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Forklifts are indispensable workhorses in warehouses, construction sites, and manufacturing facilities, but they also present significant safety risks when not properly maintained and inspected. According to OSHA statistics, forklift-related incidents cause approximately 35,000 serious injuries and nearly 100 fatalities annually in the United States, with many of these accidents directly attributable to inadequate pre-operation inspections. This comprehensive guide provides a detailed forklift daily inspection checklist that complies with all OSHA requirements (29 CFR 1910.178) and industry best practices. Whether you operate electric, propane, or diesel forklifts, implementing these inspection protocols will help ensure workplace safety, regulatory compliance, and optimal equipment performance. Remember: OSHA mandates that all forklifts must be examined at least daily before being placed in service, and when used on a round-the-clock basis, they must be examined after each shift. Important: Never operate a forklift that has failed any inspection point. Tag it as "Out of Service" and report issues to your supervisor immediately. The Essential Forklift Daily Inspection Checklist Examine the general condition for cleanliness and loose parts Check for visible damage, dents, or structural issues Inspect floor for evidence of leaks (oil, hydraulic fluid, etc.) Verify that the data plate/capacity plate is legible and matches the forklift Ensure the operator's manual is accessible Check that safety warnings and labels are visible and legible Verify seatbelt/restraint system is in good working condition Ensure overhead guard/FOPS is intact and undamaged Check load backrest extension for damage Inspect forks for cracks, bends, or excessive wear Verify fork latches/retaining pins are functional Check tires for damage, excessive wear, and proper inflation (if pneumatic) Examine wheels and rims for damage, missing lug nuts, or other issues Check fuel level is adequate for the shift Inspect propane tank for damage, rust, or dents Verify propane tank is properly mounted and secured Check propane tank valve and fittings for leaks (using soap solution) Confirm propane hose is not cracked, worn, or damaged Ensure fuel lines are secure with no leaks Verify fuel cap fits properly and gasket is intact Check for unusual odors that might indicate a leak Verify battery charge is sufficient for the shift Check battery plug connections for tightness and signs of arcing Inspect battery case for cracks or damage Ensure battery is secured properly in compartment Check battery cables for fraying or damage Verify battery electrolyte levels (if applicable) Check that battery caps are in place and vents are clear Inspect charger connector for damage or excessive wear Verify all gauges are functioning properly (temperature, fuel, hour meter, etc.) Check that all warning lights illuminate initially and then turn off Test horn functionality Verify backup alarm works properly Test front, tail, and brake lights Check turn signals and hazard lights (if equipped) Test parking brake effectiveness Verify service brake performance Check steering functionality (no excessive play or binding) Test hydraulic controls for proper operation (lift, tilt, side-shift, etc.) Verify transmission shifts smoothly in all gears Check for unusual noises, vibrations, or odors during operation Test acceleration and responsiveness Verify stability at full mast extension (if safe to do so) Verify presence and condition of fire extinguisher (if equipped) Check functioning of all operator presence sensing systems Ensure overhead guard is securely attached and undamaged Test backup alarm audibility Verify blue pedestrian warning light functionality (if equipped) Check mirrors for proper positioning and cleanliness Ensure load handling attachments are secure and functioning properly Verify all safety interlocks are working (seat switch, etc.) Step-by-Step Inspection Procedure Before Engine Start Visual Approach Inspection: Begin your inspection by walking around the forklift, looking for obvious damage, leaks, or abnormalities. Check the floor beneath the forklift for fluid puddles that might indicate leaks. Documentation Check: Verify that the forklift has a legible data plate showing its load capacity, that the operator's manual is available, and review the previous operator's inspection report (if available). Structural Components Inspection: Examine the overhead guard, load backrest, forks, carriage, mast, and chassis for cracks, bends, or other damage that could compromise safety or performance. Wheel and Tire Check: Inspect all tires for proper inflation (if pneumatic), cuts, gouges, embedded objects, and excessive wear. Check wheels for cracks, missing lug nuts, or other damage. Engine and Power System Checks Propane/Fuel System Inspection: For propane forklifts, verify the tank is properly mounted, connections are secure, and there are no leaks. For diesel or gasoline models, check fuel levels and inspect for leaks. Battery Inspection: For electric forklifts, check battery charge levels, cable conditions, connections, and ensure the battery is properly secured in its compartment. Fluid Levels: Check engine oil, hydraulic fluid, coolant, and transmission fluid (if applicable) levels before starting the forklift. Operational Checks Startup Check: Start the forklift and observe gauges, warning lights, and listen for unusual noises. Ensure warning lights illuminate initially and then turn off as appropriate. Control Testing: