

Forklift

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A **forklift** (also called a **lift truck**, a **fork truck**, or a **forklift truck**) is a powered industrial truck used to lift and move materials short distances. The forklift was developed in the early 20th century by various companies including the transmission manufacturing company Clark and the hoist company Yale & Towne Manufacturing.^{[1][2][3]} Following World War II the use and development of the forklift truck has greatly expanded worldwide. Forklifts have become an indispensable piece of equipment in manufacturing and warehousing operations.^[4] In 2013 alone the top 20 manufacturers worldwide posted sales of \$30.4 billion with 944,405 machines sold.^[5]

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Forklift



A US airman operating a Hyster forklift

Classification Vehicle

Industry Various

Application Multiple

Fuel source Various including:

- Gasoline
- Propane
- CNG
- Diesel
- Lead Acid Battery
- Fuel cell

Powered Yes

Wheels Various wheel configurations

Axles 2-3

Components Power source, Mast, Frame, Counterweight, Cab, Axles, Wheels, Overhead Guard, Load Back Rest, Hydraulic Pump, Hydraulic Lines, Hydraulic Controls, Hydraulic Cylinders and Attachments

History

The middle nineteenth century through the early 20th century saw the developments that led to today's modern forklifts. The forerunners of the modern forklift were manually powered hoists that were used to lift loads.^[4] In 1906 the Pennsylvania Railroad introduced battery powered platform trucks for moving luggage at their Altoona, Pennsylvania train station. World War I saw the development of different types of material handling equipment in the United Kingdom by Ransomes, Sims & Jefferies of Ipswich. This was in part due to the labor shortages caused by the war. In 1917 Clark in the United States began developing and using powered tractor and powered lift tractors in their factories. In 1919 the Towmotor Company, and Yale & Towne Manufacturing in 1920, entered the lift truck market in the United States.^[2] Continuing development and expanded use of the forklift continued through the 1920s and 1930s. The introduction of hydraulic power and the development of the first electric power forklifts, along with the use of standardized pallets in the late 1930s, helped to increase the popularity of forklift trucks.^[4]



A forklift truck being used during World War II

The start of World War II, like World War I before, spurred the use of forklift trucks in the war effort.^[6] Following the war, more efficient methods for storing products in warehouses were being implemented. Warehouses needed more maneuverable forklift trucks that could reach greater heights and new forklift models were made that filled this need.^[7] For example, in 1954 a British company named Lansing Bagnall, now part of KION Group, developed what was claimed to be the first narrow aisle electric reach truck.^[6] The development changed the design

of warehouses leading to narrower aisles and higher load stacking that increased storage capability.^[6] During the 1950s and 1960s operator safety became a concern due to the increasing lifting heights and capacities. Safety features such as load back rests and operator cages, called overhead guards, began to be added to forklifts produced in this era.^[4] In the late 1980s ergonomic design began to be incorporated in new forklift designs to improve operator comfort, reduce injuries and increase productivity.^[8] During the 1990s exhaust emissions from forklift operations began to be addressed which led to emission standards being implemented for forklift manufacturers in various countries.^[9] The introduction of AC power forklifts, along with fuel cell technology, are also refinements in continuing forklift development.^{[4][10]} In 2011, the size of the forklift manufacturing industry was nearly \$27 billion.^[11]

General operations

Forklifts are rated for loads at a specified maximum weight and a specified forward center of gravity. This information is located on a nameplate provided by the manufacturer, and loads must not exceed these specifications. In many jurisdictions it is illegal to alter or remove the nameplate without the permission of the forklift manufacturer.

An important aspect of forklift operation is that most have rear-wheel steering. While this increases maneuverability in tight cornering situations, it differs from a driver's traditional experience with other wheeled vehicles. While steering, as there is no caster action, it is unnecessary to apply steering force to maintain a constant rate of turn.

Another critical characteristic of the forklift is its instability. The forklift and load must be considered a unit with a continually varying center of gravity with every movement of the load. A forklift must never negotiate a turn at speed with a raised load, where centrifugal and gravitational forces may combine to cause a disastrous tip-over accident. The forklift is designed with a load limit for the forks which is decreased with fork elevation and undercutting of the load (i.e., when a load does not butt against the fork "L"). A loading plate for loading reference is usually located on the forklift. A forklift should not be used as a personnel lift without the fitting of specific safety equipment, such as a "cherry picker" or "cage".

