



OSHAcademy™
Occupational Safety & Health Training

Powered Industrial Truck Safety

This course has general information about the classes and divisions of forklifts commonly used in the workplace. It also covers the principles necessary to understand for safe loading, transferring loads, and unloading. Forklift operator training requirements and general best practices in operating, servicing and maintaining forklifts are discussed. The hazards associated with operating forklifts in enclosed areas and construction sites are also discussed.

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OSHAcademy Course 725 Study Guide

Powered Industrial Trucks Safety

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Contact OSHAcademy to arrange for use as a training document.

This study guide is designed to be reviewed off-line as a tool for preparation to successfully complete OSHAcademy Course 725.

Read each module, answer the quiz questions, and submit the quiz questions online through the course webpage. You can print the post-quiz response screen which will contain the correct answers to the questions.

The final exam will consist of questions developed from the course content and module quizzes.

We hope you enjoy the course and if you have any questions, feel free to email or call:

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Course Introduction

The American Society of Mechanical Engineers (ASME) defines a powered industrial truck as a mobile power-propelled truck used to carry, push, pull, lift, stack or tier materials. The basic reference for the safe operation of Powered Industrial Trucks (PITs) is ANSI/ASME B56.1-1993.

Powered industrial trucks, often called forklifts or lift trucks, can be ridden or controlled by a walking operator. As you can see in the photo at the right, forklifts have been around a long time and they've gone through some significant design improvements.



A powered industrial truck is defined as a fork truck, tractor, platform lift truck, motorized hand truck, and other specialized industrial trucks powered by electric motors or internal combustion engines. This course does not include safety regarding compressed air or nonflammable compressed gas-operated industrial trucks, farm vehicles, vehicles intended primarily for earth moving, or over-the-road hauling.

Every year nearly 100 workers are killed and 20,000 are seriously injured in forklift mishaps. The top four types of incidents as a percent of the total forklift related deaths are:

| Type of Incident | % of total victims |
|--|--------------------|
| The forklift overturns | 22% |
| A worker on foot is struck by the forklift | 20% |
| A person is crushed by a forklift | 16% |
| A person falls from a forklift | 9% |

This course contains general information about:

-) the kinds of forklifts commonly available
-) the principles of physics that allow a forklift to lift and move heavy loads safely
-) forklift operator training requirements

-) some basic operator safety rules
-) hazardous locations where carbon monoxide is a problem or a special forklift is needed
-) safety while servicing a forklift

This course is not designed to be a substitute for operator training in the operation of specific forklifts in a specific workplace as required by OSHA regulations.

Module 1: Types of Powered Industrial Trucks (PITs) - Forklifts

PIT Classifications

A forklift is a type of “powered industrial truck” (PIT) covered by OSHA standards. Like other powered industrial trucks, its purpose is to move, carry, push, pull, and lift a material load then stack it or place it in a storage rack (tier). Forklifts come in many sizes and capacities. They can be powered by batteries, propane, gasoline, or diesel fuel. Some are designed to be used in a hazardous location or atmosphere where an ordinary forklift might cause a fire or explosion.

Powered industrial trucks are classified into seven types based on their characteristics. Each type of powered industrial truck has its own unique characteristics and some inherent hazards. Powered industrial trucks may operate on almost any surface, from smooth level floors to rocky uneven ground. Different trucks are designed and manufactured to operate in different work environments.

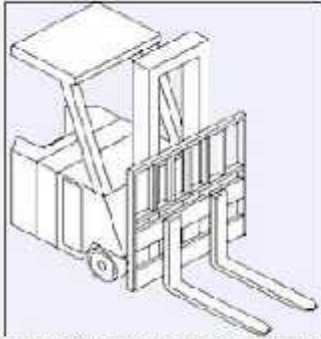
Class I Electric Motor Rider Trucks

These forklifts are equipped with either cushion or pneumatic tires. The cushion tired lift trucks are intended for use indoors on smooth floors. The pneumatic tired models are suitable for dry outdoor areas.

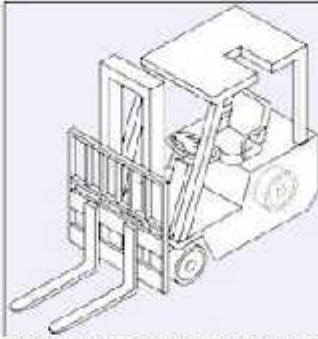
These vehicles are powered by industrial batteries and are generally found from the loading dock to the storage facility. They should also be used in areas where air quality factors need to be considered.

Class I: Electric Motor Rider Trucks

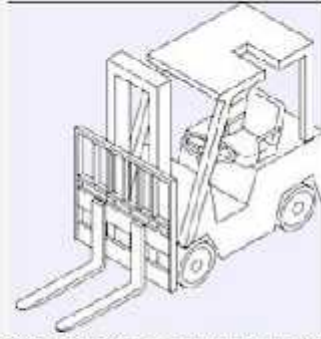
The following are examples of Class I powered industrial trucks.



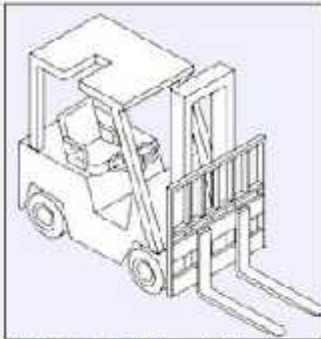
Lift Code 1: Counterbalanced Rider Type, Stand Up.



Lift Code 4: Three Wheel Electric Trucks, Sit Down.



Lift Code 3: Counterbalanced Rider, Cushion Tires, Sit Down.

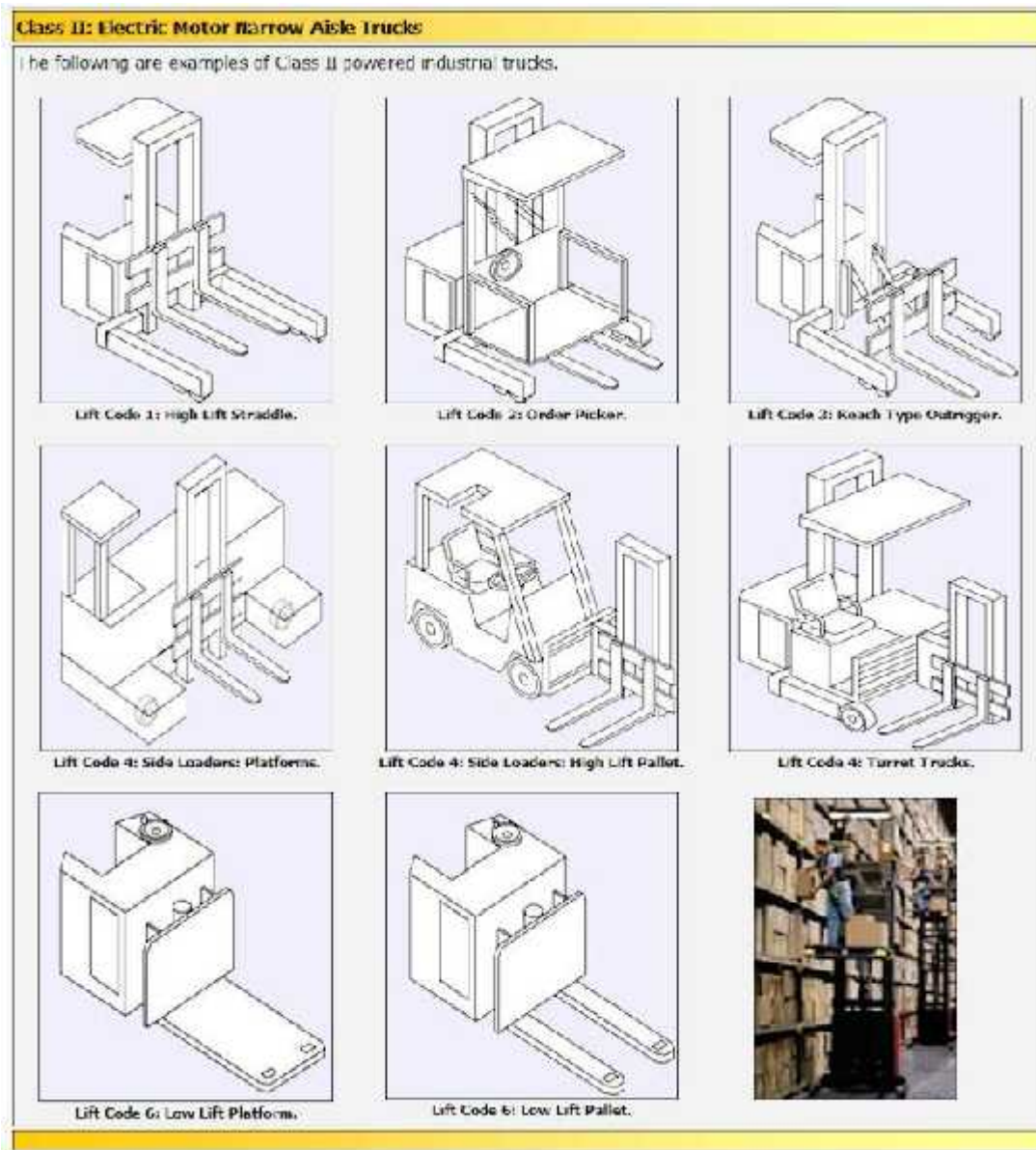


Lift Code 6: Counterbalanced Rider, Pneumatic or Either Type Tire, Sit Down.



Class II Electric Motor Narrow Aisle Trucks

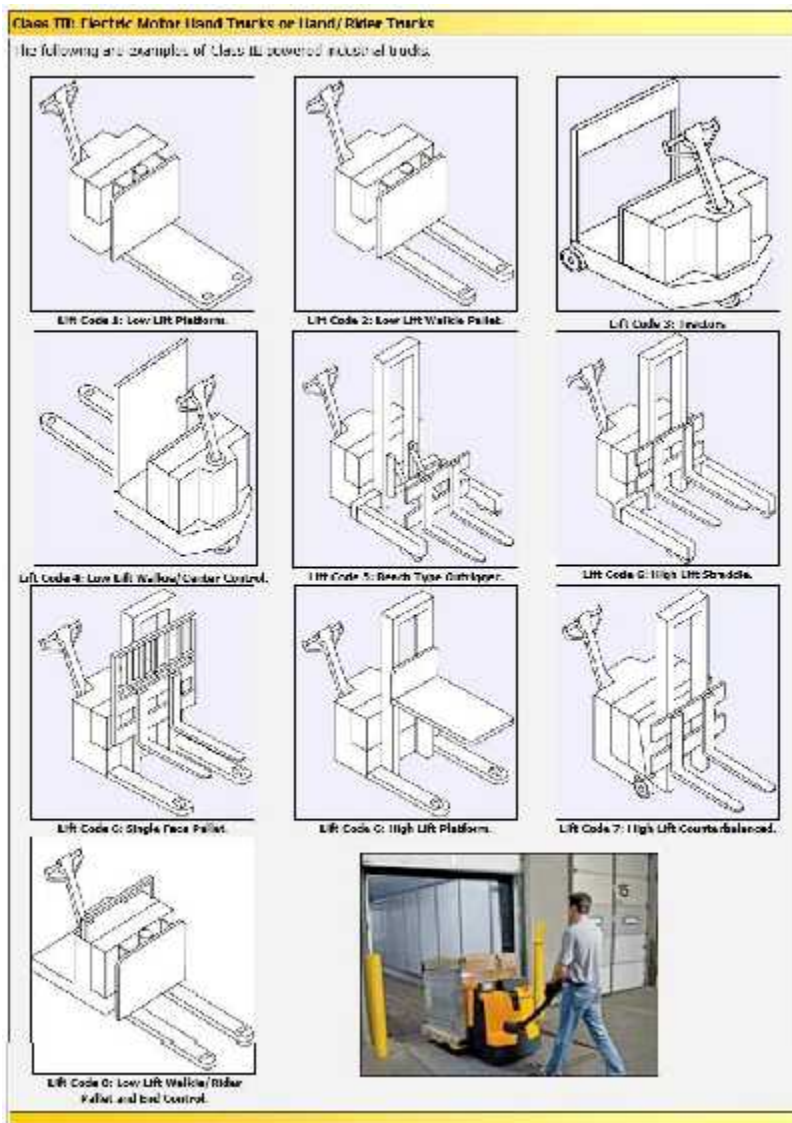
These forklifts are suitable for companies that have narrow aisles in their facilities to maximize the use of storage space. Class II vehicles have unique features that are designed to minimize the space occupied by the truck while improving speed and efficiency.



