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## 6.0 FORKLIFT TRUCKS

### 6.1 Scope

This Hanford Site Hoisting and Rigging Manual (HSHRM) chapter specifies operation, inspection, testing, and maintenance requirements for forklift trucks (also referred to in this chapter as “truck” and “forklift”) powered by internal combustion engines or electric motors. This includes manually propelled high-lift trucks controlled by a walking operator. (See Attachment 6-1, *Classes of Commonly Used Powered Industrial Trucks*) This chapter includes only ANSI/ITSDF B56 requirements for forklift trucks. Other B56 standards should be implemented as required by site-specific policies. This chapter excludes vehicles used for moving earth.

ITSDF safety standards applicable to this chapter include the following:

- B56.1, *Low Lift and High Lift Trucks*
- B56.6, *Rough Terrain Forklift Trucks*
- B56.9, *Operator Controlled Industrial Tow Trucks*
- B56.10, *Manually Propelled High Lift Industrial Trucks*

Guidelines may be taken from this chapter regarding pallet trucks and other small miscellaneous non-powered lift trucks (see Attachment 6-2, *Manually Operated Pallet Trucks*, for examples). Operating, maintenance, and testing requirements for non-powered equipment are based on the manufacturer’s instructions and recommendations.

### 6.2 Accessing Requirements

- a. Each B56 Standard is available free of charge from [ITSDF](#). Each standard is copyrighted by ITSDF and may not be published, reproduced, distributed or otherwise made publicly available without the prior written consent of ITSDF. Please visit [ITSDF](#) to ensure that you have the most recent version.
- b. To access the applicable OSHA standard, go to:
  - [OSHA 29 CFR 1910.178, Powered Industrial Trucks](#)

### 6.3 Implementation

Contractors shall comply with OSHA, ASME, this HSHRM, and manufacturers’ requirements. Users of this HSHRM are responsible to implement all applicable requirements. If standards conflict, the user shall adhere to the standard containing the most stringent requirements. In most cases, ASME standards provide the most comprehensive information.

Users should contact a Hanford Site Hoisting Rigging Committee (HHRC) representative or send an [email](#) for a formal interpretation. See Chapter 17, *Interpretations*, for the process to be followed. Notify the HHRC if any inconsistent standards are identified.

This HSHRM does not intend to require retrofitting of existing equipment. However, when any hoisting or rigging equipment is modified, its performance requirements shall be reviewed relative to the requirements within the current HSHRM and the applicable ASME standard. The

need to meet the current requirements shall be evaluated by a qualified person selected by the owner (user).

#### 6.4 Operator Training and Qualification

According to the ANSI/ITSDF B56 series of standards: “The use of powered industrial trucks is subject to certain hazards that cannot be completely eliminated by mechanical means, but their risks can be minimized by the exercise of intelligence, care, and common sense. It is therefore essential to have competent and careful operators, physically and mentally fit, and thoroughly trained in the safe operation of the equipment and handling of the loads. Serious hazards are overloading, instability of the load, obstruction to the free passage of the load, collision with objects or pedestrians, poor maintenance, and use of equipment for a purpose for which it was not intended or designed.”

The employer shall ensure that each forklift truck operator is competent to operate the equipment safely, as demonstrated by successfully completing training and an on-the-job evaluation (OJE) and as specified in Chapter 4.0, *Personnel Qualifications and Training Requirements*.

##### 6.4.1 Substance Abuse Testing for Commercial Motor Vehicle Operators

The commercial motor vehicle (CMV) definition found in OSHA 49 CFR 383.5, *Definitions*, (See Appendix A, *Commercial Motor Vehicle*) shall apply to forklifts designed for highway use with a gross vehicle weight rating of 26,001 pounds or more. CMV drivers shall pass, with a negative result, a substance abuse test performed by a recognized laboratory initially, and every 36 months thereafter.

##### 6.4.2 Training

###### 6.4.2.1 Operator Training

Training for operators of forklift trucks will be provided in the following manner:

- c. Operators of forklift trucks shall be trained and qualified as prescribed in Chapter 4.0, *Personnel Qualification and Training Requirements*. Operators of manually propelled pallet trucks and small miscellaneous trucks do not require training in accordance with Chapter 4. For the operation of non-powered and miscellaneous trucks, operators shall follow the manufacturer’s operating instructions.
- d. The forklift truck operator training program shall be successfully completed by all new operators at the Hanford Site regardless of previous experience. Chapter 4.0, *Personnel Qualifications and Training Requirements*, includes provisions for crediting previous training and experience under the Hanford Training Program.

###### 6.4.2.2 Retraining

Retraining requirements are outlined in Chapter 4.0, Section 4.4, *Retraining*. Assignment to a forklift truck having a classification for which the operator is not qualified requires retraining and/or on-the-job training (OJT) and passing an OJE for that class of forklift truck (see Attachment 6.1, *Classes of Commonly Used Powered Industrial Trucks*).

## 6.5 Responsibilities

### 6.5.1 Management at the Using Organization

- a. Classify hazardous locations and post appropriate building signs before a forklift truck is assigned to work in the area (see Attachment 6-5, *Building Signs for Posting at Entrances to Hazardous Areas*).
- b. Ensure that the proper forklift truck is assigned to hazardous areas (see Attachment 6.7, *Forklift Trucks in Hazardous (Explosive) Atmospheres*).
- c. Coordinate with and acquire concurrence from the responsible industrial safety representative before using forklift trucks in a hazardous area.
- d. Ensure that forklift truck operators are trained and qualified in accordance with Chapter 4.0, *Personnel Qualifications and Training Requirements*, and ensure that retraining is implemented in accordance with Chapter 4.0, Section 4.3.6, *Requalification*.
- e. If battery-powered forklift trucks are used, designate an area for charging batteries.
- f. If LP-gas-powered forklift trucks are used, ensure that personnel are assigned and trained to exchange LP-gas containers.
- g. Ensure that each forklift truck has been assigned a custodian.
- h. Be sure the selected forklift truck has adequate capacity for the planned work. (This requires special attention if the load's center of gravity will be beyond the truck's load center.) See Section 6.17, *Conduct of Operator*, Item d.
- i. Do not allow forklift trucks designed for indoor use to be used in wet outdoor locations without the manufacturer's approval.
- j. Before purchasing, leasing, or renting any forklift truck, consult with the responsible occupational safety and health organization to ensure that the equipment selected is appropriate for its intended work environment and will not introduce any unacceptable safety risk.
- k. Normal forklift truck material handling operations are not considered hoisting and rigging activities and do not require a Designated Leader. A Designated Leader is required for forklift operations involving a critical lift or where rigging is being used with the lift.
- l. Ensure all sit down model forklift trucks are equipped with a functioning and approved seat belt or active operator protection device.

### 6.5.2 Forklift Truck Custodian

The forklift truck custodian has the following responsibilities:

- a. Acts as “owner” of the assigned forklift truck.
- b. Ensures that frequent (pre-use) inspection instructions are readily available to operators (see Attachment 6-6, *Typical Pre-use Inspection Procedures*).

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- c. Ensures that the forklift truck manufacturer's approval is obtained before using an attachment.
- d. Ensures that nameplates and caution and instruction markings (see Section 6.6, *Nameplates and Markings*) are in place and legible. This includes markings required on trucks using attachments.
- e. Ensures that a planned maintenance and inspection program is implemented for each forklift truck and for any attachments used with it.
- f. Ensures that, if the truck is obtained on a rental agreement, it is inspected and found suitable for its intended function before putting it in service.
- g. Ensures that initial inspections are performed (see Section 6.15.1, *Inspection of New and Rented Equipment*) and maintenance files are maintained.

**6.5.3 Forklift Truck Operator**

The forklift truck operator has the following responsibilities:

- a. Operates the truck in a safe responsible manner.
- b. Is familiar with information provided on the forklift truck data plate.
- c. Is knowledgeable with the forklift truck pre-use inspection criteria and performs inspections accordingly.
- d. Notifies the responsible supervisor when a problem is detected during either inspection or operation of the truck.
- e. Ensures that the truck is taken out of service if a problem is detected that would compromise safe operation of the truck.