Test all controls including steering, brakes, lift, tilt, and other hydraulic functions. Verify smooth operation with no jerking, binding, or excessive looseness. Safety System Testing: Test horn, lights, backup alarm, and other safety devices. Verify operator presence sensing system functionality (typically requires standing up from the seat to ensure engine cutoff). Brake Testing: Test service brakes by driving forward slowly and applying the brake. The forklift should stop promptly. Test the parking brake by applying it on a slight incline (if safe to do so). OSHA Forklift Inspection Requirements OSHA standard 29 CFR 1910.178(q)(7) requires that industrial trucks be examined before being placed in service, and shall not be placed in service if the examination shows any condition adversely affecting the safety of the vehicle. Key OSHA requirements include: Forklifts must be inspected at least daily; when used around the clock, they must be examined after each shift All defects must be reported and corrected before the forklift is operated Inspection records must be maintained Any forklift found to be in unsafe condition must be removed from service until restored to safe operating condition Only trained and authorized operators may conduct inspections and operate forklifts Different forklift types (electric, propane, diesel) have specific inspection points that must be covered Inspection Frequency OSHA Requirement Before each shift Complete pre-operation inspection Monthly More detailed inspection by qualified personnel Annually Comprehensive inspection by certified technician Conducting thorough daily forklift inspections isn't just about meeting OSHA requirements—it's about ensuring workplace safety and maximizing equipment lifespan. By following this comprehensive forklift inspection checklist, operators can identify potential safety hazards before they lead to accidents, injuries, or costly downtime. Remember that proper documentation of inspections is just as important as the inspections themselves. Maintaining detailed records demonstrates compliance and creates a maintenance history that can help identify recurring issues. Transform Your Forklift Inspection Process with HVI While paper checklists have long been the industry standard, forward-thinking operations are now transitioning to digital solutions like the HVI App (Heavy Vehicle Inspection and Maintenance software). This powerful platform revolutionizes forklift safety management: Digital Documentation: HVI automatically creates and stores inspection records, eliminating paper forms while providing instantly accessible compliance documentation. Interactive Checklists: Step-by-step digital guidance ensures all operators follow the same thorough inspection process, regardless of experience level. Immediate Maintenance Alerts: When issues are identified, HVI instantly notifies maintenance personnel, dramatically reducing response times. Visual Documentation: Operators can attach photos of defects or concerns directly to inspection reports, improving communication with maintenance teams. Equipment History Tracking: Build comprehensive maintenance histories for each forklift, enabling predictive maintenance approaches. Customizable Inspection Points: Tailor checklists to specific forklift types, attachments, and operational environments. Real-time Compliance Monitoring: Supervisors can instantly verify that all forklifts have been properly inspected before operation. The HVI App streamlines forklift inspection workflows while substantially improving documentation quality, compliance verification, and maintenance responsiveness. Organizations implementing HVI typically see significant reductions in forklift-related incidents, improved OSHA compliance rates, and extended equipment lifecycles. Regardless of your fleet size—whether you operate a single warehouse forklift or manage a large fleet across multiple locations—combining systematic inspection procedures with HVI's digital management platform provides the most effective approach to forklift safety and compliance. Prioritize safety, ensure compliance, and remember: thorough daily inspections powered by HVI technology are your best defense against forklift-related incidents and the foundation of efficient materials handling operations. Meta Description: Proper forklift inspection record-keeping ensures operator safety. Explains the legal requirements for developing a formal policy for consistent record management.Proper inspection and documentation of powered industrial trucks are critical to workplace safety. This guide outlines best practices for conducting daily safety checks of forklifts and industrial trucks.It discusses OSHA regulations regarding inspection records retention and developing a formal record management policy. Understanding these compliance requirements and record-keeping procedures helps protect operator safety and ensures regulatory adherence.Key TakeawaysOSHA mandates daily inspections and documentation of all forklifts.Records must be kept for a minimum of one year to help ensure safety compliance.Thorough documentation supports training validation, equipment maintenance, and liability protection.Developing a formal retention policy outlines guidelines for consistent record-keeping practices.Organizing physical or digital records facilitates easy retrieval of inspection documents.Properly managing forklift inspection records is crucial to meet legal obligations while protecting worker safety daily.Proper record keeping of forklift inspections is essential to maintaining