Class III Electric Motor Hand Trucks or Hand/Rider Trucks

These trucks are hand controlled by the operator who is in front of the truck. The operator controls the lift truck using a steering tiller. All the controls are mounted on the top of the tiller

which is moved side to side to steer the truck. Class III vehicles are battery powered with the smaller capacity units using industrial batteries.

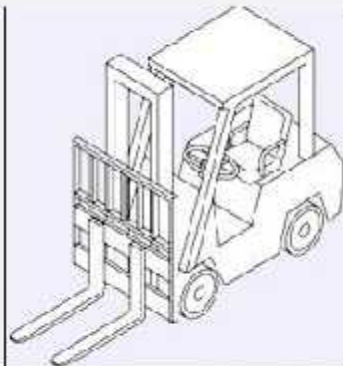


Class IV Internal Combustion Engine Trucks (Solid/Cushion Tires)

These forklifts are used primarily inside on smooth dry floors. They typically load, transfer, and unload palletized loads in manufacturing plant/warehouse loading docks and storage areas. The cushion tired forklifts are lower to the ground than pneumatic tired forklift trucks, which is more useful in low clearance areas.

Class IV: Internal Combustion Engine Trucks (Solid/Cushion tires)

The following are examples of Class IV powered industrial trucks.

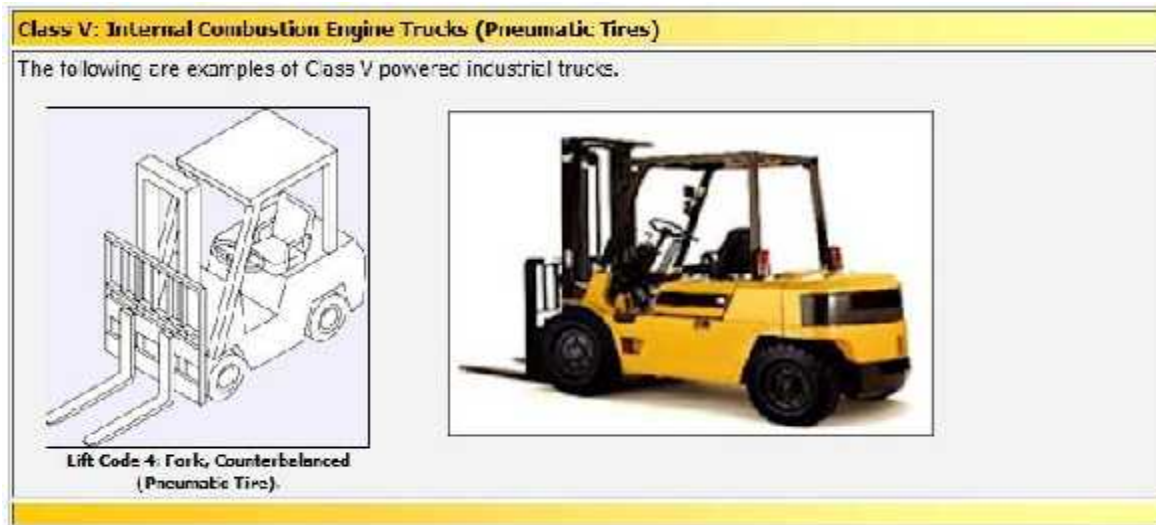


Lift Code 3: Fork, Counterbalanced (Cushion Tire).



Class V Internal Combustion Engine Trucks (Pneumatic Tires)

Class V trucks are the most common type of forklifts for inside or outside use in warehouses and other areas. They are powered by internal combustion engines and are available for use with LPG, Gasoline, Diesel, and Compressed Natural Gas fuel systems.



Class VI Electric and Internal Combustion Engine Tractors

These forklifts are versatile and can be used in various areas. They are equipped with either internal combustion engines for outdoor areas of use or battery powered electric motors for indoor use.

Class VII Rough Terrain Forklift Trucks

These forklifts have large flotation type tires for outdoor use on uneven and rough surfaces. They are most often used at construction sites to transport and lift materials to various locations and levels on the worksite. You will also see these forklifts in lumber yards and auto recycler facilities.

Class VII: Rough Terrain Forklift Trucks

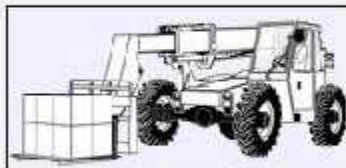
Class VII – Rough terrain forklift is a generic term used to describe forklifts typically intended for use on unimproved natural terrain and disturbed terrain construction sites. However, the term "rough terrain" does not imply that the forklift can be safely operated on every conceivable type of terrain.

There are three basic types of rough terrain forklift:



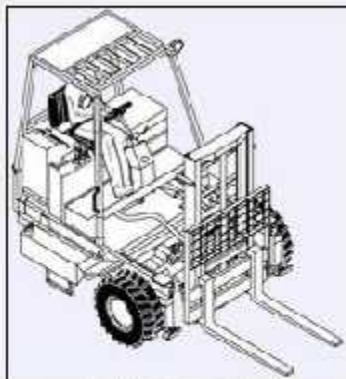
Vertical mast type.

This is an example of a ruggedly constructed forklift and is designed to be used primarily outdoors.



Variable reach type.

This is an example of a vehicle equipped with a telescoping boom, which enables it to pick and place loads at various distances and lift heights in front of the machine. The ability to reach out in front of the forklift allows the operator flexibility in the placement of a load.



Truck/trailer mounted.

This is an example of a portable self-propelled rough terrain forklift that is typically transported to the job site. It is mounted on a carrier to the back of a truck/trailer and is used to unload heavy items from the truck/trailer at the job site. Note that not all truck/trailer mounted forklifts are rough terrain forklifts.



Power Sources

The two main power sources for powered industrial trucks are:

1. internal combustion, which uses a traditional engine that runs on liquid petroleum gas (LPG), compressed natural gas (CNG), gasoline, diesel, or other fuel; and
2. electric, which uses an on-board battery.

Other power sources that may become more widespread in the future include fuel cells and hybrid systems. Hydrogen fuel cells will have zero emissions and quiet operation plus the ability to be refueled as quickly as gasoline engines. Hybrid systems will use a combination of fuel cells and batteries.



Attachments

Sometimes special attachments are installed onto the forks to extend the reach, clamp a barrel, act as hoist, lift odd-shaped items (e.g., a roll of carpet), or even lift people.

Whenever an attachment is used that could affect the capacity or safe operation of a forklift, its use must be approved by the forklift manufacturer.

The employer must mark the forklift to show the new weight with attachment. The maximum capacity at the highest elevation must also be shown.

Hazards

The hazards commonly associated with powered industrial trucks vary for different vehicle types, makes and models. All forklifts have a hazard designation assigned to them that tells whether they are



Jib Crane Attachment



Hoist Attachment



Drum Grabber Attachment



Carpet Lifting Attachment



Personnel Platform

suitable for use in certain kinds of hazardous atmospheres. You can find the designation on the forklift's load capacity plate. The table below explains the designations.

| Type | Built-in Safeguards Against Fire Hazards |
|-------------------------|---|
| D (Diesel forklift) | Minimum acceptable safeguards |
| DS | D + additional safeguards for fuel, exhaust and electrical systems |
| DY | DS + all electrical equipment enclosed plus temperature-limiting features |
| E (Electrical forklift) | Minimum acceptable safeguards |
| ES | E + safeguards to prevent sparks and limit surface temperatures |
| EE | ES + all electric motors and equipment are completely enclosed |
| EX | E, ES, or EE + can be used in flammable vapor or dust atmospheres |
| G (Gasoline forklift) | Minimum acceptable safeguards |
| GS | G + additional safeguards for fuel, exhaust and electrical systems |
| LP (Liquid Petroleum) | G + minimum safeguards for liquid petroleum gas |
| LPS | LP + additional safeguards for fuel, exhaust and electrical systems |

Selecting the Right Forklift for the Environment

Operating a forklift in an environment where chemicals or other substances are present can be hazardous. Use only forklifts that are designed for operations under those conditions.

To select the appropriate forklift, you must know the type of location (Class) in which the forklift will be operated, the name of the chemical or substance and how likely it is that the hazardous condition would be present (Division).

Below are the various classes of locations in which a forklift may be used:

-) A **Class I** location contains flammable gases or vapors.
-) A **Class II** location contains combustible dust.
-) A **Class III** location contains easily ignited fibers.

-) An **Unclassified** location is a general storage, commercial or industrial location without the hazard conditions described above.

Below are the two divisions used to define how likely a hazard is present:

-) A **Division I** location has a high potential for the hazard to be present.
-) A **Division II** location has a lower potential for the hazard to develop.

To select the right forklift for each class and division, use the table below by clicking the image.

Look in the first column of the table for the hazard class of the material.

Find the row that has the chemical or substance handled.