**6.5.4 Industrial Safety Representative**

The industrial safety representative has the following responsibilities:

- a. Ensures that the entrances to hazardous areas are properly posted to identify which trucks are permitted in the area. (See Attachments 6-5, *Building Signs for Posting at Entrance to Hazardous Areas*, and 6-7, *Forklift Trucks in Hazardous (Explosive) Atmospheres*)
- b. Approves the use of forklift trucks assigned to operate in hazardous areas
- c. Assists management at user facilities with safety issues regarding forklift truck selection and issues regarding areas for LP-gas refueling and battery charging.
- d. Where internal combustion-powered forklift trucks are proposed for use indoors, assist management at user facilities in establishing precautions to preclude the buildup of carbon monoxide in the work atmosphere. (See Section 6.12, *Work Atmosphere*.)
- e. Provide safety- and health-related information to managers and supervisors to assist them in selecting or procuring the proper class and type of vehicle for the planned work activity. (See Sections 6.10, *Fire Hazard Areas*, and 6.12, *Work Atmosphere*.)

## 6.6 Nameplate(s) and Marking

### 6.6.1 Truck Marking by the Manufacturer

Every truck shall have a durable, corrosion-resistant nameplate, legibly inscribed with the following information:

- a. Truck model and serial number
- b. Truck weight
- c. Designation of compliance with the mandatory requirements of ANSI/ITSDF B56.1, *Safety Standard for Low and High Lift Trucks*, applicable to the manufacturer
- d. Type designation to show conformance with the requirements, such as those prescribed by Underwriters Laboratories, Inc., and Factory Mutual Research Corporation
- e. Rated capacity.

In addition to these requirements, additional information is required (and allowed) on nameplates on high-lift trucks, electric trucks, and trucks intended for use in hazardous locations (see ANSI/ITSDF B56.1, Section 7.5, *Nameplates and Markings*).

### 6.6.2 Fork Arm Stamping by the Manufacturer

For forklift trucks purchased after December 1984, each fork arm shall be clearly stamped with its rated capacity in an area readily visible and not subject to wear. For example, the designation “1520 x 24” means 1,520-lb (680-kg) capacity at 24-in. (600 mm) load center.

### 6.6.3 Attachment Marking

On every removable attachment (excluding fork extensions), a nameplate with the following information is required:

- a. Model number
- b. Serial number on hydraulically actuated attachments
- c. Maximum hydraulic pressure (on hydraulically actuated attachments)
- d. Weight
- e. Capacity
- f. The following instructions (or equivalent): “Capacity of truck and attachment combination may be less than capacity shown on attachment. Consult truck nameplate.”

**NOTE:** *This information should be provided by the attachment manufacturer.*

### 6.6.4 User’s Obligation for Truck Marking

The using organization shall ensure that trucks using attachments (including fork extensions) are marked to identify the attachment(s), show the approximate weight of the truck and attachment combination, and show the capacity of the truck with attachment(s) at maximum elevation with the load laterally centered. The using organization shall see that nameplates and caution and instruction markings are in place and legible.

**Chapter 6.0 – FORKLIFT TRUCKS****Rev. 1, Rel. 86****6.6.5 Maintain Tags**

The forklift truck manufacturer's capacity, operating, and maintenance instruction plates, tags, or decals shall be maintained in legible condition.

**6.7 Attachments, Modifications, and Free Rigging from Tines****6.7.1 Attachments**

- a. Attachments almost always affect the rated capacity of the truck. When a forklift truck is equipped with an attachment, the rated capacity of the truck-attachment combination shall be established by the truck manufacturer. Capacity, operation, and maintenance instruction plates, tags, or decals shall be changed accordingly.

**CAUTION:** *Use of after-market attachments requires written approval from the truck manufacturer.*

- b. The rated capacity of an attachment-truck combination shall not be exceeded.
- c. Attachments shall be maintained and lubricated based upon the recommendations of the manufacturer or a qualified person.
- d. Attachments shall be inspected no less than annually. The inspection shall be documented.
- e. Hooks included as part of attachments shall be inspected as specified for hooks on cranes and hoists (see Chapter 5.0, *Hooks*).
- f. Load-bearing components shall be examined for deformation, and load-bearing welds shall be visually examined for cracks.
- g. Load capacity of an attachment shall be verified by the manufacturer or by a load test at 100-percent capacity. The load test shall be performed on site. Load tests are not routinely required because a catalog cut, user's manual, decals on attachment, or other manufacturer's data serves as capacity verification.

**6.7.2 Modifications**

Modifications or additions that affect capacity or safe operation shall not be performed by the customer or user without the manufacturers' prior written approval. Employers must seek written approval from powered industrial truck manufacturers when modifications and additions affect the capacity and safe operation of powered industrial trucks. When approval has been granted, the capacity, operation, and maintenance instruction plates, tags, or decals shall be changed accordingly.

However, if no response or a negative response is received from the manufacturer, OSHA will accept a written approval of the modification/addition from a qualified Registered Professional Engineer. A qualified Registered Professional Engineer must perform a safety analysis and address any safety or structural issues contained in the manufacturer's negative response prior to granting approval. When approval has been granted, machine data plates must be changed accordingly. Click to see OSHA's [Letter of Interpretation](#).

### 6.7.3 Free Rigging From Tines

Free rigging is the direct attachment to or placement of rigging equipment (slings, shackles, rings, etc.) onto the tines of a powered industrial truck for a below-the-tines lift. This type of lift does not use an approved lifting attachment and could affect the capacity and safe operation of a powered industrial truck. OSHA 29 CFR 1910.178 (o), *Loading*, Item (1) requires that: “Only stable or safely arranged loads shall be handled. Caution shall be exercised when handling off-center loads which cannot be centered.” Free rigging from the tines shall be treated as a modification and would only be allowed if approved as identified in Section 6.7.2, *Modifications*. Click to see OSHA’s [Letter of Interpretation](#).

### 6.8 Overhead Guards

High-lift rider trucks, order-picker trucks, and rough-terrain forklift trucks shall be equipped with an overhead guard that is manufactured in accordance with ANSI/ITSDF B56.1, *Safety Standard for Low and High Lift Trucks*, unless an exception is approved in writing by the responsible industrial safety organization. Rough-terrain forklift trucks shall be fitted with an overhead guard manufactured in accordance with ANSI/ITSDF B56.6, *Safety Standard for Rough Terrain Forklift Trucks*.

### 6.9 Warning Devices

- a. Every power-propelled truck shall be equipped with an operator-controlled horn, whistle, gong, or other sound-producing device. For manually propelled trucks, the using organization shall determine if operating conditions require the truck to be equipped with sound-producing or visual warning devices and be responsible for providing and maintaining them.
- b. The using organization shall determine if operating conditions require the truck to be equipped with additional sound-producing or visual devices (such as lights or blinkers) and shall be responsible for providing and maintaining such devices. Backup or motion alarms that sound continuously may be warranted in special cases but generally are less effective than operator-controlled devices.

### 6.10 Fire Hazard Areas

Powered forklift trucks for operation in fire hazard areas shall be of the type that is recommended in NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operations*. (See Attachment 6-7, *Forklift Trucks in Hazardous (Explosive) Atmospheres*).

### 6.11 Adverse Weather

Adverse weather conditions such as but not limited to wind, wind gusts, rain, snow and extreme temperatures, etc., that may inhibit the operator’s or the equipment’s ability to safely handle loads, shall be evaluated by supervision and forklift operator prior to any outdoor lifting operation. Limitations and conditions imposed by equipment manufacture for adverse weather shall be implemented. Outdoor forklift operations shall be suspended when lightning is within 50 miles of the work location, as determined by the Hanford Meteorological Station. The Hanford Meteorological station can be contacted @ (509) 373-2716.

## 6.12 Work Atmosphere

The operation of forklift trucks affects the concentrations of carbon monoxide and oxygen at indoor work locations. The atmosphere in the work locations must meet the requirements of OSHA 29 CFR 1910, *Occupational Safety and Health Standards for General Industry*. Contact your industrial safety representative if guidance is needed or if questions arise (see Attachment 6-7, *Forklift Trucks in Hazardous (Explosive) Atmospheres*).

## 6.13 Operating Near Electric Power Lines

Requirements for operating fork trucks near electric power lines can be found in DOE-0359, *Hanford Site Electrical Safety Program (HSESP)*.

## 6.14 Operator Care of the Truck

### 6.14.1 Frequent (Pre-Use) Inspection

#### 6.14.1.1 Frequent Inspection Instructions

Frequent inspection instructions that list inspection steps shall be readily available to the operator. It is recommended that the instructions be attached to the equipment. Standard instructions will be suitable for most forklift trucks; however, operating conditions may require additional instructions.