workplace safety and compliance with regulations. Regularly inspecting and maintaining powered industrial trucks helps ensure safe operation and prevents accidents and injuries.The Occupational Safety and Health Administration (OSHA) has established clear standards for record keeping of daily forklift inspections. According to OSHA regulations 29 CFR 1910.178, employers must ensure that all powered industrial trucks are inspected daily or after each shift if used on a round-the-clock basis.Any defects or deficiencies affecting safety identified during the inspection shall be immediately reported and corrected before the vehicle is placed in service. OSHA requires employers to maintain accurate written records of these inspections for at least one year to provide evidence of compliance with safety practices.OSHA also mandates that all industrial trucks be examined before being placed in service under 29 CFR 1910.178(q)(7) as an essential part of ensuring safe working conditions. Inspections help identify potential hazards and enable maintenance personnel to repair defects, thus minimizing risks promptly. Records aid supervisors in monitoring inspection quality and ensuring timely corrective actions.Specific industries may have additional record-keeping requirements beyond the OSHA standards. For example, facilities handling hazardous materials or operating in explosive environments have stricter rules regarding the inspection and certification of powered industrial trucks.Thorough record keeping demonstrates that vehicles are adequately maintained and operators are properly trained to handle such risks safely. Organizations must stay current on any regulations specific to their industry to avoid non-compliance penalties from regulatory agencies.Maintaining complete and accurate records of daily forklift inspections is crucial for operator and workplace safety training. Proper documentation also helps equipment owners meet legal obligations and mitigate liability risks.Keeping thorough records of all forklift operators’ inspections, operator certifications, and maintenance activities is crucial for various reasons. Proper documentation helps ensure regulatory compliance and significantly reduces equipment owners’ liability risks.Accurate training records are essential to demonstrate that all powered industrial truck operators have received adequate training and safety instruction as OSHA requires. Records of initial and refresher courses substantiate that personnel have been adequately trained in safety procedures and standards before operating industrial trucks. This is substantial evidence in case of any non-compliance issues during an OSHA inspection.Inspection records over time help identify maintenance trends and recurring issues. Maintaining digital or physical records allows deficiencies to be easily tracked. This enables maintenance personnel to address common problems proactively. Records also aid in scheduling preventive maintenance and performance evaluations to catch unsafe conditions before accidents occur.In the unfortunate event of an incident or injury involving a forklift, up-to-date records can significantly reduce liability for the employer. Documentation proves that daily safety checks were conducted correctly and the vehicle was fit for operation.Records of the forklift operator, certifications, and training demonstrate the employee was also adequately trained. This evidence supports due diligence and can influence liability decisions in legal cases. Organizations of forklift training that carefully maintain inspection and training records are better positioned in case of inspections or litigation.Determining the appropriate duration for retaining forklift inspection records can help ensure compliance and reduce liability risks. While laws set a minimum period to maintain forklifts and records, extending the retention schedule provides added benefits.As per 29 CFR 1910.178, OSHA requires employers to maintain written records of daily industrial truck inspections for at least one year. This one-year retention satisfies the vehicle’s safety and legal obligations according to OSHA regulations.However, some industries may have specific standards beyond this minimum. It is essential to research the rules for individual operations and comply with the stricter requirements if there is a difference.Keeping inspection records for more than the mandated one year can strengthen an organization’s position in accident investigations and potential litigation.Maintaining physical or digital files for the lifetime of each vehicle provides a complete safety history that is useful for evaluating operator performance and identifying recurring issues over extended periods. Some experts recommend indefinite retention of critical records for maximum protection.Proper record retention management and extended duration as per company and individual needs help ensure ongoing compliance with occupational safety standards. It also supports due diligence and risk mitigation goals through meticulous documentation practices.Maintaining well-organized records is crucial for compliance and easy access when needed. Implementing robust record-keeping procedures helps streamline documentation practices.For companies retaining physical copies, files should be neatly organized in labeled binders, folders, or boxes according to vehicle number and year. Inspection checklists can be stored chronologically by date or grouped into annual volumes. A consistent filing system prevents lost or misplaced records. Access to older documents is