Choose the second or third column based on the division that represents the exposure condition.

| Hazard Classification | Acceptable Forklift Designations | |
|---|--|--|
| Class 1 Flammable gases or vapors are or may be present in quantities sufficient for explosion or ignition. | Division I Condition exists continuously, intermittently, or periodically under normal operating conditions. | Division II Condition may occur accidentally (e.g., puncture of a storage drum) |
| Acetylene, Acetaldehyde, Butadiene, Cyclopropane, Diethyl ether, Ethylene, Ethylene oxide, Isoprene, Propylene oxide, Hydrogen (or gases or vapors equivalent in hazard to hydrogen, such as manufactured gas), Unsymmetrical dimethyl hydrazine (UDMH) | Forklift use prohibited | DY, EE, EX (also DS, ES, GS, LPS) if the only exposure is sealed containers or liquefied or compressed gases in containers |
| Acetone, Acrylonitrile, Alcohol, Ammonia, Benzene, Benzol, Butane, Ethylene dichloride, Gasoline, Hexane, Lacquer Solvent, Natural gas, Naphtha, Propane, Propylene, Styrene, Xylenes, Vinyl acetate, Vinyl chloride | EX | DY, EE, EX (also DS, ES, GS, LPS) if the only exposure is sealed containers or liquefied or compressed gases in containers |
| Class II) Combustible dust is present | Division I Explosive or conductive mixture may be present under normal conditions or where equipment failure can lead to both this condition and arcing or sparking. | Division II Explosive mixture not normally present but where deposits of dust may cause heat rise in electrical equipment. |
|) Aluminum, magnesium, and their commercial alloys) Other metals of similarly | Forklift use prohibited | Forklift with electrical enclosures manufacturer approved where magnesium, aluminum or aluminum bronze may be present |
|) Carbon black,) Coal or coke dust | EX | Forklift manufacturer approved for this location. |
|) Other combustible dusts | EX | DY, EE, EX |

| Class III Easily ignitable fibers or flyings are present but not likely to be in suspension in quantities sufficient to ignite. | Division I Locations in which these materials are handled, manufactured or used | Division II Locations in which these materials are stored or handled (other than manufacture) |
|---|---|---|
| Baled waste, Cocoa fiber, Cotton, Excelsior, Hemp, Istle, Jute, Kapok, Oakum, Sisal, Spanish moss, Synthetic fibers, Tow | DY, EE, EX | DS, DY, ES, EE, GS, LPS (Type E may continue to be used if used previously at this location.) |
| Unclassified Locations Piers and wharves inside and outside general storage, general industrial or commercial properties | D, E, G, LP (more protective designations may also be used) | |

Module 1 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

- 1. Powered industrial trucks are classified into seven types based on ____.**
 - a. the area of use
 - b. their characteristics
 - c. size
 - d. the number of wheels

- 2. Which of the following forklift classes are hand controlled by the operator who is in front of the truck?**
 - a. Class III Electric Motor Hand Trucks or Hand/Rider Trucks
 - b. Class V Internal Combustion Engine Trucks (Pneumatic Tires)
 - c. Class VI Rough Terrain Forklift Trucks
 - d. Class IV Internal Combustion Engine Trucks (Solid/Cushion Tires)

- 3. The two main power sources for powered industrial trucks are ____ and ____.**
 - a. fuel cells, diesel
 - b. liquid petroleum gas (LPG), hybrid systems
 - c. internal combustion, electric
 - d. compressed natural gas, hydrogen

4. Which of the following forklift designations indicates that a diesel forklift has all electrical equipment enclosed?
- a. G
 - b. DS
 - c. GS
 - d. DY
5. A Class I, Division I area in which a forklift operates will have _____ for the presence of flammable gases or vapors.
- a. a high potential
 - b. a low potential
 - c. a possible existence
 - d. a reasonable expectation

Module 2: Operator Training

An untrained operator of a forklift can be as dangerous as an unlicensed operator of a motor vehicle.

Requirements

OSHA regulations require that the employer ensure that a forklift operator is competent to operate the forklift he or she is assigned to use. Training must be conducted by a competent person. The employer must document operator training and an evaluation of the operator's performance while using the forklift.



Initial forklift training has three parts:

1. **Formal instruction** may include a lecture, discussion, interactive computer learning, videotape and/or written material (can be taken anywhere).
2. **Practical training** includes hands-on demonstration(s) by the trainer and exercises by the trainee (on the model of forklift the worker will use). Trainees may operate forklifts only under direction of a competent trainer, in a learning environment where doing so will not endanger the trainee or other employees. Be sure to set up a safe training area for practice.
3. **Evaluation** of the effectiveness of the training by observing the operator's performance using the forklift should be conducted in the actual workplace. This evaluation must be repeated at least once every three years (must be at workplace each time).

Refresher training must be given if the operator has been involved in an accident, near miss or unsafe operations. Also, if an operator is assigned to a new type of forklift or if workplace conditions change that could affect safety, then refresher training is required.

Trainer Qualifications

The employer may use the services of a qualified third-party trainer or formally designate and authorize an employee as a competent person to conduct the training. A competent person has demonstrated competency through knowledge, training and experience to train and evaluate forklift operators.

The trainee can only operate the forklift when directly supervised by a competent person and when this would not endanger anyone.



Training Topics

Forklift operators must be trained in the operating instructions, warnings and precautions for the types of forklifts they will be authorized to use. The topics listed below must be covered when training a forklift operator. If a specific topic does not apply to the forklift in the employer's workplace, covering it is optional.



General Forklift Training Topics

Additional general forklift training topics include:

-) differences between the forklift and an automobile
-) vehicle controls and instrumentation: Where they are located, what they do and how they work
-) engine or motor operation
-) steering and maneuvering
-) visibility (including restrictions due to loading)
-) fork and attachment adaptation, operation and use limitations
-) vehicle capacity and stability

-) vehicle inspection and maintenance that the operator will be required to perform
-) refueling and/or charging and recharging of batteries
-) operating limitations

Workplace-Specific Training Topics

-) Workplace-specific training topics that should be covered include:
 -) surface conditions where the vehicle will be operated
 -) composition of loads to be carried and load stability
 -) load manipulation, stacking and unshackling
 -) pedestrian traffic where the vehicle will be operated
 -) narrow aisles and other restricted places where the vehicle will be operated
 -) hazardous (classified) locations where the vehicle will be operated
 -) ramps and other sloped surfaces that could affect the vehicle's stability
 -) closed environments and other areas where insufficient ventilation or poor vehicle maintenance could cause a buildup of carbon monoxide or diesel exhaust
 -) other unique or potentially hazardous environmental conditions in the workplace that could affect safe operation
 -) hands-on demonstration using the type of vehicle that the operator will actually be using
 -) changes in workplace conditions that could affect safe operation (e.g., new trenches, new worker access routes, or new staging areas on construction sites)



Refresher Training

Refresher PIT-forklift training may be required if any of the following situations exist:

1. The supervisor observes the operator driving the forklift in an unsafe manner, such as riding with the load too high or traveling at an unsafe speed.
2. The operator has been involved in an accident or near-miss incident.
3. The operator has received an evaluation that reveals he or she is not operating the forklift safely.
4. A workplace condition changes in a way that could affect safe operation of the forklift.
5. The operator has been assigned to drive a different type of forklift.

Unnecessary Retraining

In some instances, progressive discipline may be the appropriate response to observed operator performance. Retraining may not be the proper response if poor operator performance is observed and any of the following situations exist:

1. The operator has successfully completed previously training, and the training is appropriate to the truck and working conditions encountered.
2. The operator has been evaluated and found competent to operate the truck safely.
3. The supervisor determines that adequate training, resources, and other support has been provided.
4. The employee is engaging in horseplay while driving the forklift.

Retraining Topics

Retraining may include some or all the following information, as necessary:

- ✓ common unsafe situations encountered in the workplace
- ✓ unsafe operating methods observed or known to be used

-) the need for constant attentiveness to the vehicle, the workplace conditions, and the manner in which the vehicle is operated

Performance Test for Forklift Operators

Prior to qualifying an operator, it's important to evaluate performance to determine any areas of deficiency in knowledge or skills.

Here is a sample checklist for use in the evaluation phase of operator qualification. You should include this evaluation as part of the operator certification. The operator must perform each of the actions below to the satisfaction of the evaluator to qualify. Any areas of deficiency in knowledge or skills must result in operator retraining.



Name _____ Date _____ Evaluator _____

1. ____ Shows familiarity with truck controls.
2. ____ Gave proper signals when turning.
3. ____ Slowed down at intersections.
4. ____ Sounded horn at intersections.
5. ____ Obeyed signs.
6. ____ Kept a clear view of direction of travel.
7. ____ Turned corners correctly - was aware of rear end swing.
8. ____ Yielded to pedestrians.
9. ____ Drove under control and within proper traffic aisles.
10. ____ Approached load properly.
11. ____ Lifted load properly.
12. ____ Maneuvered properly.
13. ____ Traveled with load at proper height.
14. ____ Lowered load smoothly/slowly.
15. ____ Stops smoothly/completely.

16. ____ Load balanced properly.
17. ____ Forks under load all the way.
18. ____ Carried parts/stock in approved containers.
19. ____ Checked bridgeplates/ramps.
20. ____ Placed loads within marked area.
21. ____ Stacked loads evenly and neatly.
22. ____ Drove backward when required.
23. ____ Checked load weights.
24. ____ Placed forks on the floor when parked, neutralized controls, set brake on, and turned power off.
25. ____ Followed proper instructions for maintenance - checked both at beginning and end.

Operator Certification

The employer should formally certify that each operator has been trained and evaluated. The employer should do the following to properly document the training.

-) The written certification should include, at a minimum, the name of the operator, the date of the training, the date of the evaluation, and the identity of the person(s) performing the training or evaluation.
-) The operator must have been evaluated in the current workplace within the last three years.
-) If the operator had previous forklift training, the employer must document that the training covered the required topics described above.



Maintaining Records

The employer must keep a record that shows that each forklift operator has been trained. We recommend keeping training records for as long as the operator is employed plus at least five additional years or as the employer deems appropriate.

Module 2 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. Which of the following lists the three parts of initial forklift training?

- a. Instruction, practice, assessment
- b. Formal instruction, practical training, evaluation
- c. Informal instruction, testing, evaluation
- d. Video instruction, practical training, analysis

2. Where may forklift trainees operate forklifts during training?

- a. In the learning environment
- b. In the workplace environment
- c. Anywhere on site during off hours
- d. Anywhere as long as it is approved

3. Which of the following situations may require forklift retraining?

- a. A year has gone by since initial training
- b. An employee has taken on forklift operator duties
- c. A new forklift operator has been hired
- d. An operator must drive a different type of forklift

4. Which of the following is a situation that will most likely require forklift retraining?

- a. A new forklift operator has recently been hired
- b. An operator is repeatedly engaging in horseplay while driving the forklift
- c. The operator is seen driving a loaded forklift forward down a ramp
- d. OSHA has conducted a compliance inspection

5. To be certified as a forklift operator, he or she must have been evaluated in the current workplace ____.

- a. within the last five years
- b. by a certified safety professional
- c. within the last three years
- d. by a safety manager or staff member

Module 3: How a Forklift Works

Driving a Forklift: Different than Driving a Car

In a car or truck, the front wheels steer the vehicle. However, a forklift has the steering wheels in the rear end of the forklift so it can swing in a circle around the front wheels that support most of the load. This allows the forklift to rotate the load into the correct position.

The operator must check that there is room for the rear end to swing when making turns. This clearance can be maintained in your workplace by permanently marking aisles with painted lines or arranging storage racks in a way that creates obvious aisles for travel. However, these marked aisles will only be effective if you keep them clear of stored materials, which can gradually encroach as space is needed.

