

MATERIAL HANDLING VEHICLES

Table of Contents

	Page
<b>1.0 SCOPE</b>	2
1.1 Hazards	2
1.2 Changes	2
<b>2.0 LOSS PREVENTION RECOMMENDATIONS</b>	2
2.1 Introduction	2
2.2 Construction and Location	2
2.3 Occupancy	3
2.4 Protection	3
2.5 Equipment and Process	3
2.6 Operations and Maintenance	4
2.7 Training	4
2.8 Ignition Control	4
<b>3.0 SUPPORT FOR RECOMMENDATIONS</b>	6
3.1 General	6
3.1.1 Operation and Maintenance	6
3.2 Battery-Powered Material Handling Vehicles	7
3.2.1 General	7
3.2.2 Lead-Acid Batteries	7
3.2.3 Li-Ion Batteries	7
3.2.4 FM Approved Types	7
3.3 Gasoline-Powered Material Handling Vehicles	7
3.4 Diesel-Powered Material Handling Vehicles	8
3.5 LPG-Powered Material Handling Vehicles	8
3.6 Dual Fuel-Powered Material Handling Vehicles	8
3.7 CNG-Powered Material Handling Vehicles	9
3.8 Hydrogen-Powered Material Handling Vehicles (HPLTs)	9
3.9 Loss History	10
<b>4.0 REFERENCES</b>	10
4.1 FM	10
4.2 Other	10
<b>APPENDIX A GLOSSARY OF TERMS</b>	10
<b>APPENDIX B DOCUMENT REVISION HISTORY</b>	10

List of Figures

Fig. 3.5. Arrangement of components of LPG fuel system for material handling vehicles	9
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List of Tables

Table 2.8.1. Recommended Types of Material Handling Vehicles for Various Occupancies	5
Table 2.8.1. Recommended Types of Material Handling Vehicles for Various Occupancies (continued)	6

## 1.0 SCOPE

This data sheet provides property loss prevention recommendations for the selection, operation and maintenance of various types of material handling vehicles typically used indoors, including industrial lift trucks, automated guided vehicles (AGVs) and laser guided vehicles (LGVs). Electrically powered vehicles, including those with li-ion batteries, are limited to those having batteries smaller than 50 kWh. Hazards associated with hydrogen fueling are also addressed.

For hydrogen dispensing operations, see FM Property Loss Prevention Data Sheet 7-91, *Hydrogen*.

### 1.1 Hazards

Using standard material handling vehicles in or near flammable or explosive atmospheres creates the following hazards:

- A. Flames or sparks from the exhaust can become an ignition source.
  - B. Flashback produced by vapor being drawn into the combustion engine system can ignite the flammable or explosive atmosphere.
  - C. Overspeed of the engine can occur due to combustion of flammable vapor.
  - D. Hot surface temperatures of the exhaust system and other engine components may act as an ignition source.
  - E. Leaking hydraulic oil from material handling vehicles is commonly ignited on hot surfaces such as the engine block or exhaust.
  - F. Arcs and sparks from electrical equipment and starter motors are potential ignition sources.
  - G. Sparks from the discharge of static electricity or from friction (e.g., tines dragging along the floor) can be an ignition source.
- Flammable gases released from batteries in thermal runaway can be ignited.
- Battery charging can ignite nearby combustibles if adequate separation is not provided.

### 1.2 Changes

**April 2025.** A full revision was completed to remove redundant recommendations and content.

## 2.0 LOSS PREVENTION RECOMMENDATIONS

### 2.1 Introduction

Use FM Approved equipment, materials and services whenever they are applicable and available. For a list of products and services that are FM Approved, see the *Approval Guide*, an online resource of FM Approvals.

### 2.2 Construction and Location

2.2.1 Provide a designated location for parking material handling vehicles during idle periods, with a minimum space separation of 5 ft (1.5 m) between the material handling vehicles and combustibles.

2.2.2 Provide a minimum space separation of 35 ft (11 m) between the service and repair area and combustibles.

2.2.3 Provide guard rails, bollards or telltales around piping exposed to potential damage near passageways and at exposed drain, gauge and hose connections on sprinkler risers. Warning of overhead piping may be suspended by metal strips (to create noise).

2.2.4 Do not place electrical chargers within storage racking.

2.2.5 Locate charging stations as follows:

2.2.5.1 Locate single-panel charging installations serving one or two material handling vehicles so that combustible material is not positioned closer than 5 ft (1.5 m) from the charging equipment and/or vehicle being charged.

2.2.5.2 Locate multiple-panel battery-charging installations serving more than two material handling vehicles in a cut-off room.