Forklifts are a critical element of warehouses and distribution centers. It's imperative that these structures be designed to accommodate their efficient and safe movement. In the case of Drive-In/Drive-Thru Racking, a forklift needs to travel inside a storage bay that is multiple pallet positions deep to place or retrieve a pallet. Often, forklift drivers are guided into the bay through guide rails on the floor and the pallet is placed on cantilevered arms or rails. These maneuvers require well-trained operators. Since every pallet requires the truck to enter the storage structure, damage is more common than with other types of storage. In designing a drive-in system, dimensions of the fork truck, including overall width and mast width, must be carefully considered.^[12]

Forklift control and capabilities

Forklift hydraulics are controlled either with levers directly manipulating the hydraulic valves, or by electrically controlled actuators, using smaller "finger" levers for control. The latter allows forklift designers more freedom in ergonomical design.

Forklift trucks are available in many variations and load capacities. In a typical warehouse setting most forklifts have load capacities between one and five tons. Larger machines, up to 50 tons lift capacity, are used for lifting heavier loads, including loaded shipping containers.^[13]

In addition to a control to raise and lower the forks (also known as blades or tines), the operator can tilt the mast to compensate for a load's tendency to angle the blades toward the ground and risk slipping off the forks. Tilt also provides a limited ability to operate on non-level ground. Skilled forklift operators annually compete in obstacle and timed challenges at regional forklift rodeos.

Design types

The following is a list, in no particular order, of the more common lift truck types:

- Hand pallet truck - no on-board power system of any kind; the operator's muscle power is used to jack-up and move loads.
- Walkie low lift truck^[14] - powered pallet truck, usually electrically powered^[15]
- Rider low lift truck^[14] - usually electrically powered
- Towing tractor - may be internal combustion engine or electrically powered
- Walkie stacker^[14] - usually electrically powered
- Rider stacker^[14] - usually electrically powered, e.g., A Ergo



Forklift cab with control layout.

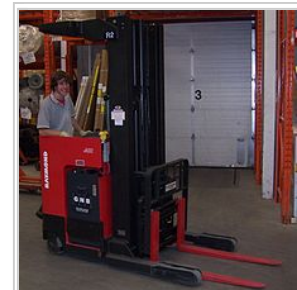


Dedicated container forklift of the HMNZS Canterbury vessel of the New Zealand Navy



A truck-mounted forklift.