simplified with an organized physical storage solution.Transitioning to digital record storage systems provides advantages like easy retrieval and searchability. Records can be scanned or entered electronically with customized data fields like operator name, inspection date, and noted defects. Storing documents in a central database or cloud-based server ensures access from anywhere. Backups protect against data loss risks compared to physical files. Digital records also simplify compliance with any electronic record-keeping mandates.All records must be indexed or cataloged for quick access, regardless of the format. Filing checklists under vehicle ID and date parameters allows targeted searches. Training and performance evaluation records of operators can similarly be indexed. Access controls maintain privacy and security. Together, streamlined organization and digital storage/retrieval of inspection documents facilitate compliance and risk mitigation goals.A well-designed system for managing documentation supports safety compliance and due diligence responsibilities through efficient, centralized record-keeping practices.Creating a formal record retention policy ensures consistent documentation practices across teams. A well-defined policy streamlines compliance.The first step involves researching applicable OSHA regulations and industry standards to understand minimum retention periods mandated by law. Documenting these requirements establishes the baseline for the policy. It ensures retention schedules are met but does not fall below regulatory obligations.The policy must specify the type of records to be retained, such as inspection checklists, operator certifications, and maintenance records. It should state the retention duration and storage method for different document types based on legal and operational needs. Proper indexing and cataloging protocols improve record accessibility.Educating relevant personnel about their record-keeping roles and the policy guidelines is critical. Training programs help inspection staff correctly fill checklists and maintenance crews note issues.Administrators must make authorized personnel understand filing and retention duties. Refresher sessions ensure continuous compliance even with staffing changes.Frequently Asked Questions (How Long Do You Keep Forklift Inspection Records) According to OSHA regulations 29 CFR 1910.178, employers must make a written record of daily forklift inspections and maintain these records for at least one year. Thorough documentation of inspections is necessary to demonstrate compliance with safety standards. OSHA requires retaining forklift inspection records for at least one year. However, experts recommend keeping records for the lifetime of the vehicle. This extensive record retention helps provide a complete safety history in accident investigations and potential litigation. OSHA mandates that forklifts be inspected daily before use. Additional inspections must be conducted after each shift if the vehicle is used round-the-clock. Any issues identified during inspections must be addressed promptly. Key OSHA regulations as per 29 CFR 1910.178 include conducting daily safety checks, documenting inspections, ensuring operators are adequately trained, and correcting defects immediately. Compliance with these standards helps maintain a safe working environment. While OSHA does not explicitly require a checklist, maintaining written records of daily inspections is mandated. A standardized checklist helps ensure thorough and consistent inspections are performed on all critical aspects of forklifts daily. Federal OSHA’s powered industrial truck standard does not require that you keep a written record of the daily inspections. The regulation requires that an inspection be made “at least daily,” or “after each shift” when the vehicle is being used around the clock. Maintaining copies of your inspection logs is a good way to document that the required inspections are occurring—both for your company records and for OSHA, should you have an inspection.Therefore, because it is not a regulatory requirement, you may keep inspection records for any time period that you specify. Document the length of time your company decides to keep the inspection records in your written safety and health program, forklift program, or company policy, whichever you use (e.g., “We retain forklift inspection forms for three months”). This will demonstrate to OSHA that your forklift operators perform the daily inspections as required in 1910.178(q)(7).UPGRADE TO CONTINUE READING This website is best viewed in Internet Explorer 10 or above. Please update your browser to view this website correctly. Powered industrial truck This article is about the powered industrial moving truck known as a forklift. For the manual pallet-moving tool, sometimes called a pallet truck, see Pallet jack. This article's lead section may be too short to adequately summarize the key points. Please consider expanding the lead to provide an accessible overview of all important aspects of the article. (December 2023) ForkliftGeneral appearance of a typical forkliftClassificationPITIndustryVariousApplicationMultipleFuel sourceVarious including: Gasoline Propane CNG Diesel Lead acid battery Fuel cell Li-ion battery PoweredYesWheelsVarious wheel configurationsAxles2–3Components Power source Mast Frame Counterweight Cab Axles Wheels Overhead guard Load backrest Hydraulic pump Hydraulic lines Hydraulic controls Hydraulic cylinders and attachments A forklift (also called industrial truck, lift truck, jitney, hi-lo, fork truck, fork hoist, and forklift truck) is a powered industrial truck used to lift and move materials over short distances. The forklift was developed in the early 20th century by various companies, including Clark, which made transmissions, and Yale & Towne Manufacturing, which made hoists.