2.2.5.2.1 Locating multiple-panel battery-charging installations in a separate area along an exterior wall or in a maintenance area is acceptable if all the conditions below are met:

A. Maintain a minimum space separation of 5 ft (1.5 m) between any combustibles and the battery chargers and vehicles being charged.

B. Provide automatic sprinkler protection per Section 2.4.

C. Provide natural ventilation at high points in the exterior walls or roof.

2.2.6 Provide physical protection around the battery chargers to prevent mechanical damage from material handling vehicles.

2.2.7 Store the material handling vehicles at least 50 ft (15 m) from an MFL wall or sprinkler risers.

2.2.8 Refuel gasoline, diesel-, LPG-, CNG-, and hydrogen-powered material handling vehicles outdoors or in a well-ventilated, detached building.

2.2.9 Remove detachable fuel cylinders prior to storing LPG- and CNG-powered material handling vehicles within the building when not in use.

2.2.10 Close the fuel valve for hydrogen-powered material handling vehicles when the vehicles are parked between shifts or in storage.

2.2.11 Store spare LPG and CNG cylinders in accordance with Data Sheet 7-50, *Compressed Gases in Portable Cylinders and Bulk Storage*.

2.2.12 Refuel detachable cylinders outdoors at least 50 ft (15 m) away from important buildings.

2.2.13 Locate LPG and CNG tanks in accordance with Data Sheet 7-55, *Liquefied Petroleum Gas (LPG) in Stationary Installations*.

2.2.14 Install all battery charging equipment in accordance with the standards of the National Electrical Code (NEC or local equivalent).

### 2.3 Occupancy

2.3.1 In occupancies where lint, combustible dust, and flyings may be present, locate battery-charging equipment in a separate room with positive pressurization, arranged so the buildup of these materials around the charging equipment can be minimized.

### 2.4 Protection

2.4.1 For electric vehicle charging locations, provide protection for the occupancy or automatic sprinklers designed to deliver a density of 0.3 gpm (12 mm/min) over the most remote 2,500 ft<sup>2</sup> (230 m<sup>2</sup>) with a hose stream demand of 250 gpm (950 L/min) for a duration of 60 minutes, whichever is greater. Use FM Approved sprinklers with a temperature rating of 160°F (70°C).

2.4.2 For LPG- and CNG- powered material handling vehicles, provide automatic sprinkler protection in accordance with Data Sheet 7-50, *Compressed Gases in Portable Cylinders and Bulk Storage*.

2.4.3 For hydrogen powered material handling vehicles provide automatic sprinkler protection in accordance with Data Sheet 7-91, *Hydrogen*.

### 2.5 Equipment and Process

2.5.1 Provide interlocks on CNG tank refill dispensers to prevent CNG tanks from being filled at pressures higher than the working pressure of the fuel cylinder. Check dispenser pressure controls and relief valves monthly for proper operation.

2.5.2 Use steel cylinders for LPG-powered material handling vehicles.

#### 2.5.3 Safeguards for Hydrogen Fuel Dispensing

2.5.3.1 Locate material handling vehicle fueling stations outdoors or in a detached building where feasible.

2.5.3.1.1 When fueling hydrogen powered vehicles indoors is necessary, arrange the fueling system in accordance with Data Sheet 7-91, *Hydrogen*, to limit the size of a hydrogen release.

2.5.3.2 Locate and arrange bulk hydrogen storage, compression equipment and supply piping outdoors in accordance with Data Sheet 7-91, *Hydrogen*.

2.5.3.3 Design and install hydrogen dispensing systems in accordance with Data Sheet 7-91, *Hydrogen*.

## 2.6 Operations and Maintenance

2.6.1 Stop all vehicles upon the operation of a fire alarm or sprinkler flow alarm. Vehicles should not obstruct:

- A. Fire doors
- B. Gates
- C. Fire escape routes

2.6.1.1 Automatically stop all automated guided vehicles (AGVs, LGVs, etc.).

2.6.2 Ensure all maintenance and repairs are carried out by qualified personnel.

2.6.3 Establish a system of regularly scheduled preventive maintenance. At a minimum, include the following:

- A. Rubber, plastic, or composite hoses
- B. Fuel tanks, fuel lines and re-filling connections
- C. Cylinders
- D. Electrical systems (batteries, wirings, etc.)
- E. Communication connections, e.g., Wi-Fi, firmware, campus cellular networks, proprietary communications protocols
- F. Operation and cleanliness of proximity and/or optical sensors
- G. Safety devices

2.6.4 Keep all enclosures and protective covers around the engine and exhaust system in place at all times when material handling vehicles are operating.

## 2.7 Training

2.7.1 Restrict the use of material handling vehicles to personnel trained in their operation.

## 2.8 Ignition Control

2.8.1 Use an appropriately rated material handling vehicle for the environment in which it will be used, per Table 2.8.1.