- Reach truck^[14] - variant on a Rider Stacker forklift, designed for small aisles, usually Electrically Powered, named because the forks can extend to reach the load. There are two variants, moving carriage, which are common in North America, and moving mast which are common in the rest of the world, and generally regarded as safer
- Electric counterbalanced truck^[14] - comes in Stand on End Control, Stand on Center Control, and Sit Down Center Control, which is the most numerous
- Internal Combustion Engine Powered Counterbalanced Forklift^[14] - comes in Stand on End Control, Stand on Center Control, and Sit Down Center Control, which is the most numerous. Engines may be diesel, kerosene, gasoline, natural gas, butane, or propane fueled, and may be either two stroke spark ignition, four stroke spark ignition (common), two stroke compression ignition, and four stroke compression ignition (common). North American Engines come with advanced emission control systems. Forklifts built in countries such as Iran or Russia will typically have no emission control systems.
- Electric forklifts - powered by lead-acid batteries, several types of forklifts are electric: cushion tire forklifts, scissor lifts, order pickers, stackers, reach trucks and pallet jacks. Electric forklifts are primarily used indoors on flat, even surfaces. Electric forklift batteries last 6 consecutive hours or throughout an 8-hour shift with 2-3 breaks. Batteries prevent the emission of harmful fumes and are recommended for facilities in food-processing and healthcare sectors.
- Fuel cell forklifts produce no local emissions, can work for a full 8-hour shift on a single tank of hydrogen, can be refueled in 3 minutes and have a lifetime of 8–10 years. Fuel-cell-powered forklifts are often used in refrigerated warehouses as their performance is not degraded by lower temperatures.
- Sideloader^[14] - comes in Stand on End Control, and Sit Down End Control, which is the most numerous. It may be electrically powered, or have an internal combustion engine. Engines may be diesel, kerosene, gasoline, natural gas, butane, or propane fueled, and may be either two stroke spark ignition, four stroke spark ignition (common), two stroke compression ignition, and four stroke compression ignition (common). North American Engines come with advanced emission control systems. Forklifts built in countries such as Iran or Russia will typically have no emission control systems. Some sideloaders have hybrid drivetrains.
- Telescopic handler - comes in Stand on Center Control, and Sit Down Center Control, which is the most numerous. Usually has an Internal Combustion Engine. Engines are almost always diesel, but sometimes operate on kerosene, and sometimes use propane injection as a power boost. Some old units are two stroke compression ignition, most are four stroke compression ignition (common). North American Engines come with advanced emission control systems. Forklifts built in countries like Iran or Russia will typically have no emission control systems. Some Telescopic handlers have Hybrid drivetrains.
- Walkie order picking truck^[14] - usually Electrically Powered
- Rider order picking truck^[14] - commonly called an "Order Picker"; like a small Reach Truck, except the operator rides in a cage welded to the fork carriage, while wearing a specially designed safety harness to prevent falls. A special toothed grab holds the pallet to the forks. The operator hand transfers the load onto the pallet one article at a time. This is an efficient way of picking less than pallet load shipments, and is popular for use in large distribution centers.
- Articulated very narrow aisle counterbalanced trucks - sometimes called "Flexi or Bendi Trucks" after two of the largest manufacturers. Comes in stand on center control, and sit down center control, which is the most numerous. May have an internal combustion engine or an electric motor. Electric motors are most common. Engines may be diesel, kerosene, gasoline, natural gas, butane, or propane fueled, and may be either two stroke spark ignition, four stroke spark ignition (common), two stroke compression ignition, and four stroke compression ignition (common). North American Engines come with advanced emission control systems. Forklifts built in countries such as Iran or Russia will typically have no emission control systems. Some units have hybrid drivetrains. Unlike Standard Counterbalance and Reach Forklifts, These forklifts are steered via the front swivel articulation of the forklift and are therefore much different to manoeuvre than regular forklifts and additionally have no pantograph feature for retrieving stock in narrow aisles.
- Guided very narrow aisle truck - A counterbalance type Sit Down Rider Electric Forklift fitted with a specialized mast assembly. The mast is capable of rotating 90 degrees, and the forks can then advance like on a reach mechanism, to pick full pallets. Because the forklift does not have to turn, the aisles can be exceptionally narrow, and if wire guidance is fitted in the floor of the building the machine can almost work on its own. Masts on this type of machine tend to be very high. The higher the racking that can be installed, the higher the density the storage can reach. This sort of storage system is popular in cities where land prices are really high, as by building the racking up to three times higher than normal and using these machines, it is possible to stock an incredible amount of material in what appears to be a small space.^[16]
- Guided very narrow aisle order picking truck - counterbalance type Order Picking Truck similar to the guided very narrow aisle truck, except that the operator and the controls which operate the machine are in a cage welded to the mast. The operator wears a restraint system to protect him against falls. Otherwise the description is the same as guided very narrow aisle truck.
- Truck-mounted forklift / sod loader - comes in sit down center control. Usually has an internal combustion engine. Engines are almost always diesel, but sometimes operate on kerosene, and sometimes use propane injection as a power boost. Some old units are two-stroke compression ignition, most are four-stroke compression ignition (common). North American engines come with advanced emission control systems. Forklifts built in countries such as Iran or Russia will typically have no emission control systems.



A Raymond reach truck. Note the pantograph allowing the extension of the forks in tight aisles.

Cost

The cost of a new forklift can vary between \$15,000 to in excess of \$150,000, dependent on the model and in particular the capacity of the forklift. The most common forklifts are typically gas powered and have a capacity of between 2 and 2.5 tonnes. The cost of these varies from around \$18,500, for some of the less well known Chinese manufactured forklifts, up to around \$20,000, for the German forklifts from well-established manufacturers; it is important to take into account fuel and maintenance costs when calculating the total cost of ownership.

Specialty trucks

At the other end of the spectrum from the counterbalanced forklift trucks are more 'high end' specialty trucks:

- **Articulated counterbalance trucks**

These are, unlike most lift trucks, front wheel steer, and are a hybrid VNA (very narrow aisle) truck designed to be both able to offload trailers and place the load in narrow aisle racking. Increasingly these trucks are able to compete in terms of pallet storage density, lift heights and pallet throughput with guided very narrow aisle trucks, while also being capable of loading trucks, which VNA units are incapable of doing.^[17]

- **Guided very narrow aisle trucks**

These are rail- or wire-guided and available with lift heights up to 40 feet non-top-tied and 98 feet top-tied. Two forms are available: 'man-down' and 'man-riser', where the operator elevates with the load for increased visibility or for multilevel 'break bulk' order picking. This type of truck, unlike articulated narrow aisle trucks, requires a high standard of floor flatness.