[1][2][3] Since World War II, the development and use of the forklift truck has greatly expanded worldwide. Forklifts have become an indispensable piece of equipment in manufacturing and warehousing.[4] In 2013, the top 20 manufacturers worldwide posted sales of $30.4 billion, with 944,405 machines sold.[5] A forklift truck being used during World War II Developments from the middle of the 19th century to the early 20th century led to today's[when?] modern forklifts. The forerunners of the modern forklift were manually powered hoists to lift loads.[4] In 1906, the Pennsylvania Railroad introduced battery-powered platform trucks for moving luggage at their Altoona, Pennsylvania, 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 and lift tractors in its factories. In 1919, the Towmotor Company and, in 1920, Yale & Towne Manufacturing, 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 electrically-powered forklifts, along with the use of standardized pallets in the late 1930s, helped to increase the popularity of forklift trucks.[4] Forklift loading cruise liners The start of World War II, like World War I before it, spurred the use of forklift trucks in the war effort.[6] Following the war, more efficient methods for storing products in warehouses were implemented, and warehouses needed more maneuverable forklift trucks that could reach greater heights.[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] That development changed the design of warehouses leading to narrower aisles and higher load-stacking, which increased storage capability.[6] During the 1950s and 1960s, operator safety became a concern due to increasing lifting heights and capacities. Safety features such as load backrests and operator cages called overhead guards, began to be added to forklifts.[4] In the late 1980s, ergonomic design began to be incorporated in new forklift models to improve operator comfort, reduce injuries, and increase productivity.[8] During the 1990s, undesirable exhaust emissions from forklift operations began to be tackled, 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, were refinements in continuing forklift development.[4][10] Forklift cab with control layout. 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 it must 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 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".[citation needed] Forklifts are a critical element of warehouses and distribution centers. It is considered 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 by 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.[11] Dedicated container forklift of HMNZS Canterbury vessel of the New Zealand Navy 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 ergonomic 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.[12] 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. Main article: Pallet jack Powered pallet truck, usually electrically powered.[13] Low lift trucks may be operated by a person seated on the machine, or by a person walking alongside, depending on the design. Main article: Reach stacker Usually electrically powered. A stacker may be operated by a person seated on the machine, or by a person walking alongside, depending on the design. A reach truck with a pantograph allowing the extension of the forks in tight aisles. Variant on a Rider Stacker forklift, designed for narrow aisles. They are usually electrically powered and often have the highest storage-position lifting ability. A reach truck's forks can extend to reach the load, hence the name. There are two types: Moving carriage. This consists of an integrated tower mast that's fixed and the forks are mounted on a deployable carriage or pantograph, typically with hydraulic or electro-mechanical actuators or in a scissor formation. They are common in North America and parts of Europe. Moving mast; which consists of a slender tower mast that is mounted on tracks, allowing the entire assembly to extend or 'reach' using hydraulic or electro-mechanical actuators. It also eliminates a separate fork extender pantograph. They are common in the rest of the world, and generally considered safer.[why?][14] A counterbalance forklift (note the counterweight at the back) being used to load logistics at an air force baseStandard forklifts use a counterweight at the rear of the truck to offset, or counterbalance, the weight of a load carried at the front of the truck.[15] Electric-powered forklifts utilise the weight of the battery as a counterweight and are typically smaller in size as a result. Truck mounted sideloader A sideloader[16] is a piece of materials-handling equipment designed for long loads. The operator's cab is positioned up front on the left-hand side. The area to the right of the cab is called the bed or platform. This contains a central section within it, called the well, where the forks are positioned. The mast and forks reach out to lift the load at its central point and lower it onto the bed. Driving forwards with a load carried lengthways allows long goods, typically timber, steel, concrete or plastics, to be moved through doorways and stored more easily than via conventional forklift trucks. Similar to a reach truck, except the operator either rides in a cage welded to the fork carriage or walks alongside, dependent on design. If the operator is riding in the order picking truck, they wear a specially-designed safety harness to prevent falls. A special toothed grab holds the pallet to the forks. The operator transfers the load onto the pallet one article at a time by hand. This is an efficient way of picking less-than-pallet-load shipments and is popular for use in large distribution centers. A ride-on order picking 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 up 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 very high, as by building the racking up to three times higher than normal and using these machines, it is possible to stock a much larger amount of material in a building with a relatively small surface area.