#### 6.14.1.2 Results of Frequent Inspection

The operator shall report any deficiencies or unusual conditions to the responsible supervisor. Conditions adversely affecting safety shall be corrected before the forklift truck is placed into service.

### 6.14.2 Key Steps in a Pre-Use Inspections

At the beginning of each shift and before operating the truck, check its condition, giving special attention to the following:

- a. Periodic maintenance and inspections have been performed and are current
- b. Condition of tires (proper inflation pressure, if pneumatic tires)
- c. Warning and safety devices
- d. Lights
- e. Battery
- f. Controls
- g. Lift and tilt systems – Ensure interlocks & safety devices are in-place for lifts that are capable of tilting forward for transportation
- h. Forks or other load-engaging means
- i. Chains and cables
- j. Limit switches

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- k. Brakes hold in forward and reverse directions
- l. Steering mechanism
- m. Fuel system(s)
- n. Additional items as specified by the manufacturer or that are unique to the facility at which the truck is operated.
- o. Ensure forklift and forklift attachment inspections are current via inspection stickers, other documentation or verbal confirmation from the equipment custodian.

See Attachment 6-6, *Typical Pre-use Inspection Procedures*, for typical pre-use inspection forms.

**6.14.3 Truck Unsafe or Needs Repair**

If during pre-use inspection or during operation the truck is found to need repair or is in any way unsafe, the operator shall immediately report the matter to his or her supervisor. The truck shall not be operated until it has been restored to safe operating condition.

**6.14.4 No Repair by Operator**

Do not make repairs or adjustments unless specifically authorized to do so.

**6.14.5 Forklift Out of Service**

Where the employer has taken the equipment out of service, a tag shall be placed in the cab stating that the equipment is out of service and is not to be used. Where the employer has taken a function(s) out of service, a tag shall be placed in a conspicuous position stating that the function is out of service and is not to be used.

**6.14.6 Refueling**

When refueling the truck, move to the refueling area, if one is designated at your facility, and always stop the engine before refueling. Always follow company- and facility-specific refueling and spill prevention and response procedures.

**6.15 Maintenance and Inspection**

Maintenance and inspection of powered forklift trucks shall be performed in conformance with the following practices:

- a. A scheduled planned maintenance, lubrication, and inspection program shall be followed; consult the manufacturer's recommendations.
- b. Only trained and authorized personnel shall be permitted to maintain, repair, adjust, and inspect forklift trucks; these services shall be provided in accordance with manufacturer's specifications.
- c. No repairs shall be made while the truck is in a hazardous (explosive/classified) area.

### 6.15.1 Inspection of New and Rented Equipment

For newly purchased equipment or newly arrived rental equipment, an initial inspection shall verify that requirements of the purchase order or rental agreement have been met and that the equipment is suitable for its intended use. Receipt inspection shall include a review to verify that the tire ply rating is consistent with the Manufacturer data plates or other manufacture specification. This inspection shall be documented and retained in the forklift truck's maintenance file. (**NOTE:** *The custodian shall retain the initial inspection report while the unit is on Site.*)

**CAUTION:** *For forklift trucks on rental, ensure that a suitable maintenance and inspection program is established for the duration of the rental period.*

### 6.15.2 Modified or Extensively Repaired Equipment

For modified or repaired equipment, an inspection shall ensure that the equipment is in good condition and suitable for its intended use.

### 6.15.3 Replacement Parts

All parts that require replacement shall be replaced only with parts that meet the safety standards of those used in the original design.

### 6.15.4 Inspection of Forks

#### 6.15.4.1 Fork Inspection Frequency

Forks in use (single shift operation) shall be inspected at intervals of not more than 12 months or whenever any defect or permanent deformation is detected. Severe applications require more frequent inspection at an interval set by facility management.

#### 6.15.4.2 Fork Load Rating

Forks used in pairs (the normal arrangement) have a rated capacity for each fork that is at least half the manufacturer's truck rated capacity at the center distance shown on the forklift truck nameplate.

#### 6.15.4.3 Fork Inspection Procedures

Fork inspection shall be carefully conducted by trained personnel with the aim of detecting any damage, failure, deformation, or other condition that might impair safe use. A fork that shows any of the following defects shall be withdrawn from service and shall not be returned to service until it is satisfactorily repaired by the fork manufacturer or an expert of equal competence:

- a. **Surface Cracks.** The forks shall be thoroughly examined visually for cracks and, if their condition warrants, subjected to nondestructive crack detection, paying special attention to the heel and to the welds that attach the mounting components to the fork blank. Inspection for cracks shall include any mounting mechanisms of the fork blank to the fork carrier. Forks shall not be returned to service if surface cracks are detected.

- b. **Straightness of Blade and Shank.** Straightness of the upper face of the blade and the front face of the shank shall be checked. If deviation from straightness exceeds 0.5 percent of the length of the blade and/or the height of the shank, respectively, the fork shall not be returned to service until it has been repaired in accordance with Section 6.15.5, *Fork Repair*.
- c. **Fork Angle (Upper Face of Blade to Load Face of the Shank).** Any fork with a deviation greater than 3 percent from the original specification shall not be returned to service. The rejected fork shall be reset and tested in accordance with Section 6.15.5, *Fork Repair*.
- d. **Difference in Height of Fork Tips.** If the difference in height between forks in a set when mounted on the fork carrier exceeds 3 percent of the length of the blade, the set of forks shall not be returned to service until repaired in accordance with Section 6.15.5, *Fork Repair*.
- e. **Positioning Lock (When Provided).** It shall be confirmed that the positioning lock is in good repair and in correct working order. If any fault is found, the fork shall be withdrawn from service until satisfactory repairs are made.
- f. **Fork Blade and Shank Wear.** The fork blade and shank shall be thoroughly checked for wear, with special attention to the vicinity of the heel. If thickness is reduced to 90 percent of the original thickness, the fork shall not be returned to service.
- g. **Fork Hooks Wear.** When fork hooks are provided, the support face of the top hook and the retaining faces of both hooks shall be checked for wear, crushing, and other local deformations. If clearance between the fork and the fork carrier becomes excessive, the fork shall not be returned to service until repaired in accordance with Section 6.15.5, *Fork Repair*.
- h. **Legibility of Fork Marking.** When fork marking in accordance with Section 6.5.2, *Forklift Truck Custodian*, is not clearly legible, it shall be renewed. Marking shall be renewed per instructions from the original fork supplier.

#### 6.15.5 Fork Repair

Only the manufacturer of the fork or an expert of equal competence shall decide if a fork may be repaired for continued use, and the repairs shall only be carried out by such authorities. Surface cracks or wear should not be repaired by welding. When resetting repairs are required, the fork shall be subject to heat treatment.

#### 6.15.6 Fork Load Test

A fork that has undergone repair, other than repair or replacement of positioning locks or marking, shall be subject to a load test as described in ANSI/ITSDF B56.1, Section 7.27, *Forks*, which lists loading and method of test for forks; except for the test load, which shall correspond to 2.5 times the rated capacity marked on the fork.

### 6.16 Forklift Truck Load Test

Forklift truck load tests are not routinely required. Load tests shall be performed after major repair or modification to components that affect the load-carrying ability of the truck. The manufacturer should be consulted if questions arise as to whether a load test is appropriate. Forklift trucks shall be load tested by or under the direction of a qualified person and in accordance with the manufacturer's recommendations.

#### 6.16.1 Verify Maintenance/Inspection is Current

Load tests shall be conducted only after confirmation that inspection and maintenance is up to date.

#### 6.16.2 Test Weight Accuracy

Test weights shall be accurate within -5 percent to +0 percent of stipulated values.

#### 6.16.3 Load Test Report

After a load test is performed, a written report shall be furnished by the qualified person that shows test procedures and confirms the adequacy of repairs or alterations. Test reports shall be retained in the truck's maintenance file.

### 6.17 Conduct of Operator

The operator has the following responsibilities while operating a forklift truck:

- a. Be certain the truck has been subjected to pre-use inspection and a workplace hazard evaluation has been performed.
- b. A seatbelt or other active operator protection device shall be used at all times when operating any sit down model forklift truck.
- c. Never exceed rated capacity. In determining total weight of the load to be handled, account for added weight that may be present as a result of field modifications, rigging hardware, shipping containers, and vessel or container contents.