- **Omnidirectional trucks**

Omnidirectional technology (such as Mecanum wheels) can allow a forklift truck to move forward, diagonally and laterally, or in any direction on a surface. Omnidirectional wheel system is able to rotate the truck 360 degrees in its own footprint or strafe sideways without turning the truck cabin. One example is the Airtrax Sidewinder. This forklift truck has also made an appearance in the TV series called 'Mythbusters'.

- **UL 558 safety rated trucks**

In North America, some internal combustion powered industrial vehicles carry Underwriters Laboratories ratings that are part of UL 558. Industrial trucks that are considered "safety" carry the designations GS (Gasoline Safety) for gasoline powered, DS (Diesel Safety) for diesel powered, LPS (Liquid Propane Safety) for liquified propane or GS/LPS for a dual fuel gasoline/liquified propane powered truck.^[18]

UL 558 is a two-stage Safety Standard. The basic standard, which is G, D, LP, and G/LP is what Underwriter's Laboratories considers the bare minimum required for a lift truck. This is a voluntary standard, and there is no requirement in North America at least by any Government Agency for manufacturers to meet this standard.

The slightly more stringent GS, DS, LPS, and GP/LPS, or **Safety** standard does provide some minimal protection, however it is extremely minimal. In the past Underwriter's Laboratory offered specialty EX and DX safety certifications. If you require higher levels of protection you **must** contact your local Underwriter's Laboratory Office and check ask them what the correct safety standard is for your workplace.

- **UL 583 safety rated trucks**

UL 583 is the Electric equivalent of UL 558. As with UL 558 it is a two-stage standard.

- **Explosion proof trucks "EX RATED"**

These are for operation in potentially explosive atmospheres found in chemical, petrochemical, pharmaceutical, food and drink, logistics or other industries handling flammable material. Commonly referred to as Pyroban trucks in Europe, they must meet the requirements of the ATEX 94/9/EC Directive if used in Zone 1, 2, 21 or 22 areas and be maintained accordingly.

- **U.S. Military 10K-AT "Adverse Terrain"**

Automated forklift trucks

In order to decrease work wages, reduce operational cost and improve productivity, automated forklifts have also been developed.^{[19][20]} Automated forklifts are also called forked automated guided vehicles and are already available from a growing number of suppliers.^[21]

Counterbalanced forklift components

A typical counterbalanced forklift contains the following components:^[22]



A straight mast container handler at Haikou Xiuying Port, Hainan, China

- **Truck frame** - is the base of the machine to which the mast, axles, wheels, counterweight, overhead guard and power source are attached. The frame may have fuel and hydraulic fluid tanks constructed as part of the frame assembly.
- **Counterweight** - is a mass attached to the rear of the forklift truck frame. The purpose of the counterweight is to counterbalance the load being lifted. In an electric forklift the large lead-acid battery itself may serve as part of the counterweight.
- **Cab** - is the area that contains a seat for the operator along with the control pedals, steering wheel, levers, switches and a dashboard containing operator readouts. The cab area may be open air or enclosed but it is covered by the cage-like overhead guard assembly. When enclosed, the cab may also be equipped with a cab heater for cold climate countries along with a fan or air conditioning for hot weather.^[23]
- **Overhead guard** - is a metal roof supported by posts at each corner of the cab that helps protect the operator from any falling objects. On some forklifts, the overhead guard is an integrated part of the frame assembly.^[24]
- **Power source** - may consist of an internal combustion engine that can be powered by LP gas, CNG, gasoline or diesel fuel. Electric forklifts are powered by either a battery or fuel cells that provides power to the electric motors. The electric motors used on a forklift may be either DC or AC types.^{[25][26]}
- **Tilt cylinders** - are hydraulic cylinders that are mounted to the truck frame and the mast. The tilt cylinders pivot the mast backward or forward to assist in engaging a load.
- **Mast** - is the vertical assembly that does the work of raising and lowering the load. It is made up of interlocking rails that also provide lateral stability. The interlocking rails may either have rollers or bushings as guides. The mast is driven hydraulically, and operated by one or more hydraulic cylinders directly or using chains from the cylinder/s. It may be mounted to the front axle or the frame of the forklift. A 'container mast' variation allows the forks to raise a few meters without increasing the total height of the forklift. This is useful when double-loading pallets into a container or under a mezzanine floor.^[27]
- **Carriage** - is the component to which the forks or other attachments mount. It is mounted into and moves up and down the mast rails by means of chains or by being directly attached to the hydraulic cylinder. Like the mast, the carriage may have either rollers or bushings to guide it in the interlocking mast rails.^[25]
- **Load back rest** - is a rack-like extension that is either bolted or welded to the carriage in order to prevent the load from shifting backward when the carriage is lifted to full height.^[25]
- **Attachments** - may consists of a mechanism which is attached to the carriage, either permanently or temporarily, to help in proper engagement of the load. A variety of material handling attachments are available. Some attachments include sidershifters, slipsheet attachments, carton clamps, multipurpose clamps, rotators, fork positioners, carpet poles, pole handlers, container handlers and roll clamps.
- **Tires** - either solid for indoor use, or pneumatic for outside use.^[28]