A forklift is not as responsive as a car when turning the steering wheel. Rear steering makes it difficult to stop a forklift quickly or swerve and still maintain control. As a result, it is important not to drive a forklift fast or round corners quickly.



Forklift Safety Measures

A backrest extension on the forks prevents part of the load from falling rearward toward the operator. This is required when loads are lifted high and the type of load would allow all or part of it to fall to the rear under conditions such as acceleration, sudden stops or driving on an uneven surface.

An overhead guard prevents an object on the forks or on a high rack from falling onto the operator while picking or placing a load at elevation. The guard is not designed to withstand the impact from a full load. It can be effective in deflecting small packages. It is required on all forklifts that can lift a load above the operator unless conditions such as clearances would not allow the forklift to be used.



The masts on newer forklifts are designed for traveling so that operators have a better view through the center in the direction of travel. The image to the right demonstrates improvements in forklift mast design.

Operator restraints will hold you in the seat if you strike an object or if the forklift overturns. Since 1992, forklift manufacturers have been required to equip new forklifts with operator restraints such as seat belts. Many forklift manufacturers offer restraint systems that can be retrofitted on older forklifts.

Failure to wear a seat belt can result in the operator being thrown outside the protective cage in the event of an overturn. If your forklift has a restraint, such as a seat belt or a lap bar, you must use it.

Principles of Lifting Loads

A forklift works on four very important principles that must be understood by all operators:

1. Fulcrum Principle
2. Stability Triangle
3. Center of Gravity
4. Moment

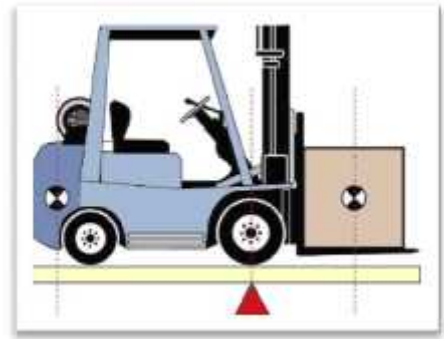


*Left: "Old design"
Right: "New design"*



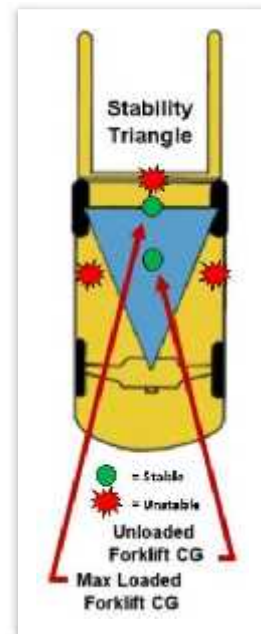
Fulcrum Principle

The Fulcrum Principle states that a forklift has two weights (load, counterweight), each located on the end of a beam which is balanced on a fulcrum, similar to a playground seesaw. A load is located on the forks and is balanced by the weight of the forklift with counterweight. The forks are supported by a fulcrum point located along the axle of the front wheels.



Stability Triangle

Operators must also understand the **Stability Triangle**. All forklifts have a stability triangle with the three sides of the triangle as shown in the illustration to the right. The sides of the triangle are formed by the center of each front wheel and the center of the rear wheel or at the center of the axle if there are two rear wheels. Just imagine you're riding a tricycle. A tricycle is nothing more than a triangle on wheels. If you peddle around a corner too fast and shift your center of gravity outside the stability triangle, you'll tip over sideways. If you shift your center of gravity over the rear wheels, you are less likely to flip over backwards.



Center of Gravity (CG)

The **Center of Gravity (CG)** is the point at which the weight on both sides of the fulcrum is equal. The load on the forks is counterbalanced by the weight of the forklift body. Counterweight is built into it. The vehicle-load combination CG must be located inside of the stability triangle to prevent the forklift from tipping forward, falling sideways or dropping its load.

Moment

The load moment must be less than the forklift moment.

A moment is calculated in inch-pounds. It equals the distance (in inches) x weight (in pounds) from a fulcrum to each end of the beam.

There are two important moment calculations that determine the stability of the forklift load.

Forklift Moment

The forklift moment is the distance from the fulcrum at the center of the front wheel to the center of gravity (CG) of the unloaded forklift multiplied by (x) the capacity rating of the forklift.

Forklift moment = distance from fulcrum to CG x capacity of forklift.

Load Moment

The load moment is the distance from the fulcrum to the forklift CG of the load multiplied by (x) the weight of the load in pounds.

Load moment = distance from fulcrum to load CG x capacity of forklift.

Whether a forklift will safely carry a load or tip over can be determined by comparing the forklift moment and the load moment. To be safe, the load moment must be less than the forklift moment.

Capacity Plates

Forklifts have a capacity plate to tell the user what loads are safe to lift. If the plate says the capacity is 30,000 pounds or less then that capacity is rated for a load with a center of gravity 24" from the face of the forks. Most pallets are 48" x 48" and have a 24" CG if the weight of the load is evenly distributed. If the forklift capacity is greater than 30,000 pounds then the label will rate the load at a 36" or 48" center of gravity since larger forklifts usually lift physically larger loads.

Examples

Let's look at an example that illustrates what we've been discussing. An evenly distributed 48" wide load on the forks has a center of gravity that is 24" from the face of the forks.

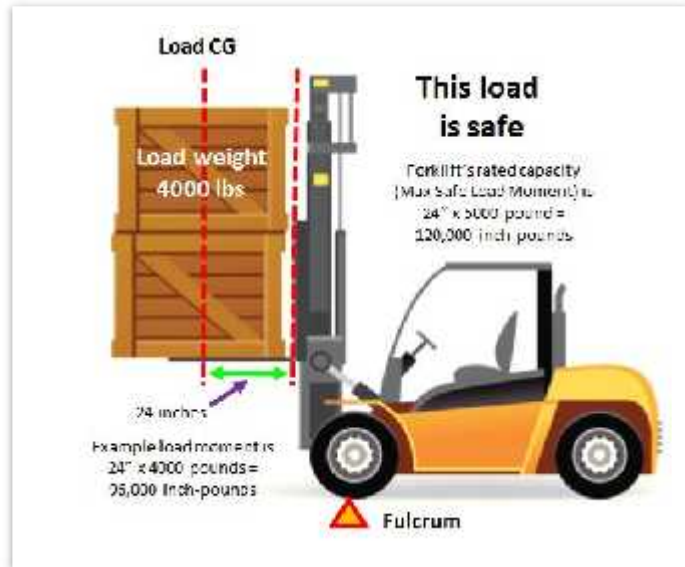


Safe Lift

If the load weighs 4,000 pounds, then the load moment will be (24" x 4,000 lb.) = 96,000 inch-pounds.

To be safe, the load moment must be less than the forklift moment.

Using the example and capacity plate in the previous section, a forklift rated at 5,000 pounds at 24 inches would safely lift a load with a moment of up to (24" X 5,000 lb.) = 120,000 inch-pounds.



In this case, the load above would be safe to lift.

Forklift Moment = (24" X 5,000 LBS) = 120,000 inch-pounds

Load Moment= (24" X 4,000 LBS) = 96,000 inch-pounds

The load is safe to lift because load moment is less than forklift moment.

Unsafe Lift

Let's say the same 4,000-pound load was 66" wide, the load moment would then be 132,000 inch-pounds (33" X 4,000 lb.). Would the load be safe?

Forklift Moment = (24" X 5,000 LBS) = 120,000 inch-pounds

Load Moment= (33" X 4,000 LBS) = 132,000 inch-pounds

In this example, the load moment is greater than forklift moment, so the load is too heavy for the forklift and it would tip forward.

Raising the Load Can Create Instability

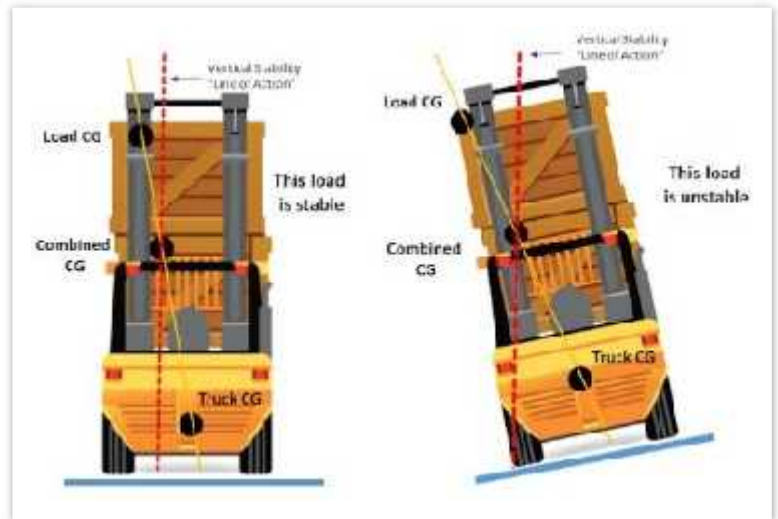
As the load is raised, it becomes possible for the forklift to fall to the side as well as tip forward because the combined CG might move outside the stability triangle. The operator must consider the CG of the forklift and load together. This combined CG moves forward as the forklift is loaded. The combined CG also moves as the load is moved and as the forklift travels over surfaces that are rough or inclined.

The combined CG can move outside the stability triangle if:

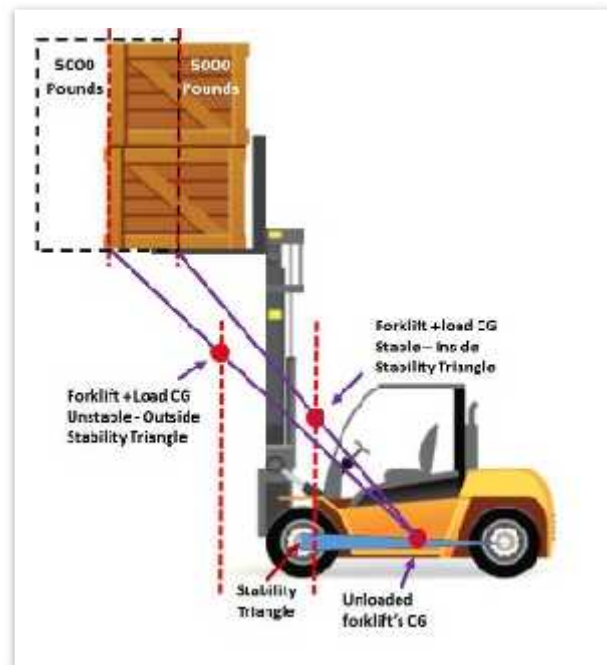
- ⌋ The load is picked up on the tip of the forks.
- ⌋ The load is tilted forward.
- ⌋ The load is tilted too far back when raised.
- ⌋ The load is wide.
- ⌋ Forklift movement causes the center of gravity to shift.

These actions will have the following effects:

- ⌋ Tilting the load forward moves the combined CG toward the front axle.
- ⌋ Tilting the load back moves the combined CG toward the rear axle.
- ⌋ Driving across an inclined surface moves the combined CG toward the downhill side of the triangle.



If the Load CG moves outside the Safety Triangle, the forklift may tip forward.