**NOTE:** *Rated capacity is the weight established by the manufacturer at a required load center at an established height. For large or unusually configured loads, the position of the load's center of gravity relative to the truck's load center must be considered when determining the truck's ability to carry the load.*

- d. When handling large or unusually configured loads outside the truck's load center, the forklift manufacturer's instructions must be consulted. If applicable manufacturer's instructions are not available, for a counterbalance-type truck, field calculations may be used to estimate the reduced lifting capacity.

**Example:** A 5,000-lb (2268 kg)-capacity forklift truck having a 24 in. (61 cm) load center must handle a load with the load's center of gravity (c. g.) 28 in. (71 cm) from the front face of the forks. In this configuration, with the load's c. g. 4 in. (10 cm) beyond the fork load center, estimate the truck's safe load capacity.

24 in/28 in X 5,000 lb = 4,285 lb (approximate safe load capacity)  
61 cm/71 cm X 2268 kg = 1949 kg (approximate safe load capacity)

This calculation method will not produce exact load reduction figures. Use this method only as a rule of thumb. The forklift truck manufacturer is the source of more precise information.

- e. “Free rigging” from tines is considered a modification and requires approval in accordance with Section 6.7.2, *Modifications*.
- f. Prohibit riders on forklift trucks, unless the truck is built with passenger seating.
- g. To avoid personal injury, keep head, arms, and legs inside the operator’s area of the machine.
- h. Under all travel conditions, operate the truck at a speed that will permit it to be brought to a stop in a safe manner. Unless facility-specific procedures state otherwise, the guideline is: Inside plant buildings, drive no more than 5 mi (8 km) per hour; on in-plant roads, drive no more than 15 mi (24 km) per hour. Go slowly around curves.
- i. Stop and sound the horn at blind intersections and doorways. Watch out for blind corners; stop and/or sound horn if appropriate.
- j. Use low gear or slowest speed control when descending ramps.
- k. Always spread the forks to suit the load width.
- l. Prohibit any person from standing or passing under the elevated portion of any forklift truck, whether loaded or empty.
- m. Lift, lower, and carry loads with the mast vertical or tilted back; never forward.
- n. Avoid reaching through the mast for any purpose.
- o. Lower and raise the load slowly, and only while the vehicle is stopped. Make smooth gradual stops.
- p. Use special care when high-tiering. Return the mast to a vertical position before lowering load.
- q. Avoid sudden stops and starts.
- r. Watch overhead clearance.
- s. Never travel with forks raised to unnecessary heights.
- t. Drive slowly over railroad tracks and rough surfaces. Cross tracks at an angle whenever possible.

**CAUTION:** *Parking closer than 8 ft (2.4 m) from the center of railroad tracks is prohibited.*

- u. Consider both the truck and load weight when operating in railcars and semitrailers.

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- v. When loading trucks or trailers, ensure that the wheels are chocked and the brakes are set. Operate in front end of the semitrailer only if the tractor is attached, or if adequate trailer jacks are in place.

**CAUTION:** *Semitrailers not coupled to a tractor may require supports (e.g., fixed jacks) to prevent upending or corner dipping.*

- w. Inspect floors on trucks, boxcars, unfamiliar ramps, or platforms before beginning operation.
  - x. Ensure that dockboards and bridge plates into trucks or freight cars are sufficiently wide, strong, and secure. Check them frequently. Portable or powered dockboards and bridge plates must be marked to show their carrying capacity. The carrying capacity indicated shall not be exceeded.
  - y. While turning, be cautious of rear-end swing and keep clear of the edge of loading docks.
  - z. If the load being carried obstructs the forward view, travel with the load trailing, except when ascending a ramp or incline.
  - aa. When ascending or descending grades in excess of 5 percent, drive a loaded rider truck with the load upgrade.
  - bb. Operate unloaded forklift trucks on grades with the forks downgrade.
  - cc. Avoid turning, if possible, and use extreme caution on grades, ramps, or inclines; normally travel straight up and down.
  - dd. Unless a towing hitch is supplied by the manufacturer, do not use forklift trucks as tow trucks. When a towing hitch is provided, use tow bars.
  - ee. Never butt loads with forks or rear end of truck.
  - ff. Split-forked or bulldozing a load into position using the forks is an accepted practice with administrative controls in place. The operators shall not push loads with forks or “bulldoze” a load when it exposes personnel to risk of injury, compromises the forklift’s capacity, could cause the load, or part of the load to tip, could result in damage to the forks, interferes with the maneuverability of the forklift, or reduce the operator’s control of the load.
- NOTE:** *Administrative controls may be addressed in a job hazard analysis, procedure, or in the work package/record.*
- gg. Do not drive forklift trucks onto any elevator unless specifically authorized and instructed to do so by a written, approved procedure.
  - hh. Safeguard pedestrians at all times. Do not drive a truck up to anyone standing in front of a fixed object. All trucks must yield the right of way to pedestrians and emergency vehicles. Manually powered trucks must yield the right of way to power propelled trucks.
  - ii. Before leaving a forklift truck unattended, fully lower the forks, neutralize the controls, shut off the power, and set the brakes. If parked on an incline, block the wheels. (A

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forklift truck is unattended when the operator is 25 ft (7.6 m) or more away from the truck, or whenever the truck cannot be viewed directly by the operator.) Before leaving an LPG-fueled forklift parked indoors, ensure the service valve of the fuel (LPG) container is closed.

- jj. If the operator is dismounted, less than 25 ft (7.6 m) away, and within view of the truck, before dismounting, fully lower the forks, neutralize the controls, and set the brakes.
- kk. At the end of the operator's shift, return the forklift truck to its assigned parking place, set the brakes, lower forks flat on the floor, place controls in neutral position, turn ignition off, secure the key, and when the forklift is LPG fueled, ensure the service valve of the fuel (LPG) container is closed.
- ll. Report all accidents and "near misses" promptly to the operator's supervisor.
- mm. Do not attach or operate any attachment that has not been approved for use on that forklift truck.
- nn. Never lift with only one fork without an engineering analysis and approval.
- oo. Request a trained spotter(s) whenever vision is obstructed in direction of travel or when needed to provide a warning or stop signal during forklift operation prior to violation of proximity restrictions or pre-determined distance limitations to structures or hazards such as power and communication lines, overhead obstructions, buildings, telephone poles, ground penetrations and etc.
- pp. Exercise extra caution when handling loads that cause the truck to approach its maximum design characteristics. For example, when handling a maximum load, the load should be carried at the lowest position possible, the truck should be accelerated slowly and evenly, and the forks should be tilted forward cautiously. However, no precise rules can be formulated to cover all eventualities. The final responsibility for the handling of a truck remains with the operator.
- qq. When lifting Freight Containers/Conex boxes, follow direction provided in Attachment 1, *Freight Container Lifting Standard*.

**6.17.1 Load Securing and Stability**

Only stable, safely arranged or secured loads shall be handled. Caution shall be exercised when handling off-balanced or loads that cannot be centered (See Section 6.17.d, *Conduct of Operator*). Methods of securing and stabilizing loads and materials moved on forklift trucks must be specific to the load (s) and forklift. The forklift manufacturer or a qualified person should be contacted for guidance if the forklift's stability or structural integrity could be affected by securing a specific load or material to the forklift.

The forklift truck operation shall:

1. Ensure the load's weight and center of gravity is within the lift's capacity ratings.
2. Ensure loads and materials are stable and will remain stable during forklift movements and travel.
3. Secure loads and materials that are or may become unstable before movements or travel.

4. Ensure placed or stacked loads and materials are stable.
5. Adjust speed of travel and forklift movements for terrain and surface conditions.

## 6.18 Lifting of Personnel

### 6.18.1 Special Provisions Prior to Lifting Personnel

Only operator-up high-lift trucks have been designed to lift personnel. If a personnel lifting platform is used on trucks designed and intended for handling materials, the manager who is specifically responsible for the work to be performed shall determine that there is no practical alternative way to perform the needed work.

For each platform lifting operation, the manager who is responsible for the task shall issue a written statement describing the procedure and its time frame. The statement shall be signed by the authorizing manager and, when approved, the statement also shall be signed by the responsible industrial safety representative. The statement shall be readily available at the job site when personnel lifting is in progress.