Attachments

Below is a list of common forklift attachments:^[29]

- **Dimensioning devices**-fork truck-mounted dimensioning systems provide dimensions for the cargo to facilitate truck trailer space utilization and to support warehouse automation systems. The systems normally communicate the dimensions via 802.11 radios. NTEP certified dimensioning devices are available to support commercial activities that bill based on volume.
- **Sidershifter** - is a hydraulic attachment that allows the operator to move the tines (forks) and backrest laterally. This allows easier placement of a load without having to reposition the truck.^[30]
- **Rotator** - To aid the handling of skids that may have become excessively tilted and other specialty material handling needs some forklifts are fitted with an attachment that allows the tines to be rotated. This type of attachment may also be used for dumping containers for quick unloading.
- **Fork positioner** - is a hydraulic attachment that moves the tines (forks) together or apart. This removes the need for the operator to manually adjust the tines for different sized loads.
- **Roll and barrel clamp attachment** - A mechanical or hydraulic attachment used to squeeze the item to be moved. It is used for handling barrels, kegs, or paper rolls. This type of attachment may also have a rotate function. The rotate function would help an operator to insert a vertically stored paper into the horizontal intake of a printing press for example.^[31]
- **Pole attachments** - In some locations, such as carpet warehouses, a long metal pole is used instead of forks to lift carpet rolls. Similar devices, though much larger, are used to pick up metal coils.
- **Carton and multipurpose clamp attachments** - are hydraulic attachments that allow the operator to open and close around a load, squeezing it to pick it up. Products like cartons, boxes and bales can be moved with this type of attachment. With these attachments in use, the forklift truck is sometimes referred to as a clamp truck.^[31]
- **Slip sheet attachment (push - pull)** - is a hydraulic attachment that reaches forward, clamps onto a slip sheet and draws the slip sheet onto wide and thin metal forks for transport. The attachment will push the slip sheet and load off the forks for placement.
- **Drum handler attachment** - is a mechanical attachment that slides onto the tines (forks). It usually has a spring-loaded jaw that grips the top lip edge of a drum for transport. Another type grabs around the drum in a manner similar to the roll or barrel attachments.



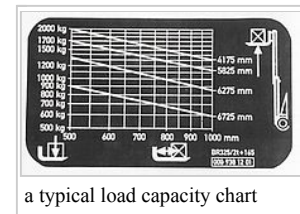
- **Man basket** - a lift platform that slides onto the tines (forks) and is meant for hoisting workers. The man basket has railings to keep the person from falling and brackets for attaching a safety harness. Also, a strap or chain is used to attach the man basket to the carriage of the forklift.
- **Telescopic forks** - are hydraulic attachments that allow the operator to operate in warehouse design for "double-deep stacking", which means that two pallet shelves are placed behind each other without any aisle between them.
- **Scales** -Fork truck-mounted scales enable operators to efficiently weigh the pallets they handle without interrupting their workflow by travelling to a platform scale. Scales are available that provide legal-for-trade weights for operations that involve billing by weight. They are easily retrofitted to the truck by hanging on the carriage in the same manner as forks hang on the truck.
- **Single-double forks** - are forks that in the closed position allow movement of a single pallet or platform but when separated, turn into a set of double forks that allow carrying two pallets side by side. The fork control may have to replace the side-shifter on some lift trucks.