-) Driving across rough or uneven surfaces moves the combined CG toward the rut or low side of the triangle.
-) Turning moves the combined CG toward the side now facing the original direction of travel.

If you drive a forklift on an incline, you must keep the load on the uphill side. Otherwise, you may have no weight on the wheels that steer and can lose control. The load could also fall off or cause the forklift to tip.

Operator procedures that reduce the risk of overturn, collision or loss of the load use the following procedures:

-) Make sure the load is stable and safely arranged on the forks.
-) Do not tilt the forks forward except when picking up or depositing a load.
-) Tilt the load backward only enough to stabilize the load.
-) Keep the load low just above the pavement with forks tilted back when traveling.
-) Cross railroad tracks diagonally when possible.
-) Enter elevators squarely.
-) Keep the load uphill when going up or down an incline.
-) Drive at a speed that will allow you to stop safely within the stability triangle.
-) Slow down on wet or slippery surfaces.
-) Slow down to make turns.
-) Avoid driving over loose objects or on surfaces with ruts and holes.



Watch this short Washington State OSHA video [on the importance of the forklift cage and the stability triangle.](#)

Module 3 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

- 1. A forklift has the steering wheels _____ so it can rotate the load into the correct position.**
 - a. in the front end of the forklift
 - b. in the rear end of the forklift
 - c. locked by special mechanisms
 - d. in opposition to each other

- 2. Which of the following is the point at which the weight on both sides of the fulcrum is equal?**
 - a. Center of Gravity
 - b. Stability Triangle
 - c. Moment
 - d. Stable Point

- 3. Which of the following equals the distance from the fulcrum to the CG of the load multiplied by (x) the weight of the load in pounds?**
 - a. Load moment
 - b. Forklift moment
 - c. Capacity moment
 - d. CG moment

4. The forklift combined center of gravity (CG) will not move out of the stability triangle if _____.

- a. the load is picked up on the tips of the forks
- b. the load is wide
- c. the weight of the operator increases
- d. the load is tilted forward

5. Turning moves the combined center of gravity (CG) _____.

- a. toward the back side of the stability triangle
- b. toward the side now facing the original direction of travel
- c. toward the side now opposite the original direction of travel
- d. toward the front of the stability triangle

Module 4: Safe Forklift Operations

A forklift is a powerful tool that allows one person to precisely lift and place large heavy loads with little effort. Using a tool such as a forklift, cart or hand truck instead of lifting and carrying items by hand can reduce the risk that you will suffer a back injury.

However, there is great risk of injury or death when a forklift operator:

- has not been trained in the principles of physics that allows a forklift to lift heavy loads

- is not familiar with how a particular forklift operates

- operates the forklift carelessly

- uses a forklift that is not safe due to malfunctioning or missing parts



Minimum Age Requirement

It is a violation of Federal law for anyone UNDER 18 years of age to operate a forklift or for anyone OVER 18 years of age who is not properly trained and certified to do so. Given the significant number of young workers employed, especially during the summer months, OSHA believes that it is important to remind all employers of the regulations that prohibit workers under 18 years of age from operating specified hazardous machines and equipment, including forklift trucks in non-agricultural operations.



Pre-Use Inspection

The forklift should be checked for defects before initial use, usually by the operator before beginning a work shift. If someone else has used the forklift during a shift, it's a good idea to check it for defects again.

Even if you operate a forklift safely, a defect can cause or contribute to a serious accident. Any defects that would affect safety must be corrected before the forklift is returned to service.



Look at the following checklist items for things to look for during an inspection:

- ✓ Is the horn working? Sound the horn at intersections and wherever vision is obstructed.
- ✓ Are there hydraulic leaks in the mast or elsewhere? These could cause slipping hazards or lead to hydraulic failure.
- ✓ Are fuel connections tight and battery terminals covered? Dropping a piece of metal across battery terminals can cause an explosion.
- ✓ Is there a lot of lint, grease, oil or other material on the forklift that could catch on fire?
- ✓ Do sparks or flames come out from the exhaust system?
- ✓ Does the engine show signs of overheating?
- ✓ Are tires at proper pressure and free of damage? A tire with low pressure or a tire failure can cause a forklift to tip or fall when a load is high.
- ✓ Do all controls such as lift, lower, and tilt work smoothly? Are they labeled?
- ✓ Is there any deformation or cracks in the forks, mast, overhead guard, or backrest?
- ✓ Are lights operating if used at night or in dark locations?
- ✓ Is steering responsive? A lot of play or hard steering will reduce your control.
- ✓ Do brakes stop smoothly and reliably? Sudden stops can cause tipping.
- ✓ Does the parking brake hold the forklift on an incline?
- ✓ Are seat belts (if equipped) working and accessible?
- ✓ Is the load capacity plate readable?

Check out this short video on [Pre-Shift Forklift Inspections](#).

Traveling

Precautions and best practices while traveling in a forklift include:

-)] The most basic rule for traveling is that you maintain control of your forklift at all times.
-)] Operate a forklift only while in the seat or operator's station.
-)] Never start it or operate the controls while standing beside the forklift.
-)] Never allow passengers unless the forklift was designed for a passenger.
-)] Do not put any part of your body between the uprights of the mast or when traveling, outside of the forklift frame.
-)] Never drive with wet or greasy hands. If necessary, keep a towel or rag handy at all times.
-)] Whether loaded or empty, carry forks and platforms on lift trucks as low as possible. This lowers the center of gravity and reduces the possibility of overturning the truck or dumping the load.
-)] Always look in the direction of travel and keep a clear view of the travel path. Travel in reverse if the load blocks your view.
-)] Always observe posted speed limits (usually 5 mph) at your workplace. A forklift should not be driven faster than a quick walking pace.
-)] Keep a distance of at least three forklift lengths between you and any forklift traveling in front of you.
-)] Do not pass a forklift traveling in the same direction if it is at a blind spot, intersection or other dangerous location.
-)] Never drive a forklift up to anyone in front of a bench or other fixed object.

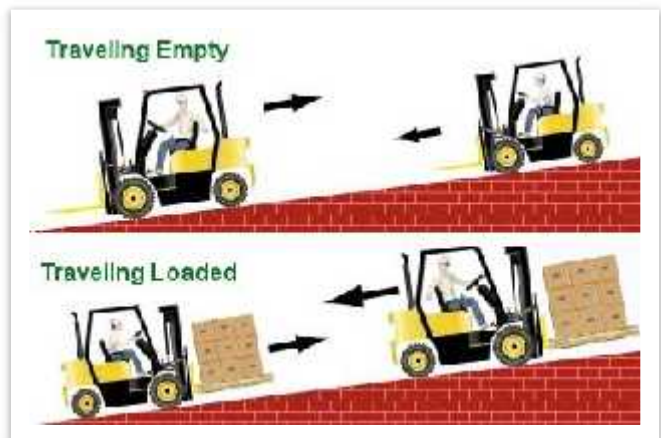


-) Never allow anyone to walk or stand under the elevated forks—even if the forks are not carrying a load.
-) Check that there is adequate clearance under beams, lights, sprinklers, and pipes for the forklift and load to pass.
-) Never engage in stunt driving or horseplay.

Driving on Ramps and Grades

Forklift operators should follow certain general rules of the road when traveling on ramps and other inclines. Traveling up and down ramps and grades can be quite dangerous because the forklift can more easily tip over. Be sure to follow these safety practices when operating the forklift on ramps and grades:

-) Always look in the direction of travel.
-) Never turn on a ramp or incline. Turn prior to the ramp or incline to place forks in proper direction.
-) Keep a safe distance from the edge of a ramp.
-) Do not travel on ramps with slopes or other conditions that exceed the manufacturer's recommendation.
-) When traveling with a load, the load should point up the incline, regardless of direction of travel.
-) When traveling without a load, the forks should point downgrade, regardless of direction of travel.



Driving onto Trucks, Trailers, and Railroad Cars

Forklifts are often driven onto trucks, trailers, or railroad cars over a dock board (also known as a bridge plate) at loading docks. If the truck, trailer or car is not secured to the dock or otherwise chocked, it may move forward. The dock board can then fall between the trailer and the dock as the forklift crosses it.



You can secure wheel chocks with chains at each loading dock bay and tell truck drivers that they must place them in front of the rear wheels. Another way of securing the trailer is to use a vehicle restraint system mounted to the dock that clamps onto a bar below the trailer as it backs into place. This system will signal when the restraint is engaged or if there is a problem.

The pavement at some loading docks slopes downhill toward the loading dock. This is not a substitute for chocking wheels.

Check out this video to [see what happens when the truck is not chocked](#).

Sometimes a trailer is left at a loading dock without the tractor attached. Use trailer jacks to prevent the trailer from up-ending when a forklift drives to the front of the trailer to load or unload. Here are some additional loading and unloading procedures:



-) Inspect the floor of the trailer to be sure that it will support the forklift and load.
-) Ensure that the height of the entry door is adequate to clear the height of your vehicle, taking into consideration the height of the loading platform.
-) Drive straight across the bridge plates when entering or exiting the truck trailer or railroad car.
-) Use dock lights and headlights when working in a dark trailer.
-) Sound the horn when entering or exiting the trailer.
-) In determining the capacity of the trailer floor to support a forklift, consider various factors, including floor thickness and cross-member spacing or unsupported floor area.

In general, the larger the unsupported area, the lower the forklift capacity the trailer will have for the same floor thickness.

) Never use the forklift to open railroad car doors unless:

- It has a device designed for that purpose.
- The operator is trained in the use of the device.
- All other employees stand clear.

) Keep a safe distance from the edge of a loading dock or a ramp. The edge must be painted yellow or with alternating yellow and black diagonal stripes to warn of both the fall hazard and the potential to be crushed by a trailer backing into the dock.



) A portable dock board must be secured in place to prevent it from moving. Some boards have pins that are inserted into the sides and project below the board. This prevents the board from moving toward the dock or toward the trailer. To prevent crushed fingers and make for safe handling, a portable dock board must also have handholds or lugs that allow the forklift to pick it up.

) Some loading docks have a bull rail that prevents a wheel from slipping off the sides of ramps or edges of the dock where a forklift would not have to cross to enter a trailer.



) Any part of the dock edge that is four feet or more above the adjacent surface must have a standard guardrail. Removable rails (such as chain rails) and posts can be used at the place where trucks or trailers will be loaded.

) Use rail mounted chocks to secure a railroad car. Also, prevent anyone from moving the rail car while the forklift is working. A blue sign with the word "STOP" attached to the track is one way of signaling that the car must not be moved. A special attachment must be used if a forklift is used to open a rail car door.