### 6.18.2 Qualification of Trucks Used for Lifting Personnel

Hydraulic or pneumatic hoisting systems shall include means to prevent unintended descent in excess of 120 ft/min (0.6 m/s) in the event of a hose failure. Be certain that the lifting mechanism is operating smoothly throughout its entire lift height, both empty and loaded, and that lift-limiting devices and latches, if provided, are functional.

### 6.18.3 Standard Precautions – Lifting Personnel with Forklift Trucks

- a. Be certain the truck is set on a firm and level surface.
- b. Use only work platforms that are manufactured for the purpose of lifting personnel. Platforms shall be in conformance with ANSI/ITSDF B56.1, Section 7.37, *Platforms-Elevating*.
- c. Be certain that the platform is securely attached to the lifting carriage or forks. When being supported by a forklift, the personnel platform shall be attached in such a manner that it cannot slide or bounce off the forks.
- d. Be certain the platform is horizontal and is never tilted forward or rearward when elevated.
- e. The operator shall remain in the control position of the forklift truck.
- f. Overhead protection, as necessary by operating conditions, shall be provided.
- g. Means shall be provided to protect personnel from moving parts of the forklift truck that present a hazard when the personnel platform is in the normal working position.
- h. Do not transport personnel from one location to another while they are on the personnel lifting platform.
- i. Whenever a truck (except for high-lift order-picker trucks) is equipped with vertical hoisting controls that can be elevated with the lifting carriage or forks, take the following additional precautions to protect personnel:

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1. Provide means for personnel on the platform to shut off power to the truck.
  2. Provide means to render inoperative all operating controls, other than those on the elevating platform, when the controls on the elevating platform have been selected for use. Only one location of controls shall be capable of being operated at one time.
  3. Ensure that emergency-lowering means are available at ground level and are protected against misuse.
- j. A forklift truck is not permitted to be used as an anchorage point per DOE-0346, *Hanford Site Fall Protection Program*.

**6.19 Hand Signals**

- a. Two types of hand signals are shown in Attachment 6.3, *Hand Signals*.
- b. The operator should respond to signals only from the designated signaler, but obey a STOP signal no matter who gives it.
- c. For operations not covered by standard hand signals, special signals shall be agreed on in advance by both the operator and the signal person, and they should not conflict with the standard signals.

**6.20 Designated Leader**

Operations that involve more than one person for hoisting and rigging activities require a designated leader (DL)/lift director. See Chapter 2.0, Sections 2.2.4, *Designated Leader/Lift Director for Critical Lifts*, and 2.2.5, *Designated Leader*.

**6.21 Critical Lifts**

Critical lifts require approved procedures (see Chapter 3.0, *Critical Lifts*).

**6.22 Maintenance Files**

The forklift truck maintenance file is a compilation of various documents and records relating to operation, maintenance, inspection, testing, evaluating, and repair of the equipment. The file may be centrally located or proportioned into satellite holding areas. The methods selected for establishing adequate information retention and retrieval shall be determined by the equipment custodian, who is the responsible person for ensuring that a safe and reliable maintenance program is in place.

**6.22.1 Contents of Maintenance Files**

The maintenance file shall contain, as a minimum, the required current, dated periodic inspection records and other documentation to provide the user with evidence of a safe and reliable maintenance program. Inspection records should be retained in an easily accessible format and location. Maintenance file information should provide a source for comparing present and past equipment conditions. This comparison will help determine whether existing conditions show a trending pattern of wear, deterioration, or other conditions that may compromise continued safe use of the equipment. Length of record retention shall be determined by the equipment custodian's established maintenance program.

- a. Waivers applicable to the forklift truck
- b. Documentation for replacement forks or other altered, replaced, or repaired load-sustaining parts
- c. Records of documented inspection, repair, modification, and overhaul:
  - 1. The most recent periodic inspection records
  - 2. Load test reports
  - 3. Initial inspection records for procured or newly arrived rental equipment
  - 4. The forklift truck manufacturer's written approval for any modifications or additions

### 6.23 Equipment Qualification

To qualify for operation, a forklift truck shall have the following:

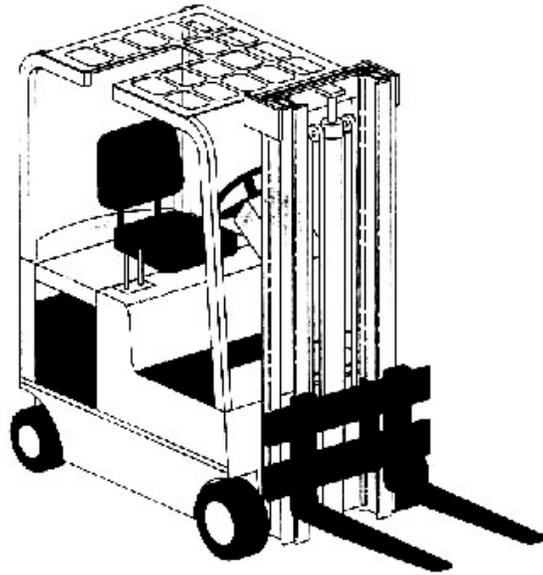
- a. A record of successful inspection and maintenance
- b. A frequent (pre-use) inspection instruction available to the operator
- c. A qualified operator
- d. The proper type designation for working in a classified hazardous area, if applicable  
(See Attachment 6-7, *Forklift Trucks in Hazardous (Explosive) Atmospheres*).

**Attachment 6-1: Classes of Commonly Used Powered Industrial Trucks**

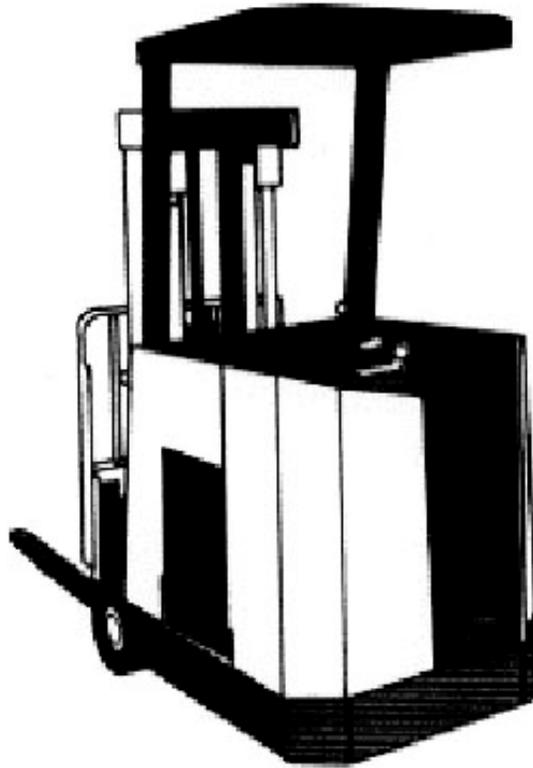
For training purposes, powered industrial trucks (see Section 4.3.4.1, *Powered Industrial Trucks*) are divided into the following eight classes as determined by the Industrial Truck Association:

- Class 1      Electric motor, sit-down or stand-up rider, counter-balanced trucks, solid and pneumatic tires
- Class 2      Electric motor, narrow-aisle trucks, solid tires
- Class 3      Electric motor, hand trucks or hand/rider trucks, solid tires
- Class 4      Internal combustion engine trucks, solid tires
- Class 5      Internal combustion engine trucks, pneumatic tires
- Class 6      Electric and internal combustion engine tractors, solid and pneumatic tires
- Class 7      Rough-terrain forklift trucks, pneumatic tires.
- Class 8      Rough Terrain Telescopic Boom Forklift Truck

Class 1 - Electric Motor, Sit-Down or Stand-Up Rider, Counter-Balanced Trucks,  
Solid and Pneumatic Tires