Any attachment on a forklift will reduce its nominal load rating, which is computed with a stock fork carriage and forks. The actual load rating may be significantly lower.

Replacing or adding attachments

It is possible to replace an existing attachment or add one to a lift that doesn't already have one. Considerations include forklift type, capacity, carriage type, and number of hydraulic functions (that power the attachment features). As mentioned in the preceding section, replacing or adding an attachment may reduce (down-rate) the safe lifting capacity of the forklift truck (See also General operations, below).

Forklift attachment manufacturers offer on-line calculators to estimate the safe lifting capacity when using a particular attachment. However, only the forklift truck manufacturer can give accurate lifting capacities. Before installing any attachment you should contact your local authorized dealer of your forklift brand and ask them to begin re-rating your lift according to the attachment you want to install. Once re-rated the forklift should have a new factory authorized specification plate, to replace the original plate, installed showing the new rating for the lift.



a typical load capacity chart

In the context of attachment, a hydraulic function consists of a valve on the forklift with a lever near the operator that provides two passages of pressurized hydraulic oil to power the attachment features. Sometimes an attachment has more features than your forklift has hydraulic functions and one or more need to be added. There are many ways of adding hydraulic functions (also known as adding a valve). The forklift manufacturer makes valves and hose routing accessories, but the parts and labor to install can be prohibitively expensive. Other ways include adding a solenoid valve in conjunction with a hose or cable reel that diverts oil flow from an existing function. However, hose and cable reels can block the operator's view and are problematic, easily damaged. The Ditto Valve kit uses a solenoid valve and special HydWire hoses, in which the wire reinforcing braid doubles as an electrical conduit. These hoses replace those already on the forklift, nesting in the original reeving, keeping it safe from damage and out of the operators field of vision.^[32]

Lift truck associations and organizations

There are many national as well as continental associations related to the industrial truck industry. Some of the major organizations are listed as:

- Industrial Truck Association (ITA) (North America)^[33]
- Material Handling Equipment Distributors Association (MHEDA) (North America)^[34]
- Fédération Européenne de la Manutention - European Federation of Materials Handling (FEM)^[35]
- Fork Lift Truck Association (FLTA) (UK)^[36]
- British Industrial Truck Association (BITA)^[37]
- Japan Industrial Vehicles Association (JIVA)^[38]
- Korean Construction Equipment Manufacturers Association (KOCEMA)^[39]

There are many significant contacts among these organizations and they have established joint statistical and engineering programs. One program is the *World Industrial Trucks Statistics (WITS)* which is published every month to the association memberships. The statistics are separated by area (continent), country and class of machine. While the statistics are generic, and do not count production from most of the smaller manufacturers, the information is significant for its depth. These contacts have brought to a common definition of a Class System to which all the major manufacturers adhere.

Forklift safety

Standards

Forklift safety is subject to a variety of standards worldwide. The most important standard is the ANSI B56—of which stewardship has now been passed from the American National Standards Institute (ANSI) to the Industrial Truck Standards Development Foundation after multi-year negotiations. ITSDf is a non-profit organization whose only purpose is the promulgation and modernization of the B56 standard.^[40]

Other forklift safety standards have been implemented in the United States by the Occupational Safety and Health Administration (OSHA) and in the United Kingdom by the Health and Safety Executive.^[41]

Driver safety

In many countries forklift truck operators must be trained and certified to operate forklift trucks. Certification may be required for each individual class of lift that an operator would use.^[42]

Forklift training (<http://forkliftlicenseguide.com>) has many names, it is also called forklift license or forklift certification. Whatever the term to be used, training must adhere to federal or national laws that govern its standard.

Health care providers should not recommend that workers who drive or use heavy equipment such as forklifts treat chronic or acute pain with opioids.^[43] Workplaces which manage workers who perform safety-sensitive operations should assign workers to less sensitive duties for so long as those workers are treated by their physician with opioids.^[43]