Module 4 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

- 1. It is a violation of Federal law for anyone _____ to operate a forklift.**
 - a. under 18 and not properly trained
 - b. 18 years and under
 - c. under 18 years old and not authorized by the employer
 - d. under 18 of age

- 2. Why should a forklift operator check that tires are at the proper pressure and free of damage?**
 - a. The forklift might bounce too much on rough surfaces
 - b. The tires might get damaged over time
 - c. The forklift could tip or fall when the load is high
 - d. Fuel efficiency decreases

- 3. The most basic rule for traveling in a forklift is that you _____.**
 - a. maintain control of your forklift at all times
 - b. always follow OSHA rules when driving a forklift
 - c. always travel with the load at least 12 inches above the ground
 - d. never allow another employee to drive your forklift

- 4. What should the forklift operator do if he or she does not have a clear view ahead when traveling?**
 - a. Travel in reverse
 - b. Raise the load above eye level
 - c. Reduce the size of the load
 - d. Use a spotter to guide the operator

5. Keep a distance of _____ between you and any forklift traveling in front of you.

- a. at least one forklift length
- b. at least three forklift lengths
- c. at least two forklift lengths
- d. at least four forklifts lengths

Module 5: Safe Forklift Operations (Continued)

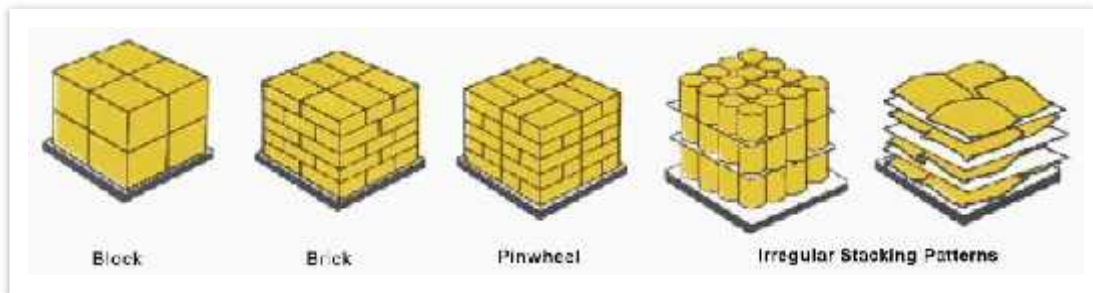
Loading and Unloading the Forklift

Because of the wide variety of equipment used and the different kinds of stock and materials handled, each company must form additional rules for loading and unloading to fit the needs of its facilities. Know the maximum load that each truck can carry safely; do not overload it. An overloaded truck will not operate in a safe manner.

Answer the following questions and check the load before you pick it up.



-) Is it stable or will parts slide or fall during transit? Secure it as necessary. The illustrations below show some common pallet stacking patterns.



-) Do the dimensions and weight of the load fall within the capacity rating of the forklift at the highest elevation and maximum extension you will handle the load? If not, can you break the load into smaller parts?

When you pick up the load:

-) Move squarely into position in front of the load.
-) Make sure your view is not obstructed.
-) Do not permit anyone to stand under or too close to a load that is being hoisted or lowered.
-) Position the forks wide apart to keep the load balanced.
-) Drive the forks fully under the load.



-) Tilt the mast backward slightly to stabilize the load and lift. Check the destination before you place the load.

Check out this great video on [basic forklift operations](#).

Check out the destination:

-) Is the destination flat and stable—or, will the load rock, tilt or lean?
-) Never place heavy loads on top of light loads.
-) Observe maximum stacking quantities and orientation if printed on cartons.
-) Do you know the load bearing capacity of your rack or storage loft destination?
-) Are rack legs or support members bent or disconnected? The load bearing capacity of a damaged rack is unknown. Wait until the damaged component has been replaced before loading.
-) Are racks arranged back to back with a stock behind where you will place the load? Someone may need to be in the next aisle to control access while you place the load.
-) Are wooden stringers or decking laid between front and rear rack beams in good condition? They may support the load if the pallet is not properly placed on both front and rear rails.
-) If you are stacking, are other pallets in the stack in good condition and capable of supporting the load in addition to what they are already supporting?



When you place the load at its destination:

-) Move squarely into position in front of the rack or stack where the load will be placed.
-) When ready to place the load, tilt the mast to level. Only tilt forward when the load is over the spot where it will be placed.
-) Lower the forks and back away.
-) Visually verify that the load is stable.



Watch this short video demonstrating [what can happen with a high-center unstable load](#).

Leaving a Forklift Unattended

A forklift is considered to be unattended when it is not in view of the operator or if it is in view, the operator is 25 feet or more away.

If you leave a forklift unattended:

1. Select a secure location on level ground.
2. Set the brakes.
3. Set the controls to neutral.
4. Tilt the forks forward and lower them to the ground.
5. Turn off the power and remove the key.
6. If the forklift is parked on an incline, block the wheels.
7. If you dismount a forklift and stay within 25 feet, you must at least lower the forks to the ground, set the controls to neutral, and set the brakes.

Lifting and Lowering People

Lifting or lowering a person on forks or a pallet can result in a fall injury or fingers caught in moving parts of the mast.

No worker should be allowed to be lifted while standing on the forks or on a pallet lifted by the forks. The image to the right is a good example of what should never be done. These workers in the photo are lucky they did not get hurt or killed.

If you want to use a forklift to raise an employee to an elevated position, use a platform or structure specifically built for this purpose that meets the conditions described below.

-) The platform must have standard guardrails which include a top rail 36" to 42" above the platform (39" to 45" on a construction site), midrail and toeboard. It must also prevent contact with chains and shear points on the mast. See the illustration for an example.
-) The platform must be securely attached to the forks such as by a clamp or chain.
-) Check with the forklift manufacturer to verify that the hydraulic system will not allow the lift mechanism to drop faster than 135 feet per minute in the event of a system failure. Identify the forklift as approved for use with the platform.
-) Lock or secure the tilt control to prevent the boom from tilting.
-) A forklift operator must be at the normal operating position when lifting and lowering the platform. The operator must be near the forklift while a worker is elevated.
-) Except to inch forward/backward or maneuver at low speeds, do not move the forklift between two points when a worker is on the platform.

Order picker forklifts are designed to allow the operator to be lifted along with the controls to an elevated location. However, if the operator station does not have standard guardrails on all open sides, then the operator must wear a full body harness with lanyard attached to a manufacturer approved anchor.

Traffic Patterns

The first step to prevent powered industrial truck accidents in a facility is to establish a traffic pattern. This is management's responsibility.

Management must ensure:

-) Aisles are well-lighted and free from obstructions.
-) Floors are sound and in good shape. Wet, oily or icy surfaces should be avoided. Clean them up as soon as possible.
-) Aisles are marked clearly. When they are wide enough for two trucks to pass each other, the center of the aisle and the two extreme edges should be marked with painted lines. In some plants, the aisles are wide enough for two truck lanes and a pedestrian lane.
-) Do not allow for two trucks to run side by side in the same direction.
-) A truck must never pass another truck at an intersection, blind spot or other dangerous location. In areas where there is high concentration of truck traffic, it may be best to have one-way aisles.
-) Speed limits are set and strictly enforced. A few speed limit signs at strategic points serve as constant reminders to truck operations.
-) Prominently display stop signs at all crossings. These may be regular stop signs or signs painted or set into the floor. You can also use stripes and discs as indicators.
-) Each plant must set up its own rules regarding traffic control, but a required four-way stop at every intersection is a wise way to avoid collisions. Plants that have adopted the four-way stop requirements have found that no significant time is lost by this extra precautionary measure.



Workplace Conditions

Workplace surface and overhead conditions are an important part of safe lift truck operation. Operating surfaces must be strong enough to support the forklift, its load and its operator. They must also be free of holes, grease, oil or obstructions that could cause the lift truck to skid, bounce, and/or possibly tip over.



Workplace surface and overhead conditions and factors to consider when traveling include:

-) **Slippery Conditions.** There is a danger of skidding when traveling on oil, grease, water or other spills. A forklift could tip over when traveling on ice, snow, mud, gravel and uneven areas.
-) **Obstructions and Uneven Surfaces.** There is a danger of tip over when traveling over obstructions, holes and bumps.
-) **Floor Loading Limits.** There is a danger of the floor collapsing if it's unable to support the weight of the forklift, load, and operator.
-) **Overhead Clearance.** There is a chance of damage to lights, stacks, doors, sprinklers and pipes. Damage to the load may also occur, and the forklift may tip over when traveling and hitting an overhead obstruction.

Housekeeping

Develop a model for good housekeeping. Develop specific procedures for storing tools and material in the proper location. Items to consider for proper housekeeping include the following:

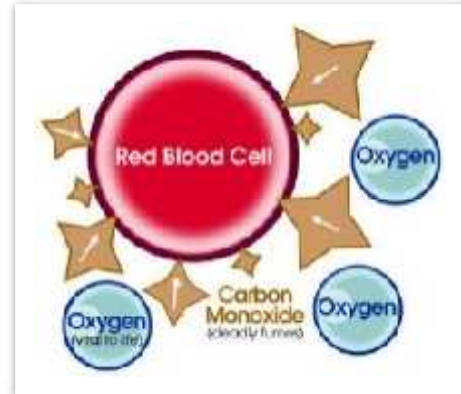
-) uncluttered and well-marked aisles
-) a corner mirror for traffic safety at the intersection
-) adequate lighting



Other standard precautions, which management should consider, include guardrails or flashing lights in front of doors that open into aisles; curbs around docks, pits or drop areas; and mirrors at intersections.

Carbon Monoxide

Internal combustion engines produce carbon monoxide. This gas can rapidly build up in any indoor area. Once inhaled, carbon monoxide decreases the ability of the blood to carry oxygen to the brain and other vital organs. Even low levels of carbon monoxide can set off chest pains and heart attacks in people with coronary artery disease.



Workers can be overcome without even realizing they are being exposed. Confusion, headache, dizziness, fatigue, and weakness may set in too quickly for victims to save themselves. Carbon monoxide poisoning can cause permanent brain damage, including changes in personality and memory.

OSHA standards set the maximum allowable exposure to carbon monoxide. Gasoline powered forklifts should not be used indoors. Propane forklifts also produce carbon monoxide and must be regularly inspected and maintained. If you are concerned about the exposure level in an enclosed area where a forklift operates, contact a qualified industrial hygienist to make measurements and recommendations to improve ventilation.

Check out this short video that gives examples of [what can happen when forklift safety rules are not followed](#).

Maintenance Records

It is very important to maintain accurate records of all corrective and preventative maintenance for a substantial period of time. Doing so will help in conducting accident investigations by providing a maintenance history for analysis. It will also make it easier to establish trends in maintenance needs.

If an OSHA compliance officer investigates an accident involving a forklift, he or she will ask to see maintenance and repair records. If you do not have records, it will be impossible for you to prove any maintenance was done and may result in a citation.



Module 5 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

- 1. Which of the following questions should be asked when picking up a load?**
 - a. Are the forks set close?
 - b. Are the forks positioned at least half-way under the load?
 - c. Is the load stable or will parts slide or fall during transit?
 - d. Is the load positioned and centered on the mast to see under the load?