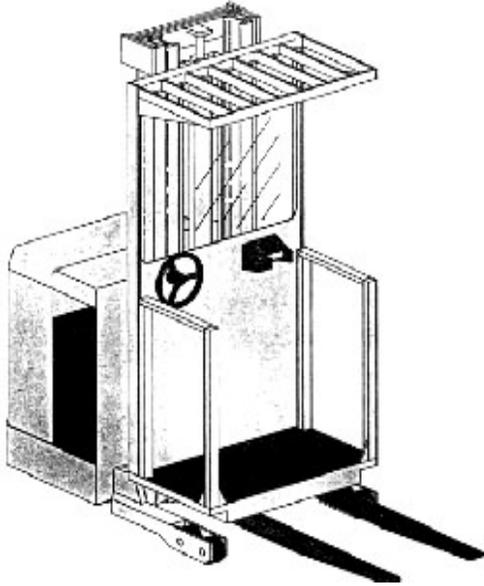


Electric Motor,  
Sit-Down Rider Truck

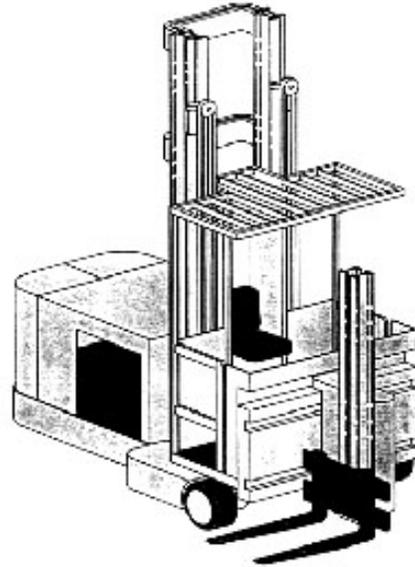


Counterbalanced Stand-Up Rider

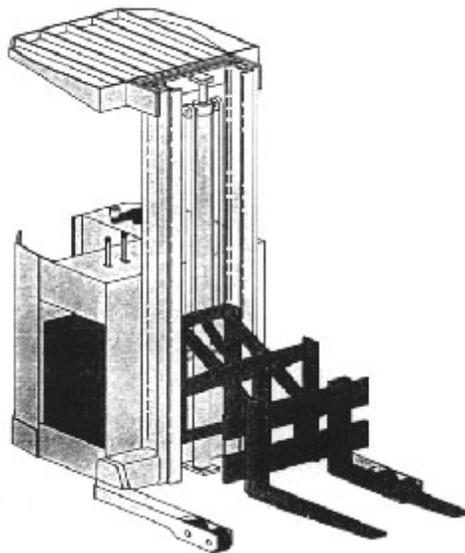
Class 2 - Electric Motor Narrow-Aisle Trucks, Solid Tires



Order Picker



Turret Truck



Reach-Type Outrigger



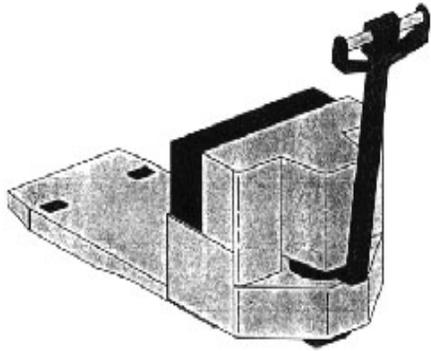
Rider Reach Truck

Class 2 - Electric Motor, Narrow-Aisle Trucks, Solid Tires

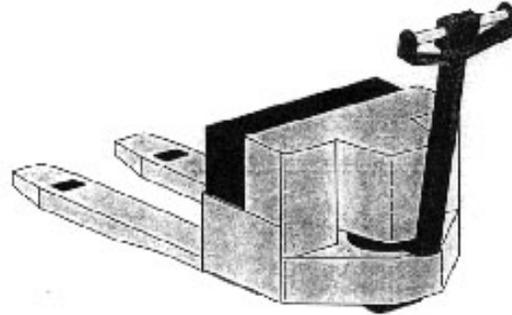


Order Picker

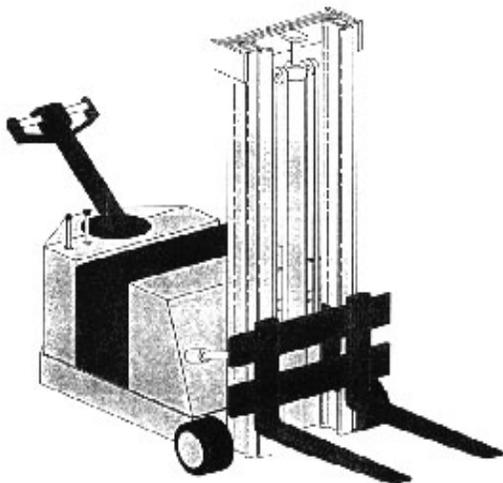
Class 3 - Electric Motor, Hand Trucks or Hand/Rider Trucks, Solid Tires



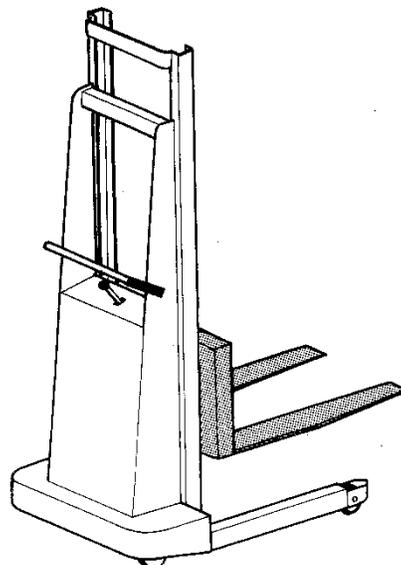
Low Lift Platform



Low Lift Walkie Pallet



High Lift Counterbalanced



Manually Propelled High Lift Industrial Truck

Class 3 – Electric Motor, Hand Trucks or Hand/Rider Trucks, Solid Tires

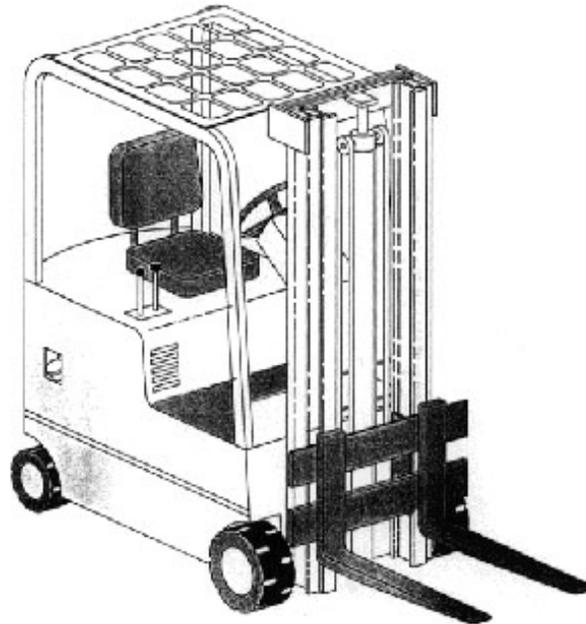


Walkie Powered Pallet Truck



Walkie/Rider Powered Pallet Truck

Class 4 - Internal Combustion Engine Trucks, Solid Tires

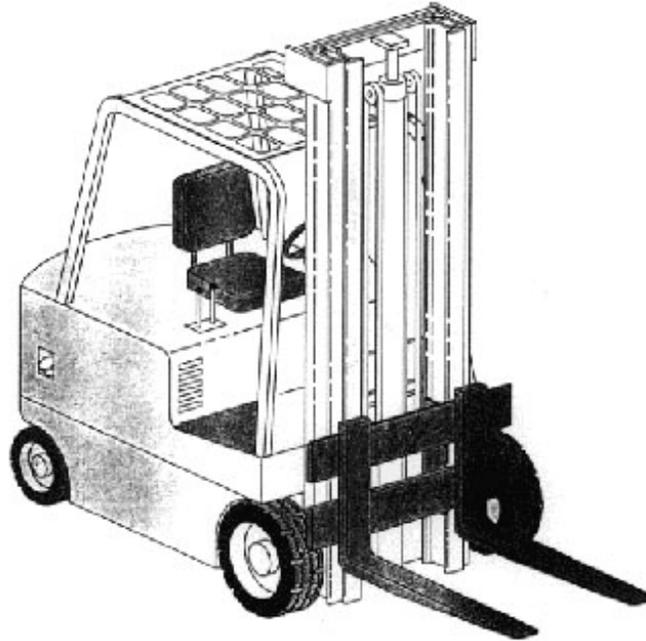


Counterbalanced, solid tires

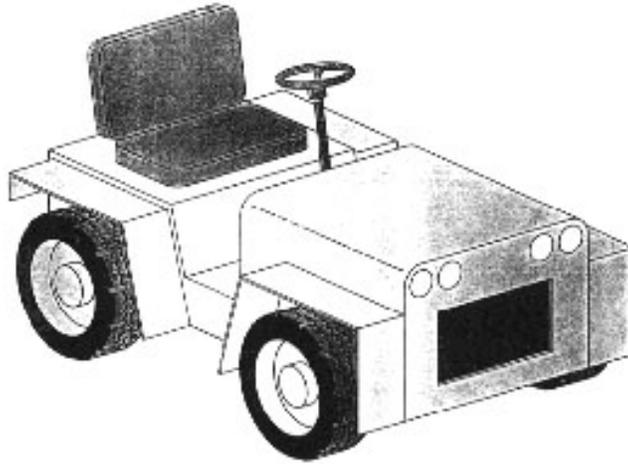


Sit-Down Rider Forklift Truck – LPG

Class 5 - Internal Combustion Engine Trucks, Pneumatic Tires



Class 6 - Electric and Internal Combustion Engine Tractors, Solid and Pneumatic Tires