Forklift training in the United States

In the U.S., workplace forklift training is governed federally by OSHA the Occupational Safety and Health Administration. In 1999, OSHA updated its 29 CFR 1910.178 regulations governing "Powered Industrial Trucks" (the term OSHA uses to include forklifts among other types of industrial vehicles.) A major component of these regulations deals with forklift operator training. The standard requires employers to develop and implement a training program based on the general principles of safe truck operation, the types of vehicle(s) being used in the workplace,^[44] the hazards of the workplace created by the use of the vehicle(s), and the general safety requirements of the OSHA standard. OSHA believes, that trained operators must know how to do the job properly and do it safely as demonstrated by workplace evaluation. Formal (lecture, video, etc.) and practical (demonstration and practical exercises) training must be provided. Employers must also certify that each operator has received the training and evaluate each operator at least once every three years. Prior to operating the truck in the workplace, the employer must evaluate the operator's performance and determine the operator to be competent to operate a powered industrial truck safely. Refresher training is needed whenever an operator demonstrates a deficiency in the safe operation of the truck.^[45]

Forklift training in the United Kingdom

In the UK, the Provision and Use of Work Equipment Regulations state that operators of fork lift trucks must be adequately trained, the general standards of that training and good operating practice are found in the HSE Code of Practice 117 (Third edition)^[46] issued in 2013. Third party organisations have developed de facto 'best practice' standards for forklift training, commonly referred to in the UK as a 'forklift licence', (these are no longer recognised as proof of training as defined in the COP 117 (third edition) and as such training is **not** a legal requirement as is commonly believed.^[47] Organised training however helps to demonstrate that an employer has taken steps to ensure its 'duty of care' in the unfortunate event of an accident.

In the UK, forklift training is carried out by a number of different voluntary standard training organisations, They can be directly recognised by the HSE who have formed a new organisation known as "Accrediting Body Association Work place transport 2012".^[48] In all cases qualified forklift instructors must be registered with at least one of the voluntary training organisations. Although RTITB operators are registered on a database which has to be a 3 yearly basis, the amount of time determined between refresher courses is subject to the H&S Executive, Insurance companies or company policies. The H&S Executive (HSG136 Workplace Transport Safety) does recommend re-training/testing every 3 to 5 years.^[49]

Forklift instructors throughout the UK tend to operate either as small independent training companies or as a part of a larger training provider. Training is delivered in one of two ways; on-site (sometimes referred to as in-house training) where training is delivered to a clients' premises making use of their own equipment, or off-site (public courses) at a training centre. Training centres offer the opportunity for the unemployed with little or no forklift operating experience to achieve a certificate of competence and increase their employment opportunities. Training certification standards at schools tends to follow closely the standard required by there individual Training Standards Accrediting Body to which they are affiliated. It is not unusual for a Training school to be registered with one or more body at any one time.

The British Industrial Truck Association (BITA) categorises the different forklift truck types into groups and assigned a unique identifier to each classification. Known as the 'BITA List' it has become accepted as a standard in the UK. Forklift training certificates display the appropriate BITA classification to clearly identify the confines of the certification.^[50]

Forklift training in Australia

Prior to 2011 all States and Territories of Australia independently regulated occupational health and safety in that state, including forklift licensing.

Whilst the Occupational Health and Safety laws of the different states were based on similar underlying principles there were differences between the various jurisdictions in the detail and application of those Occupational Health and Safety laws.

In 2008 the Inter-Governmental Agreement for Regulatory and Operational Reform in Occupational Health and Safety was formed between the Commonwealth of Australia and the six states and two territories of Australia to formalize cooperation between these jurisdictions on the harmonization of Occupational Health and Safety legislation.^[51]

As a result, the national Model Work Health and Safety Act (WHS) was enacted following a review into work health and safety laws across Australia, which review included significant public consultation. This act was finalized in June 2011.^[52]

This act formed a framework for the individual jurisdictions to enact supporting legislation, as the individual jurisdictions are tasked with managing State and Territory Occupational Health and Safety laws, including the issue of licences coming under the legislation.

Each individual state and territory issue licences in their own jurisdiction, including what is known as "high risk work licences" for high risk work. Forklift licences are classed as "high risk work licences".^[53]

To obtain a forklift licence in any State or Territory an applicant must undertake a training course with an approved training organisation and then, on completion of the course, apply to the appropriate State or Territory for a forklift licence. The unit of competence is known as the National High Risk Licence Unit of Competence TLILIC2001A – Licence to Operate a Forklift Truck, or in the case of an LO licence Unit of Competence LILIC2002A – Licence to Operate an Order Picking Forklift Truck. There is a fee attached which varies from jurisdiction to jurisdiction.