Table 2.8.1. Recommended Types of Material Handling Vehicles for Various Occupancies

Location	Typical Occupancies	Material Handling Vehicles <sup>b,c</sup>
Indoor or outdoor locations containing materials of ordinary fire hazard	<ul style="list-style-type: none"> <li>• Grocery warehouse</li> <li>• Cloth storage</li> <li>• Paper manufacturing and working</li> <li>• Textile processes except opening, blending bale storage, and other Class III locations</li> <li>• Bakery</li> <li>• Leather tanning</li> <li>• Foundries and forge shops</li> <li>• Sheet-metal working</li> <li>• Machine-tool occupancies</li> </ul>	Electrical: Type E Gasoline: Type G Diesel: Type D LPG: Type LP CNG: Type CN Dual-fuel: Type G/LP or G/CN Hydrogen: Type H2
Class I, Division 1 <sup>a</sup> locations in which explosive concentrations of flammable gas or vapor may exist under normal operating conditions, or where accidental release of hazardous concentrations of such materials may occur simultaneously with failure of electrical equipment	There are few areas in this division in which material handling vehicles would be used	Electric: Type EX
Class I, Division 2 <sup>a,e</sup> Locations in which ignitable liquid or flammable gas is handled in closed systems or containers from which they can escape only by accident, or locations in which hazardous concentrations are normally prevented by positive mechanical ventilation	<ul style="list-style-type: none"> <li>• Paint mixing, spraying, or dipping</li> <li>• Storage of flammable gases in cylinders</li> <li>• Storage of ignitable liquids in drums or cans</li> <li>• Solvent recovery</li> <li>• Chemical processes using ignitable liquids</li> <li>• Paper and cloth coating using ignitable solvents in closed equipment</li> </ul>	Electric: Type EE or EX Diesel: Type DY
Class II, Division 1 <sup>a,f</sup> Locations in which explosive mixtures of combustible dust may be present in the air under normal operating conditions, or where mechanical failure of equipment might cause such mixtures to be produced simultaneously with arcing or sparking of electrical equipment, or in which electrically conductive dust may be present	<ul style="list-style-type: none"> <li>• Grain processing</li> <li>• Starch processing</li> <li>• Starch molding (candy manufacturing)</li> <li>• Wood/flour processing</li> </ul>	Electrical: Type EX
Class II, Division 2 <sup>a</sup> Locations in which explosive mixtures of combustible dust are not normally present or likely to be thrown into suspension through the normal operation of equipment, but where deposits of such dust may interfere with the dissipation of heat from electrical equipment, or where such deposits may be ignited by arcing or sparks from electrical equipment	<ul style="list-style-type: none"> <li>• Storage and handling of grain, starch or wood flour in bags or other closed containers</li> <li>• Grinding of plastic molding compounds in tight systems</li> <li>• Feed mills with tightly enclosed equipment</li> </ul>	Electrical: Type EE or EX preferred Type ES Gasoline: Type GS <sup>d</sup> Diesel: Type DS <sup>d</sup> or DY LP-Gas: Type LPS <sup>d</sup> Dual-fuel: Type GS/LPS <sup>d</sup> and GS/CNS <sup>d</sup>

Table 2.8.1. Recommended Types of Material Handling Vehicles for Various Occupancies (continued)

Location	Typical Occupancies	Material Handling Vehicles <sup>b,c</sup>
Class III, Division 1 <sup>a</sup> Locations in which easily ignitable fibers or materials producing combustible brands are handled, manufactured, or used	<ul style="list-style-type: none"> <li>• Opening, blending, or carding of cotton or cotton mixtures</li> <li>• Cotton gins</li> <li>• Sawing, shaping, or sanding areas in cordage plants</li> </ul>	Electrical: Type EE preferred, Type ES <sup>a</sup> Diesel: Type DY
Class III, Division 2 <sup>a</sup> Locations in which easily ignitable fibers are stored or handled (except in process of manufacture)	<ul style="list-style-type: none"> <li>• Storage of textile and cordage fibers</li> <li>• Storage of excelsior, kapok, or Spanish moss</li> </ul>	Electrical: Type ES Gasoline: Type GS <sup>d</sup> Diesel: Type DS <sup>d</sup> LP-Gas: Type LPS <sup>d</sup> Dual-fuel: Type GS/LPS <sup>d</sup> and GS/CNS <sup>d</sup>

a. Hazardous location as classified in the *National Electrical Code* (NFPA 70), and Sec. 32 of the Canadian Electrical Code. See Data Sheet 5-1, *Electrical Equipment in Hazardous (Classified) Locations*.

b. Type G (gasoline), Type D (diesel), Type LP (LP-Gas), and Type G/LP (gasoline and LP-Gas) material handling vehicles are considered to have comparable fire hazards.

c. Type GS (gasoline), Type DS (diesel), Type LPS (LP-Gas), and Type GS/LPS (gasoline and LP-Gas) material handling vehicles are considered to have comparable fire hazards.

d. Acceptable if kept clean and well maintained.

e. For Group D environments. Also valid for Group C environments if FM Approved for that environment.

f. For Group F and G environments.