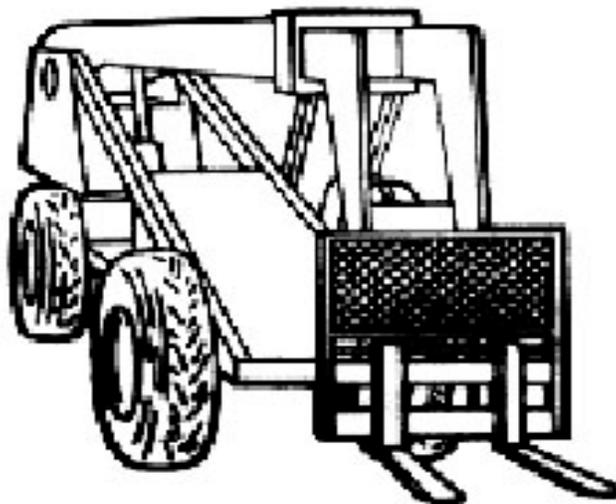
**NOTE:** *This HSHRM does not specifically include requirements for tractors. However, OSHA and general industry administer training programs for powered industrial trucks (Classification 6) under the same classification program as forklift trucks. Thus, powered industrial trucks (tractors) are shown here for clarification. See Chapter 4.0, Section 4.3.4.1, Powered Industrial Trucks.*

Class 7 – Rough-Terrain Forklift Trucks, Pneumatic Tires



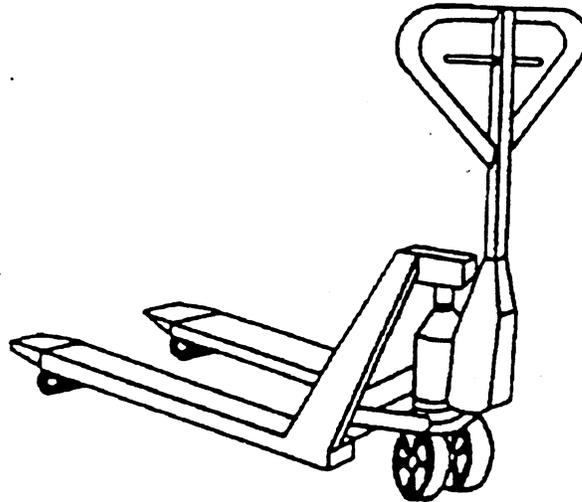
Straight-Mast Forklift

Class 8 - Rough Terrain Telescopic Boom Forklift Truck

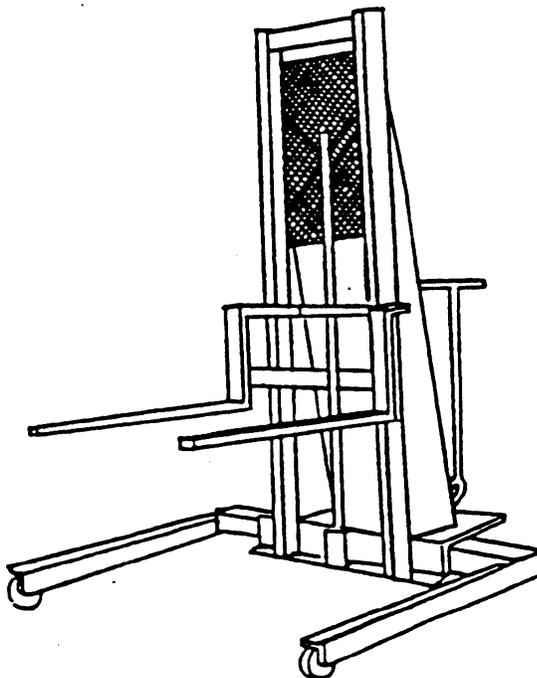


Extended Reach Forklift

Attachment 6-2: Manually Operated Pallet Trucks



- Small Miscellaneous Truck

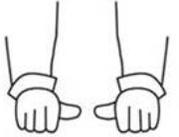
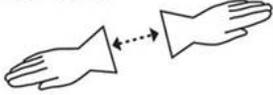
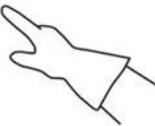


Attachment 6-3: Hand Signals

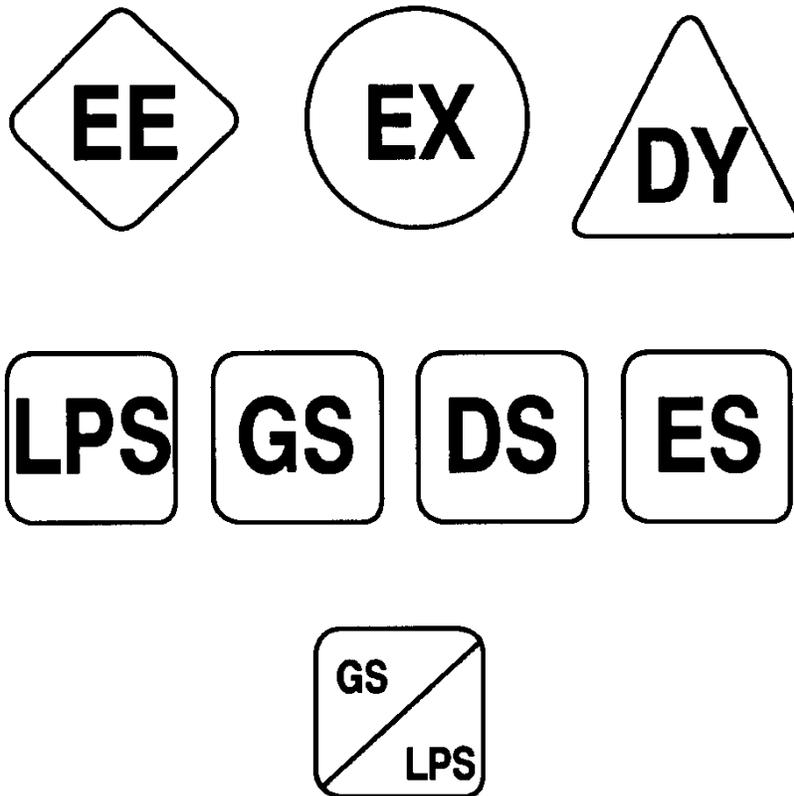
Standard Hand Signals for Controlling Forklift Operations

 <p>RAISE THE TINES. With forearm vertical, forefinger pointing up, move hand in small horizontal circle.</p>	 <p>LOWER THE TINES. With arm extended, palm down, lower arm vertically.</p>	 <p>TILT MAST BACK. With forearm vertical, thumb extended, jerk thumb over shoulder.</p>
 <p>TILT MAST FORWARD. With arm extended, thumb down, lower arm vertically.</p>	 <p>MOVE TINES IN DIRECTION FINGER POINTS. With arm extended, palm down, point forefinger in direction of movement.</p>	 <p>DOG EVERYTHING. Clasp hands in front of body.</p>
 <p>STOP. Extend both arms, palms down.</p>		

Standard Hand Signals for Telescopic Boom Forklift Operations

<p><b>Retract Boom</b></p> 	<p><b>Raise Boom</b></p> 	<p><b>Stop</b></p> 		
<p><b>Extend Boom</b></p> 	<p><b>Lower Boom</b></p> 	<p><b>Shift Fork Left</b></p>  <p><b>Shift Fork Right</b></p> 		
<p><b>Tilt Forks Left</b></p> 			<p><b>Tilt Forks Up</b></p> 	<p><b>Tilt Forks Down</b></p> 
<p><b>Tilt Forks Right</b></p> 				

Attachment 6-4: Markers To Identify Type Of Industrial Truck



**NOTE:** The markers for EE, EX, and DY are 5 in. (12.7 cm) high. The rest are 4 in. (10 cm) square. The signs shall have black borders and lettering on a yellow background. For Marker definitions see Attachment 6-7, Section 6-7.6, Hazardous Areas.

