheet). This method is not common mainly because special truck attachments must be used for loading and unloading.

BOXES AND CRATES

Wooden packing is used especially for heavy goods and for export loads, since both goods and the packing are subjected to great stress during transit. Wooden packing is often tailor-made for a particular product. Therefore, there are numerous different types and sizes. A crate can be described as a wooden box with spaced slats. A crate is not as strong as a box. Objects (e.g. forks) can in the event of careless handling damage the goods due to the spacings between the slats.





EXPENDABLE CONTAINERS

There are many different types of expendable packing. Here we have an expendable container of paperboard.

Another common approach is to totally wrap the palletised load in plastic. This is called shrinkwrapping.



TIPPING CONTAINERS

A sheet metal tipping container is available for forklift trucks. This is often used for handling scrap metal and waste.

CONTAINERS AND PLATFORMS

Steel plate containers are often used for handling large quantities of goods. Standard sizes are from 10 - 40 ft in length and they are used mostly for transport by road, rail and sea. Containers permit undercover loading and unloading. There is special equipment available at ports and terminals for the handling of containers.

A platform (not shown) consists of the bottom part of a container and it can be fitted with sides and a cover.



Handling and Storing Goods Pallet Handling

PARALLEL FORKS

The forks must be parallel with the pallet runners. The centre of the pallet should be aligned between the forks. If the forks are run in at an angle, the pallet may be damaged or the goods may fall off.



It is important that the forks are horizontal when they are run in under the pallet. They must not be forced in, but must run freely. Carrying the pallet, after an incorrect insection results in the entire weight of load being borne by a single board, which might then break.

ONG

FORK SPREAD

Correct fork spread is expecially important when handling heavy palletised loads. Too great or too small a spread results in the pallet bending, with the resultant risk than the load will slide or fall off. Furthermore, if the pallet is fitted with collars, these do not bear against the pallet and goods can fall off.



USE THE FULL LENGTH OF THE FORKS

When you pick up a load you must, when the fork length permits, run the forks completely under the pallet. If the pallet is unevenly loaded you must have the heaviest part nearest the mast. During travel the pallet must always bear against the fork heels; this reduces stress on the forks and improves truck stability. Furthermore, there is less risk of shedding the load. During travel you should tilt the mast backwards to cradle the load and increase its stability.



EXTENSION FORKS

If you need longer forks temporarily, you can use a pair of extension forks. These are not as strong as a pair of normal forks and are therefore not suitable for permanent use. The max permitted load and associated load centre should be marked on the extension. Normally the extension should not be more than 50% longer than basic forks.



KEEP FORK LENGTH IN MIND

When the forks stick out beyond the end of the pallet, you must be extra careful that you do not damage other pallets or goods.



PUSHING PALLETS

You must never slide or push pallets with the forks. Never lift a pallet on one corner or on one side only. Incorrect handling of the pallet can result in nailed connections being loosened and the wooden members can split apart.



UNEVEN GROUND

A loaded pallet must not be placed on uneven ground. If there is an object under the pallet, the runners can be broken. The risk of this happening is especially great in the case of heavy pallets or when stacking.



EMPTY PALLETS

Empty pallets must be stacked and handled with care. Careless handling can result in warped or otherwise damaged pallets.

Damaged pallets must not be used, but must either be repaired or discarded.



Marking symbols for packaging

Goods are sometimes perishable, dangerous or unsuitable for certain types of handling. The packaging is marked in order to inform all personnel involved in the transport as to how the goods must be handled.

There are standardized symbols for different types of goods and you, as a forklift operator, must know what the different symbols means. The marking of dangerous goods is presented in the chapter on **Dangerous Goods** later in this book.



Fragile - handle with care



Use no hooks





Keep away from heat



Temperature limits



Keep dry



Centre of gravity



Do not roll







Clamp here



Sling here

Handling of rolls and long loads

HANDLING OF ROLLS

Roll clamps are normally the safest attachments to use when handling cylindrically shaped goods, e.g. paper rolls. Remember that you must transport the roll in the vertical position. If you transport the goods in the horizontal position and the ground is uneven, then the forces on the bottom clamp can be so great as to cause you to shed the load. If this happens it is liable to roll and people may be injured and equipment damaged.

Steel coils (plate rolls), steel wire, rolled mats and other rolls difficult to grip are best handled with a boom.



HANDLING LONG GOODS

This side-loading truck and the four-way truck are especially designed for long goods. An ordinary forklift truck can often be used for shorter distances. The forks must be at maximum spread. Make sure that the centre of gravity of the load lies between the forks. Pipes and bars should be tied together when transported in this way. Tilt the mast as far back as possible and check during travel that the ends of the goods do not catch in anything.



Handling Containers

CONTAINERS REQUIRE CAREFUL HANDLING

All containers are designed to be as light as possible when empty. Their weight is kept to minimum by using thin guage steel which means that the container is sensitive to careless handling.