[17] 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 them against falls. Otherwise, the description is the same as guided very-narrow-aisle truck.[citation needed] Moffett forkliftMoffett forklift on flatbed truck A walk-along version Also referred to as a 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. 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.[citation needed] A straight mast container handler at Haikou Xiuying Port, Hainan, China Container handler moving two empty 53-foot boxes by their 40-foot posts At the other end of the spectrum from the counterbalanced forklift trucks are more 'high-end' specialty trucks.[citation needed] Articulating counterbalance trucks are designed to be both able to offload trailers and place the load in narrow aisle racking. The central pivot of the truck allows loads to be stored in racking at a right angle to the truck, reducing space requirements (therefore increasing pallet storage density) and eliminating double handling from yard to warehouse.[18] Frederick L Brown is credited with perfecting the principle of an articulated design in about 1982, receiving an award in 2002 from the UK's Fork Lift Truck Association for Services to the Forklift Industry[19] and the Queen's Award for Innovation in 2003.[20] He took inspiration from the hand pallet truck and found that by reversing the triangle of stability and changing the weight distribution he could solve the issues that had long eluded earlier attempts of articulating a forklift truck.[21] Freddy's patent application[22] referenced specific drive methods, allowing competitors to enter the market by offering alternative methods, but using the same articulating principle. 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.[citation needed] These lifts are found in places like marinas and boat storage facilities. Featuring tall masts, heavy counterweights, and special paint to resist seawater-induced corrosion, they are used to lift boats in and out of storage racks. Once out, the forklift can place the boat into the water, as well as remove it when the boating activity is finished. Marina forklifts are unique among most other forklifts in that they feature a "negative lift" cylinder.[23] This type of cylinder allows the forks to actually descend lower than ground level. Such functionality is necessary, given that the ground upon which the forklift operates is higher than the water level below. Additionally, marina forklifts feature some of the longest forks available, with some up to 24 feet long. The forks are also typically coated in rubber[24] to prevent damage to the hull of the boats that rest on them. Omnidirectional technology (such as Mecanum wheels) can allow a forklift truck to move forward, diagonally and laterally, or in any direction on a surface. An omnidirectional wheel system is able to strafe sideways without turning the truck cabin and allow for more forklifts to be able to rotate 360 degrees within its own footprint. 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.[25] UL 558 is a two-stage safety standard. The basic standards are referred to as G, D, LP, and G/LP. They are considered by Underwriters Laboratories to be 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.[citation needed] The slightly more stringent safety standards GS, DS, LPS, and GP/LPS do provide some minimal protection; however, it is extremely minimal. In the past, Underwriter's Laboratory offered specialty EX and DX safety certifications.[citation needed] UL 583 is the Electric equivalent of UL 558. As with UL 558 it is a two-stage standard.[citation needed] These are for operation in potentially explosive atmospheres found in chemical, petrochemical, pharmaceutical, food and drink, logistics or other fields handling flammable material. Commonly referred to as mainly Miretti or sometimes 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.[citation needed] In order to decrease work wages, reduce operational cost and improve productivity, automated forklifts have also been developed.[26][27] Automated forklifts are also called forked automated guided vehicles and are already[when?] available for sale. 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.[citation needed] These forklifts use an internal combustion engine modified to run on LPG. The fuel is often stored in a gas cylinder mounted to the rear of the truck. This allows for quick changing of the cylinder once the LPG runs out. LPG trucks are quieter than their diesel counterparts, while offering similar levels of performance.[28] Powered by lead-acid batteries or, increasingly, lithium-ion batteries; battery-electric types include: cushion-tire forklifts, scissor lifts, order pickers, stackers, reach trucks and pallet jacks. Electric forklifts are primarily used indoors on flat, even surfaces. Batteries prevent the emission of harmful fumes and are recommended for indoor facilities, such as food-processing and healthcare sectors. Forklifts have also been identified as a promising application for reuse of end-of-life automotive batteries.