- 2. When picking up a load and placing the load at a destination, the forklift operator should always ____.**
 - a. tilt the load slightly backward prior placing
 - b. move squarely into position in front of the load or rack/stack
 - c. position the forklift diagonally into position prior to loading and unloading
 - d. ensure the forks are evenly tilted into the load

- 3. When is it permissible to lift or lower a worker standing on the forks of a forklift?**
 - a. Never
 - b. When properly tied off
 - c. Only when feasible
 - d. When approved or authorized to do so

- 4. The first step to prevent powered industrial truck accidents in a facility is to ____.**
 - a. invite OSHA to inspect
 - b. ensure barriers and block are in place
 - c. post warning signs
 - d. establish a traffic pattern

- 5. Which of the following is produced by forklift internal combustion engines, is odorless, and causes a decrease in the ability of blood to carry oxygen?**
- a. Carbon dioxide
 - b. Carbon monoxide
 - c. Dihydrogen monoxide
 - d. Hydrogen sulfide

Module 6: Forklift Maintenance

“Out of Service” and Required Check Intervals

A forklift should be checked by a qualified maintenance person for defects the first time it is placed into service and every day that the forklift is used. If the forklift is used continuously, then a maintenance inspection should be checked at the end of each shift.

The maintenance department should conduct inspections of all forklifts at regular intervals. We have included samples of an operator’s “Daily Forklift Safety Checklist” at the end of this module that can be adapted and attached to the forklift as a reminder to the operator to do this check. Some employers keep records of these daily checks.



Corrective Maintenance

Corrective maintenance is a reactive measure conducted only after defects are discovered. It should be the duty of every operator to promptly report to the person in charge any mechanical trouble with the forklift, any bad flooring or obstruction in the aisles, and other safety hazards that are encountered. If a forklift is found unsafe then it must be removed from service until repaired by an authorized person.



Preventive Maintenance

Preventive maintenance is a proactive measure conducted according to a formal schedule to prevent defects that might affect forklift operation. The forklift owner’s manual will have routine checks and preventive maintenance tasks that must be done by a skilled maintenance person to keep the forklift in safe operating condition. Keep a record of this maintenance as well as any repairs that are made.




Maintain the truck in accordance with rules prescribed by the manufacturer. These are some of the rules that truck operators, who are responsible for maintaining their own equipment, should follow:

-) When servicing electrical storage batteries, wear protective clothing to guard against chemical splashes and burns, rubber boots, rubber apron, chemical goggles, face shield and rubber gloves.
-) Do not attempt to lift a storage battery without suitable hoisting equipment.
-) Handle the storage battery carefully to prevent cracking the case and spilling the fluid.
-) Change and charge batteries in locations designed for this specific purpose.
-) Refuel internal combustion powered trucks in the open or where ventilation will carry vapors away.
-) Do not leave trucks unattended or parked with the engine running.
-) Turn off internal combustion engines before refueling.
-) No smoking in service areas.

Safety in the Maintenance Area

To prevent injury or illness when doing maintenance on a forklift:

- J Do not do repairs in an area with a potentially flammable or combustible atmosphere.
 - J Make sure there is adequate ventilation to prevent accumulation of exhaust or gas fumes.
 - J Do not use a flammable solvent to clean a forklift. Use a non-combustible (flash point above 100 degrees Fahrenheit) solvent.
 - J Never get under a forklift supported only by a jack or under any part supported only by hydraulic pressure. Install jack stands or a secure block support.
 - J To prevent the forklift from accidentally being started, remove and keep control of the key or disconnect the battery while making repairs. If the electrical system will be serviced, you must disconnect the battery before starting repairs.
- 
- A black forklift is shown in a workshop, elevated on a blue hydraulic lift. The forklift is positioned horizontally, and its front end is facing right. The workshop has a polished floor that reflects the light, and the background shows some industrial equipment and structural elements of the building.



-) Battery changing stations for forklifts should reflect both proper safety precautions and good housekeeping techniques. A clean, uncluttered work area reduces the possibility of accidents to workers and equipment.
-) Install “No smoking” signs and eye wash stations to prevent serious injuries.

Modifying Forklifts

When you replace parts, make sure they are equivalent to the original manufactured part.

Do not alter or eliminate any forklift parts or add any accessories such as additional counterweights or lifting attachments unless approved by the manufacturer in writing. Make any necessary changes to the load capacity plate and operating instructions.



Cleaning Forklifts

Operators are responsible for keeping their forklifts clean. At the end or the start of every shift, clean all surfaces of the truck with a suitable cloth to remove all dust, dirt and grease. It's best to use a wax-treated flannel dusting cloth such as those commonly used to clean dust and dirt off cars.

Refueling: Gasoline and Diesel

Forklifts that use gasoline are easy to refuel. However, gasoline is very flammable. Below are recommended best practices for refueling:

-) Refuel only at designated safe locations. A designated safe location outdoors is preferable to a refueling area indoors. Do not refuel trucks in hazardous areas or around heat sources.
-) Stop the engine during refueling.
-) Do not smoke while refueling.
-) Do not allow the forklift to become low on fuel or run out of fuel. Sediment or other impurities in the tank could be drawn into the fuel system causing difficulties in starting and cause damage to the internal components.



-) Fill the fuel tank at the end of each day.
-) Do not fill the tank to the top, as it may overflow because fuel expands as it is heated.
-) Follow correct refueling procedures:
 - Park the forklift in the designated refueling area.
 - Engage the parking brake.
 - Place the transmission in "Neutral."
 - Lower the forks to the ground.
 - Shut off the engine.
 - Open the filler cap.
 - Fill the tank slowly (if spillage occurs, wipe off fuel and wash down the area with water).
 - Close the filler cap.

Refueling: Liquid Petroleum Gas

Liquid petroleum gas (LPG) is a commonly used fuel for forklifts. It is a safe fuel when handled properly. When handled improperly, it can cause serious injury or death.

-) LPG vapor is heavier than air and will seek the lowest lying area. If not adequately dissipated, it will collect in pockets and possibly ignite when exposed to a heat source.
-) LPG is extremely flammable.
-) LPG is extremely cold when exposed to the atmosphere. If your skin is exposed to LPG, you can get frostbite.

Below are the requirements and recommended best practices for refueling:

-) Do not refuel LPG-powered trucks in confined areas where LPG vapors could collect if a leak occurs.

-) Do not leave LPG-powered trucks near heat sources, stairways, exits, or other egress areas.
-) When parking LPG-powered trucks for a long period of time, turn the service valve off.
-) Only trained and authorized personnel should replace LPG containers.
-) Follow proper procedures for storing and handling liquid petroleum gas.

Check out this short video by Ted Johnson Propane on [Forklift Fuel Filling](#).

Operator's Daily Checklist: Gas or LPG Forklift

Check each item before the shift starts. Put a check in the box if the item is OK. Explain any unchecked items at the bottom and report them to a supervisor.

Forklift Serial Number:

Operator:

Hour Meter Reading:

Date:

| | |
|-------------------------------------|--|
| <input checked="" type="checkbox"/> | Visual Check |
| <input type="checkbox"/> | Tires are inflated and free of excessive wear or damage. Nuts are tight. |
| <input type="checkbox"/> | Forks and mast are not bent, worn, or cracked. |
| <input type="checkbox"/> | Load back rest extension is in place and not bent, cracked, or loose. |
| <input type="checkbox"/> | Overhead guard is in place and not bent, cracked, or loose. |
| <input type="checkbox"/> | Attachments (if equipped) operate OK and are not damaged. |
| <input type="checkbox"/> | Forklift body is free of excessive lint, grease, or oil. |
| <input type="checkbox"/> | Engine oil is full and free of leaks. |
| <input type="checkbox"/> | Hydraulic oil is full and free of leaks. |
| <input type="checkbox"/> | Radiator is full and free of leaks. |
| <input type="checkbox"/> | Fuel level is OK and free of leaks. |
| <input type="checkbox"/> | Battery connections are tight. |
| <input type="checkbox"/> | Covers over battery and other hazardous parts are in place and secure. |

| | |
|--|--|
| | Load rating plate is present and readable. |
| | Warning decals and operators' manual are present and readable. |
| | Seat belt or restraint is accessible and not damaged, oily, or dirty. |
| | Engine runs smooth and quiet without leaks or sparks from the exhaust. |
| | Horn works. |
| | Turn signal (if equipped) operates smoothly. |
| | Lights (head, tail, and warning) work and are aimed correctly. |
| | Gauges and instruments are working. |
| | Lift and lower operates smoothly without excess drift. |
| | Tilt operates smoothly without excessive drift or "chatter". |
| | Control levers are labeled, not loose or binding and freely return to neutral. |
| | Steering is smooth and responsive, free of excessive play. |
| | Brakes work and function smoothly without grabbing. No fluid leaks. |
| | Parking brake will hold the forklift on an incline. |
| | Backup alarm (if equipped) works. |

Module 6 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

- 1. Which type of maintenance is a reactive measure conducted only after defects are discovered?**
 - a. Preventive maintenance
 - b. Corrective maintenance
 - c. Routine maintenance
 - d. Scheduled maintenance

- 2. Which type of maintenance is a proactive measure conducted according to a formal schedule to prevent defects that might affect forklift operation?**
 - a. Preventive maintenance
 - b. Corrective maintenance
 - c. As needed maintenance
 - d. Safety maintenance

- 3. Why is it important to wear appropriate personal protective equipment when servicing forklift electrical batteries?**
 - a. To protect against fire and explosion
 - b. To guard against static electrical shock
 - c. To guard against chemical splashes and burns
 - d. To protect feet if battery is dropped

4. Do not modify forklifts unless ____.

- a. approved informally by the safety manager
- b. approved by a qualified maintenance person
- c. approved by the manufacturer in writing
- d. approved by an OSHA consultant in writing

5. When parking LPG-powered trucks for a long period of time, ____.

- a. set the brake to the neutral position
- b. insulate the propane tank
- c. remove the propane tank
- d. turn the service valve off

Module 7: Forklift Maintenance (Continued)

Electric Forklifts

Electric-powered forklifts are most commonly used indoors in warehouses. They produce zero emissions, virtually eliminate the hazard of carbon monoxide poisoning, and run more quietly than internal combustion forklifts. However, they present other serious hazards that must be addressed.

Recharging Electric Forklifts

Electric forklifts are powered by large lead-acid batteries, which must be routinely charged. The hazards and recommended practices for charging and changing batteries are reviewed below.

The hazards and recommended practices for charging and changing batteries are reviewed below. Requirements and recommended practices include:

-) Designate an area for battery charging.
-) Make sure that the forklift is charged before using.
-) Recognize that heavy loads drain the battery more quickly.

The Battery Charging Area

A properly-equipped battery charging area will have:

-) a no smoking policy with signs posted
-) warning signs posted
-) adequate fire protection
-) ample and readily available water supply for flushing and neutralizing spilled electrolyte



-) an eyewash able to provide at least a 15-minute flow (Note: For large installations, there should be a plumbed drench shower and an eyewash.)
-) a phone or other means of communication in the event of an emergency
-) adequate ventilation to avoid the build-up of hydrogen gas during battery charging
-) soda ash or other neutralization materials in the immediate area
-) a dry chemical, CO2 or foam fire extinguisher
-) means to protect charging apparatus from damage from trucks

Battery Charging and Changing Procedures

An electric forklift is designed to operate for one shift and then be charged on the next shift or overnight. Some employers routinely change batteries instead of charging them in the vehicle. The discharged battery is removed from the forklift and a charged battery is installed in its place.