INCORRECT HANDLING

Incorrect handling can easily lead to damage to the container floor, panels or structural sections. **Damage occurs if:**

- The forks are incorrectly placed in the fork tunnels.
- The container is pushed by the forks against walls etc.
- The container is placed on uneven ground.
- Handling is effected with a lifting yoke which is not fastened correctly to each corner of the container.
- The container collides with other objects.
- The weight inside the container is not evenly distributed.

Stacking - Counterbalanced Truck

1. Drive up to the stack with the load in the correct travel position and the mast tilting backwards so that the load is secure. Stop in front of the stack and apply the brakes.



- 2. Reduce the tilt until it is just sufficient to stabilise the load, check overhead clearance then lift the load so that it is a little higher than the stack.
- 3. Drive up to the stack. Avoid turning with the load in the raised position.

When the load is in a suitable position above the stack apply the brakes and make final tilt adjustment. The load must be set down evenly so as not to damage the goods underneath.

4. Lower the forks so that they are not in contact with the pallet, and reverse the truck from the stack. It can be easier if the mast is slightly tilted forward.

Do not forget to check behind "before" you commence reversing.

5. When the forks are free of the stack: stop, apply the brakes, lower the forks to the travel position and tilt them back before checking that the way is clear and moving off.









Stacking - Reach Truck

- 1. Drive up to the stack with the load low, reached back, and tilted backwards. Stop at the face of the stack and apply the brakes.
- 2. Reduce the tilt until it is just sufficient to maintain the load stability. Check overhead clearance then raise the load until it is clear of the stack.

3. Drive forward, if necessary, to come close to the stack. Avoid turning with the load in the raised position. Apply the brakes and reach the mast forward.

4. Tilt the mast to a vertical position. Make the final tilt adjustment, reach or move closer to the stack if necessary. When the load is in a suitable position lower the load onto the stack.

Lower the forks so that they are not in contact with the pallet, and reach back. It can be easier if the mast is slightly tilted forward. Reverse to get the forks fully clear of the stack if necessary.
Do not forget to check behind before you commence reversing.

6. When the forks are clear of the stack: stop, apply the brakes, lower the forks to the travel position and tilt them back before checking that the way is clear and moving off.













REMOVING LOADS FROM THE STACK

The removal of loads from the stack is carried out in the reverse order to stacking. However, you must keep the following in mind:

- The truck must have adequate rated lifting capacity for the load!
- The forks must be run in as far as possible under the pallet without objects positioned behind the load being damaged by the fork tips!
- The load must be lowered to the travel position before you turn and drive!

STACKABILITY

Before you stack goods you must make sure that they are stackable. Remember that the bottom load will be subjected to a great weight, if it gives way the entire stack will collapse. Goods on damaged pallets must never be stacked.

You must place the goods squarely and accurately on top of the goods underneath. Failure to do so may create an unstable stack which may collapse.





STACKING IN PALLET RACKS

Each bearing level has a rated loading which must never be exceeded. High pallet racks normally have a reduced rated loading for the higher levels.

From the point of view of stability, the lower bearing levels should be filled first, and then stacking level by level upwards should follow. When removing goods you should work in the reverse order. There are often local rules and these must be followed.

A pallet rack is designed for either short side or long side pallet handling. Always place the goods in the correct manner to suit the racking being used. Special racks or special equipment between the bearing members are necessary for half pallets or containers having pallet feet.

POSITION IN A PALLET RACK

Pallet racks are often arranged in double rows, partly to give improved stability and partly to reduce the number of aisles. For both double row and (as shown below) single row racks you must always place a pallet in the middle of the shelf in order for the rack to be evenly loaded and to prevent the pallet sliding off the bearing members. If a pallet is positioned too far in, then the pallet backing onto it can be pushed out of its space and fall down.







DAMAGE TO PALLET RACKS

When handling goods in a pallet rack you must be careful not to damage the racking uprights.

A damaged pallet rack is a safety risk and must be reported. For example, if an upright has been damaged, the rack has a lower bearing capacity than previously.

VISIBLE MARKING

Marked goods must always be placed with their identity labels facing outwards. If the labels are facing inwards, neither you or anyone else can see what the pallet contains.



Vehicle loading and unloading

Before you attempt to load or unload a lorry or trailer, a few basic rules must be learned and adhered to:

- Ensure the vehicle is parked in the correct place.
- Ensure that the brakes are applied and the engine of the lorry or tractor is switched off. Chock the wheels if necessary.
- Ensure that the bed of the vehicle is free from debris and that it will support the weight of the load(s) you intend to place upon it.

With some uncoupled semi-trailers, it may be necessary to place a prop under the front-end in order to prevent it from tipping.



LOADING LORRIES OR TRAILERS

You, as a forklift truck operator, must always follow the instructions given by the lorry driver whose lorry you are loading. However, you should be aware of the following rules.

- Loading should commence at the front of the lorry platform and goods must be in delivery order — First on — Last off.
- It might be necessary to disregard the rule of even load distribution in order to achieve the correct axle weight!
- Load from both sides (never slide or push the load to the other side)!
- Always follow the instructions given by the driver of the vehicle you are loading (the driver is responsible for his load)!