[29] See also: Fuel cell forklift Hydrogen fuel cell forklifts are powered by a chemical reaction between hydrogen and oxygen.[30] The reaction is used to generate electricity which can then be stored in a battery and subsequently used to drive electric motors to power the forklift. This method of propulsion produces no local emissions, can be refueled in three minutes, and is often used in refrigerated warehouses as its performance is not degraded by lower temperatures.[10] As of 2024, approximately 50,000 hydrogen forklifts are in operation worldwide (the bulk of which are in the U.S.), as compared with 1.2 million battery electric forklifts that were purchased in 2021.[31] A typical counterbalanced forklift contains the following components: Truck frame – 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 – 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 battery may serve as part of the counterweight. Cab – 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.[32] Overhead guard – 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.[33] 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 cell that provides power to the electric motors; some fuel cell forklifts may be powered by multiple fuel cells at once. For warehouses and other indoor applications, electric forklifts have the advantage of not producing carbon monoxide.[34][35] Tilt cylinders – hydraulic cylinders that are mounted to the truck frame and the mast. The tilt cylinders pivot the mast backwards or forwards to assist in engaging a load. Mast – 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 or cylinders. 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.[36] Carriage – 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.[34] Load backrest – 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.[34] Attachments – may consist of a mechanism that is attached to the carriage, either permanently or temporarily, to help in the proper engagement of the load. A variety of material-handling attachments are available. Some attachments include sideshifters, 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.[37] Below is a list of common forklift attachments:[38] 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. Sideshifter – 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.[39] Rotator – to aid the handling of skids that may have become excessively tilted, and for 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 – 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.[40] 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 – 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.[40] Slip sheet attachment (push-pull) – 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 – 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 – hydraulic attachments that allow the forklift to operate in warehouses designed 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 – 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. Snow plough – a mechanical attachment that allows the forklift operator to easily and quickly move snow. The snow plough can often also be utilised at other times of the year as an attachment to clean up workplaces.[41] Skips – a mechanical attachment that is fitted to the forklift to allow safe and speedy removal of waste to the appropriate skip or waste compactor. There are two types of skips: the roll-forward type and the bottom-emptying type.[42] 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. A typical load capacity chart It is possible to replace an existing attachment or add one to a lift that does not 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 online calculators to estimate the safe lifting capacity when using a particular attachment. However, only the forklift truck manufacturer can give accurate lifting capacities. Forklifts can be re-rated by the manufacturer and have a new specification plate attached to indicate the changed load capacity with the attachment in use. 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 the 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). Forklift manufacturers make 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 easily damaged. There are many national as well as continental associations related to the industrial truck sector. Some of the major organizations include: Industrial Truck Association (ITA) (North America)[43] Material Handling Equipment Distributors Association (MHEDA) (North America)[44] Fédération Européenne de la Manutention – European Federation of Materials Handling (FEM)[45] UK Material Handling Association (UKMHA) www.ukmha.org.uk Japan Industrial Vehicles Association (JIVA)[46] Korean Construction Equipment Manufacturers Association (KOCEMA)[47] 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.[citation needed] Operating a forklift can be dangerous. In the United States, approximately 7,500 workers annually are reported injured in forklift-related incidents, while nearly 100 are killed.[48] A common hazard in manufacturing environments is forklifts striking pedestrian workers.[49] Forklift accidents that involve being caught in objects during loading or unloading and collisions during driving had the highest risk of injury, especially complex lower extremity injuries with a relatively high occurrence of complications.[50] Beyond incidents, regular forklift driving invol