Attachment 6-5: Building Signs For Posting At Entrance To Hazardous Areas



**NOTE:** The minimum width of the sign is 11 in. (28 cm); the minimum height is 16 in. (40 cm). The sign shall have the word CAUTION in yellow letters on a black background.

The body of the sign shall have black letters on a yellow background.

A marker, identical to the one used on the side of the truck as shown in Attachment 6-4, *Markers to Identify Type of Industrial Truck*, shall be installed on the sign.

**Attachment 6-6: Typical Operator Pre-Use Inspection Checklist**

(ELECTRIC FORKLIFT)

Date \_\_\_\_\_ Vehicle No. \_\_\_\_\_ Shift \_\_\_\_\_

Type and Model \_\_\_\_\_ Hour Meter \_\_\_\_\_

OK	<i><b>VISUAL CHECKS</b></i>	Maintenance Needed- Reported to:
	Periodic maintenance and inspections are current	
	Leaks - Hydraulic Oil, Battery	
	Tires - Condition and pressure	
	Forks, Top Clip retaining pin and heel - Condition	
	Load Backrest Extension - solid attachment	
	Hydraulic hoses, Mast chains & Stops	
	Finger guards - attached	
	Safety warnings - attached and legible	
	Operators manual - Located on truck and legible	
	Capacity Plate – attached, information matches Model & Serial Nos. and attachments.	
	Seat Belt - Buckle and retractor working smoothly	
<b>OPERATIONAL CHECKS -Unusual Noises Must be Reported Immediately</b>		
	Accelerator Linkage	
	Parking Brake/Deadman – Forward and Reverse	
	Steering	
	Drive Control - Forward and Reverse	
	Tilt Control - Forward and Back – Ensure interlocks & safety devices are in-place for lifts capable of tilting forward for transportation purposes	
	Hoist & Lowering Control	
	Attachment Control	
	Horn	
	Lights	
	Back-Up Alarm	
	Hour Meter	
	Battery Discharge Gauge	

Inspected by: \_\_\_\_\_

Custodian: \_\_\_\_\_

Daily Pre-Shift Inspections are an OSHA requirement. It is recommended that you document that these inspections have been made.

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(GAS, LP, or DIESEL FORKLIFT)

Date \_\_\_\_\_ Vehicle No. \_\_\_\_\_ Shift \_\_\_\_\_

Type and Model \_\_\_\_\_ Hour Meter \_\_\_\_\_

OK	<i><b>VISUAL CHECKS</b></i>	Maintenance Needed- Reported to:
	Periodic maintenance and inspections are current	
	Fluid Levels -Oil , Radiator , Hydraulic	
	Leaks - Hydraulic Oil, Battery, Fuel	
	Tires - Condition and pressure	
	Forks, Top Clip retaining pin and heel - Condition	
	Load Backrest Extension - solid attachment	
	Hydraulic hoses, Mast chains & Stops	
	Finger guards - attached	
	Safety warnings - attached and legible	
	Operators manual - Located on truck and legible	
	Capacity Plate – attached, information matches Model & Serial Nos. and attachments.	
	Seat Belt - Buckle and retractor working smoothly	
<b>OPERATIONAL CHECKS -Unusual Noises Must be Reported Immediately</b>		
	Accelerator Linkage	
	Parking Brake – Forward and Reverse	
	Steering	
	Drive Control - Forward and Reverse	
	Tilt Control - Forward and Back– Ensure interlocks & safety devices are in-place for lifts capable of tilting forward for transportation purposes	
	Hoist & Lowering Control	
	Attachment Control	
	Horn	
	Lights	
	Back-Up Alarm	
	Hour Meter	

Inspected by: \_\_\_\_\_

Custodian: \_\_\_\_\_

Daily Pre-Shift Inspections are an OSHA requirement. It is recommended that you document that these inspections have been made.

**Attachment 6-7. Forklift Trucks In Hazardous (Explosive) Atmospheres**

- 6-7.1 Hazardous Area Equipment. It is essential to use proper equipment in hazardous (explosive) areas. Trucks approved for use in hazardous areas shall have the manufacturer's label or some other identifying mark indicating approval for the intended use by a recognized national testing laboratory [e.g., Underwriters Laboratories (UL) or Factory Mutual (FM)].
- 6-7.2 Truck Designation. Durable markers indicating the designation of the type of truck for use in hazardous areas shall be applied to each side of the vehicle in a visible but protected area. These markers shall be distinctive in shape, as indicated in Attachment 6-4, *Markers to Identify Type of Industrial Truck*.
- 6-7.3 Hazardous-Area Signs. The entrance to hazardous areas shall be posted with a sign to identify the type of forklift truck permitted (see Attachment 6-5, *Building Signs for Posting at Entrance to Hazardous Areas*).
- 6-7.4 Hazardous Area Classification. The responsible industrial safety organization shall classify hazardous locations where a powered forklift truck is to be used. Location classifications are described as follows:
- a. Class I—locations in which flammable gases or vapors are present or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures
  - b. Class II—locations that are hazardous because of the presence of combustible dust
  - c. Class III—locations where easily ignitable fibers or filings are present but are not likely to be suspended in quantities sufficient to produce ignitable mixtures
  - d. Unclassified—locations not possessing atmospheres defined as Class I, II, or III locations.
- 6-7.5 Non-Hazardous Areas. The following units are not suitable for use in hazardous areas because they include only minimum safeguards against inherent fire hazards:
- a. Type D Forklifts—diesel-powered units having minimum acceptable safeguards against inherent fire hazards
  - b. Type E Forklifts—electrically powered units having minimum acceptable safeguards against inherent fire and electrical shock hazards
  - c. Type G Forklifts—gasoline-powered units having minimum acceptable safeguards against inherent fire hazards
  - d. Type LP Forklifts—liquefied-petroleum-gas-powered units having minimum acceptable safeguards against inherent fire hazards
  - e. Type G/LP Forklifts—gasoline- or liquefied-petroleum-gas-powered units having minimum acceptable safeguards against inherent fire hazards.

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- 6-7.6 Hazardous Areas. The following units are suitable for use in hazardous areas because they are equipped with additional safeguards (i.e., special exhaust, fuel, or electrical systems) or other modifications against inherent fire hazards:
- a. Type DS Forklifts—diesel-powered units that are provided with all the requirements for the type D units and that have additional safeguards to the exhaust, fuel, and electrical systems
  - b. Type DY Forklifts—diesel-powered units that have all the safeguards of the type DS units except that they do not have any electrical equipment, including ignition; they are equipped with temperature-limitation features
  - c. Type ES Forklifts—electrically powered units that are provided with all the requirements for the type E units and that have additional safeguards to the electrical system to prevent emission of hazardous sparks and to limit surface temperatures
  - d. Type EE Forklifts—electrically powered units that are provided with all the requirements for the type E and ES units, and that also have electric motors and all other electrical equipment completely enclosed
  - e. Type EX Forklifts—electrically powered units that differ from type E, ES, or EE units in that the electrical fittings and equipment are designed, constructed, and assembled so that the units may be used in atmospheres containing specifically named flammable vapors, dusts, and, under certain conditions, fibers; type EX units are specifically tested and classified for use in Class I, Group D, or for Class II, Group G locations as defined in NFPA 70, *National Electrical Code*
  - f. Type GS Forklifts—gasoline-powered units that, in addition to all the requirements for the type G units, are provided with additional safeguards to the exhaust, fuel, and electrical systems
  - g. Type GS/LPS Forklifts—gasoline- or liquefied-petroleum-gas-powered units that, in addition to all the requirements for the type G/LP units, are provided with additional safeguards to the exhaust, fuel, and electrical systems
  - h. Type LPS Forklifts—liquefied-petroleum-gas-powered units that, in addition to the requirements for the type LP units, are provided with additional safeguards to the exhaust, fuel, and electrical systems.