Batteries are heavy and contain sulfuric acid that is highly corrosive and could be splashed on personnel servicing or changing batteries. Toward the end of the battery charging process, batteries can give off highly explosive hydrogen gas. Contact with battery cells can cause electrical short circuits, which can burn unprotected skin.

Only trained personnel should charge and change batteries in electric forklifts. In addition to training in battery changing and charging procedures, these employees should be trained on emergency procedures in the event of an acid splash, including how to use eyewash and shower facilities.

Always follow your facility's specific safety procedures. Follow the recharger manufacturer's recommendations for attaching and removing cables and for proper operation of your equipment. Requirements and recommended practices for charging batteries include:



The battery charge gauge indicates over-discharging.



This electric forklift is properly positioned while changing batteries.

Properly position trucks and apply brakes before attempting to change or charge batteries.

Use a lifting beam or equivalent material handling equipment when lifting the battery. Do not use a chain with two hooks. This may cause distortion and internal damage.

Charge batteries in the designated battery charging area.

Provide an area for flushing and neutralizing spilled electrolyte, for fire protection, for protecting charging apparatus from damage by trucks, and for adequate ventilation for dispersal of fumes from gassing batteries.



The battery is hoisted from forklift compartment with lifting beam.



Battery charging area

NOTE: OSHA Directive, STD 1-11.4 - 29 CFR 1910.178(g)(2); Battery Charging Stations for Fork Lifts and Other Industrial Trucks, 10/30/1978 states:

"Battery charging" areas where power industrial truck batteries are charged only--no maintenance is performed, batteries are not removed from the trucks and no electrolyte is present in the area--are not subject to the requirement of [29 CFR 1910.178(g)(2)]. The charging areas shall be in compliance with [29 CFR 1910.178(g)(1), (8), (9), (10), (11) and (12)]. Personal protective equipment shall be used when and where required.

When charging batteries, pour acid into water. Never pour water into acid.

Check to assure that vent caps are functioning properly. The battery (or compartment) cover(s) should be open to dissipate heat.

Prohibit smoking in the charging area.

Take precautions to prevent open flames, sparks, or electric arcs in battery charging areas.

Remove all metallic jewelry before recharging. Tools and other metallic objects must be kept away from the top of uncovered batteries.

Wear personal protective equipment (face shield, safety goggles, neoprene or rubber gloves and apron).

Where the eyes or body of any person may be exposed to injurious corrosive materials, suitable facilities for quick drenching or flushing of the eyes and body must be provided within the work area for immediate emergency use.



Eyewash station

Check the electrolyte level before recharging. Record the specific gravity with the hydrometer in the service log. Check the pilot cell.

Check the water level. Do not add water prior to recharging. Record in service log.

Check the voltage. If the battery has sealed vents, do not recharge with a current greater than 25 amperes.

Unplug and turn off the charger before connecting or disconnecting the clamp connections.

Attach the positive clamp (+, usually colored red) to the positive terminal first and then the negative clamp (-, usually colored black) to the negative terminal, keeping the proper polarity.

Turn off the charger if the battery becomes hot or the electrolyte fluid comes out of the vents. Restart charging at a lower charging rate.

Check water level after charging. Add distilled water or de-ionized water if water level is below level indicator. Record in service log.

Return battery to forklift with lifting beam and secure in place after charging.

Check the indicator on the hour meter to see that battery is fully charged.

Battery Maintenance

Under normal operating conditions, power industrial truck forklift batteries can be expected to remain in service for 2,000 work shifts or charge/discharge cycles. Implementing a proper battery maintenance program can increase the life of the batteries and help protect employees. Battery failure could lead to mechanical breakdowns and possible accidents involving forklift operators and/or other personnel.

When working with batteries, be sure to do the following:

Do not continue a battery in service merely because it continues to deliver power.

Do not exceed the service hours in the manufacturer's recommendations.

Do not over charge or under charge batteries.

Avoid discharging batteries beyond the manufacturer's discharge level. This can result in permanent battery damage and shorten battery life considerably.

Warning signs of a low battery include slow starting, dim headlights, and the ammeter indicating discharge at high RPM.

Recycle or properly dispose of batteries. Spent batteries are a hazardous waste unless they are properly reclaimed at a lead smelter or battery recycler.

Here are a couple of good videos to review: The first is by Fallsway Equipment Company on [Industrial Battery Maintenance](#). The second video is by National Lift Truck on [Industrial Battery Dos and Don'ts](#).

Sulfuric Acid Splash

Battery acid is diluted sulfuric acid. Sulfuric acid is a clear, colorless liquid with an acrid smell. It is corrosive and can cause severe burns, especially to the eyes. Below are requirements and recommended safe practices to prevent injuries from sulfuric acid:



Discharging a battery beyond recommended levels may ruin or damage the battery.



Water is added at the end of the charge by an operator wearing PPE.

-) Wear personal protective equipment.
-) Wear chemical splash goggles or full face shield with safety glasses equipped with side shields.
-) Wear acid-proof gloves made of rubber or neoprene.
-) Wear acid-resistant clothing or rubber or neoprene apron.
-) Wear acid-resistant safety shoes or boots.
-) Employees who wear contact lenses should wear chemical splash goggles during battery charging. In the event of an acid splash to the eyes, the contact lens could hold the acid to the eye, making it more difficult to flush the acid away and causing more serious damage to the eye.

Emergency Procedure in the Event of an Acid Splash

These are sample procedures. Your facility may have its own safety procedure, requiring employees to contact their supervisors or medical personnel either on-site or off-site. Consult the Safety Data Sheet for additional information.

If the acid splash is to the eyes:

-) Remove safety glasses and flush eyes with clean water in eyewash for at least 15 minutes.
-) Seek medical attention immediately.
-) Report the incident to your supervisor.

If the acid splash is to the skin:

-) Remove acid soaked clothing immediately.
-) Flush acid contacted skin with clean water for at least 15 minutes.
-) Seek medical attention immediately if redness or burns occur.
-) Report the incident to your supervisor.

If the acid is swallowed and the victim is conscious:

-) Remove victim from battery area and provide fresh air.
-) Wash out mouth with large amounts of water.
-) Give victim milk to drink.
-) Do not try to induce vomiting.
-) Monitor victim's breathing and condition. Start CPR if victim stops breathing.
-) Use a NIOSH approved acid mist respirator if the OSHA Permissible Exposure Limit (PEL) of 1.0 mg/m³ is exceeded or if respiratory irritation occurs.
-) Seek immediate medical attention.
-) Report the incident to your supervisor.

If the acid is swallowed and the victim is unconscious:

- 1) Remove victim immediately from battery area and provide fresh air.
- 2) Start CPR if victim stops breathing.
- 3) Provide oxygen, if properly trained personnel are available.
- 4) Seek immediate medical attention.
- 5) Report the incident to your supervisor.

Sulfuric Acid Spill (In the event of battery breakage)

- J Neutralize the spill with soda ash or baking soda. Use 1 pound of baking soda to 1 gallon of water.
- J The acid reaction is complete when it stops fizzing. Make certain the acid is neutralized by checking the pH is neutral between 6 and 8.

- J Absorb neutralized material onto clay or other absorbent material, if necessary. If the spill is very large, contain the spill with earth or clay dikes.
- J Brush under the battery connectors and remove all grime. Rinse the residue from the battery with clean water with a hose.
- J Report the incident to your supervisor.
- J Determine proper disposal by contacting local environmental authorities.

Hydrogen Gas


Flammable hydrogen gas is always present during battery recharging. Hydrogen gas is potentially explosive if allowed to accumulate in a closed area. Below are requirements and recommended best practices to prevent injuries from hydrogen gas:

-) Post no smoking signs.
-) Use non-sparking tools.
-) Prevent open flames, sparks, or electrical arcs in the battery charging area to minimize the danger of explosion.
-) Provide adequate ventilation.
-) Open the battery cover when charging so the hydrogen gas can vent better. This is especially important in confined areas where the danger of accumulation is greatest.

Operator's Daily Checklist: Electric Forklift

Check each item before the shift starts. Put a check in the box if the item is OK. Explain any unchecked items at the bottom and report them to a supervisor.

Forklift Serial Number:**Operator:****Hour Meter Reading:****Date:**

| | |
|---|--|
|  | Visual Check |
| | Tires are inflated and free of excessive wear or damage. Nuts are tight. |
| | Forks and mast are not bent, worn, or cracked. |
| | Load back rest extension is in place and not bent, cracked, or loose. |
| | Overhead guard is in place and not bent, cracked, or loose. |
| | Attachments (if equipped) operate OK and are not damaged. |
| | Forklift body is free of excessive lint, grease, or oil. |
| | Hydraulic oil is full and free of leaks. |
| | Battery connections are tight. |
| | Covers over battery and other hazardous parts are in place and secure. |

| | |
|--|--|
| | Load rating plate is present and readable. |
| | Warning decals and operators' manual are present and readable. |
| | Seat belt or restraint is accessible and not damaged, oily, or dirty. |
| | Motor runs smooth without sudden acceleration. |
| | Horn works. |
| | Turn signal (if equipped) operates smoothly. |
| | Lights (head, tail, and warning) work and are aimed correctly. |
| | Gauges and instruments are working. |
| | Lift and lower operates smoothly without excess drift. |
| | Tilt operates smoothly without excessive drift or "chatter". |
| | Control levers are labeled, not loose or binding and freely return to neutral. |
| | Battery charge level is OK while holding full forward tilt. |

| | |
|--|---|
| | Steering is smooth and responsive, free of excessive play. |
| | Brakes work and function smoothly without grabbing. No fluid leaks. |
| | Parking brake will hold the forklift on an incline. |
| | Backup alarm (if equipped) works. |

Check out this Workplace Safety North video on [Industrial Lift Truck Operation](#). It's a great review prior to taking the final exam.

Module 7 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **The eyewash station in the forklift battery charging area should be able to provide _____.**
 - a. at least 10 minute flow using bottled water
 - b. a 5-minute flow of cold water
 - c. at least a 15-minute flow
 - d. a 15-minute flow of warm filtered water
2. **Which of the following types of fire extinguishers is not suitable for use in a forklift battery charging area?**
 - a. Water
 - b. Dry chemical
 - c. CO2
 - d. Foam
3. **Which of the following chemicals associated with forklift batteries is a clear, colorless dilute acid with an acrid smell?**
 - a. Dilithium acid
 - b. Hydrogen acid
 - c. Benzene acid
 - d. Sulfuric acid
4. **Employees _____ should wear chemical splash goggles during battery charging.**
 - a. operating forklifts
 - b. who wear contact lenses
 - c. work around a battery charging area
 - d. load and unload forklifts

5. What would you use to neutralize a sulfuric acid spill while servicing forklift batteries?

- a. Sand or dirt
- b. Any absorbent material
- c. A mild solution of bleach
- d. Soda ash or baking soda

Endnotes

1. 29 CFR 1910.178, Powered Industrial Trucks, OSHA. Derived from:
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