Forklift licences issued in one jurisdiction are recognized in all. Licence cancellation in one jurisdiction is also recognized in all.^[54]

Safety Products

A number of solutions can be found on the market today to reduce occupational hazards caused by forklifts.

Ultrasound Radars

Ultrasonic sensors are proximity sensors that detect objects at distances ranging from a few centimeters to several meters. The sensor beeps and measures the time it takes for the signal to return. It does not discriminate between people and objects. Any obstacle located behind the truck will be detected. Normally, this type of sensor is used only for detection in rear areas.

RF Systems

These are solutions that alert forklift drivers of the people found in its vicinity. Pedestrians must carry a radio frequency device (electronic tags) which, emit a signal when a truck detects them, alerting the driver of the potential risk of accident. It detects both in the front and at the back and it differentiates between people and the usual obstacles found in warehouses. For this reason, the driver is only alerted when there is a pedestrian near the truck. There are different solutions on the market:

- **Pedestrian Alert System PAS**^[55]

Manufacturers' worldwide ranking

Every year Modern Materials publishes a Top 20 Global Ranking of Forklift Manufacturers by sales in dollars.^[56] A modified copy of the report is below in a sortable table.

Rank	Company Name	2013 Rank	2014 Revenue	North American Brands	World Headquarters	Country
1	Toyota Industries	1	\$7,712,000,000	Toyota, BT, Raymond	Aichi	Japan
2	KION Group	2	\$5,314,000,000	VOLTAS, Linde, STILL, OM, Baoli	Wiesbaden	Germany
3	Jungheinrich Lift Truck Corp.	3	\$3,033,000,000	Jungheinrich	Hamburg	Germany
4	Hyster-Yale Material Handling	4	\$2,767,000,000	Hyster, Yale	Cleveland, Ohio	USA
5	Crown Equipment Corporation	5	\$2,500,000,000	Crown, Hamech	New Bremen, Ohio	USA
6	Mitsubishi Caterpillar Forklift America Inc.	6	\$2,159,000,000	Mitsubishi, CAT	Sagamihara	Japan
7	UniCarriers Americas Corporation (http://www.unicarriersamericas.com/)	7	\$1,533,000,000	Nissan, Barrett, Atlet, TCM, UniCarriers (http://www.unicarriers.co.jp/en/)	Tokyo	Japan
8	Anhui Forklift Group	8	\$1,123,000,000	Heli	Hefei, Anhui	China
9	Zhejiang Hangcha Engineering Machinery Co.	9	\$971,000,000	HC	Hangzhou	China
10	Komatsu Utility Co.	10	\$900,000,000	Komatsu, Tusk	Tokyo	Japan
11	Clark Material Handling Company	11	\$741,000,000	Clark	Seoul	South Korea
12	Doosan Infracore	12	\$683,000,000	Doosan	Seoul	South Korea
13	Hyundai Heavy Industries	13	\$477,000,000	Hyundai	Ulsan	South Korea
14	Lonking Forklift Company, Ltd	14	\$190,000,000	Lonking	Shanghai	China
14	Combilift	16	\$190,000,000	Combilift	Monaghan	Ireland
16	Tailift	15	\$181,000,000	Tailift, Worldlift	Taichung	Taiwan
17	Hubtex	17	\$108,000,000	Hubtex	Fulda	Germany
18	Hystu	18	\$82,000,000	Hystu	Shanghai	China
19	Godrej & Boyce Manufacturing	19	\$76,000,000	Not available in N.A.	Mumbai	India
20	Palettrans Equipment	20	\$69,000,000	Palettrans	Cravinhos	Brazil

See also

- Electrocar
- *Forklift Driver Klaus – The First Day on the Job*
- Hydrogen vehicle
- Non-road engine
- Pallet
- Pallet jack
- Slip sheet

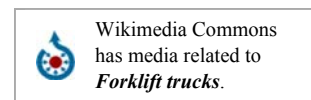
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External links

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- Safety and Health Topic: Powered Industrial Trucks (<http://www.osha.gov/SLTC/powerindustrialtrucks/index.html>), from the Occupational Safety and Health Administration (OSHA)
- Forklift LPG Cylinder Mounting (<http://www.propane101.com/forkliftcylindermounting.htm>), Proper cylinder mounting and LPG forklift cylinder safety.
- In Queensland, Australia, when applying for forklift licence, follow these steps. (<http://www.forkliftlicenseguide.com/forklift-licence-qld>)
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