2.8.2 Provide bonding and grounding between the hose nozzle or can spout and the tank to minimize accumulation of static electricity.

### 3.0 SUPPORT FOR RECOMMENDATIONS

#### 3.1 General

Material handling vehicles are used at facilities, both indoors and outdoors, for moving and lifting materials. They are essential to the operation of most facilities because of their efficiency in material handling. Their use, however, introduces hazards of fire, explosion, mechanical damage and water damage.

Material handling vehicles are available in various designs to suit the type of load being handled. They are powered by batteries, gasoline, diesel, LPG, CNG, hydrogen or a combination of these fuels.

Electrical short circuits, sparks from electrical equipment, sparks from exhaust systems and hot metal surfaces of material handling vehicles are potential ignition sources, both in the material handling vehicle itself and in combustible material within the facility.

Material handling vehicles have made it possible to pile storage to greater heights, increasing the difficulties of firefighting and (unless proper clearances are maintained) potentially decreasing the effectiveness of sprinklers. Also, collisions with sprinkler piping can impair protection and release large quantities of water on equipment or goods.

Some of the largest losses on record have occurred when material handling vehicles handling ignitable liquid have dropped their loads, breaking or spilling the liquid, which is then ignited by hot surfaces or sparks from the truck.

#### 3.1.1 Operation and Maintenance

Improper operation of material handling vehicles can lead to severe damage, including physical damage to building fixtures. Widespread damage may occur if water is released from a broken pipe or fitting on an automatic sprinkler or industrial water system. Fire doors and other important fire protection equipment intended to limit the size or spread of fire may be rendered inoperative if hit by a truck. Mechanical damage to process piping, equipment, drums or tanks may release ignitable liquids or other hazardous material, causing fire.

Sprinkler pipe breakage accounts for nearly one-third of all losses involving material handling vehicles reported to FM. Sprinkler leakage resulting from lift truck operation is most likely to occur in storage areas where activities are concentrated. Most accidents have been caused by careless operation of high-lift trucks. Operators failed to consider sprinkler piping while lifting stock or failed to leave adequate clearance between a load and overhead piping while moving with the mast raised. Gauge connections at risers, hose

connections, feeder mains and even risers have been broken. In a few reported cases, a section of roof collapsed when a column was knocked out from under it.

### 3.2 Battery-Powered Material Handling Vehicles

#### 3.2.1 General

Plastic vehicle shells, insulation, battery boxes and accumulated grease deposits on a battery-powered material handling vehicles are combustible materials that could be ignited and involve the material handling vehicle in a fire.

The principal source of ignition is short circuits in wiring. Fires have also resulted from electrical arcs, current being left on, ignitable liquid being unsafely carried and collision.

#### 3.2.2 Lead-Acid Batteries

Small quantities of hydrogen develop from a lead-acid battery on a charge and can introduce a potential fire and explosion hazard. An electrical disturbance may cause a fire in grease and dirt on the truck, insulation or charging equipment.

#### 3.2.3 Li-Ion Batteries

Recommendations in this standard apply to all li-ion batteries when they remain installed in the material handling vehicles during charging and they are smaller than 50 kWh, independent of the battery type [i.e., Lithium Cobalt Oxide ( $\text{LiCoO}_2$ ), Lithium Manganese Oxide ( $\text{LiMn}_2\text{O}_4$ ), Lithium Nickel Manganese Cobalt Oxide ( $\text{LiNiMnCoO}_2$ ), Lithium Iron Phosphate ( $\text{LiFePO}_4$ ), Lithium Nickel Cobalt Aluminum Oxide ( $\text{LiNiCoAlO}_2$ ), Lithium Titanate ( $\text{Li}_2\text{TiO}_3$ )].

When in thermal runaway, batteries release flammable gases. The flammable gases produced by these batteries generate the hazards, including non-thermal and fire. For example, lithium iron phosphate batteries are a lower capacity battery; sometimes they do not self-ignite the flammable gases. However, the flammable gases can accumulate and be ignited by any other ignition source(s). Presentations which demonstrate the li-ion battery hazard which support the importance of isolating the charging stations from the main occupancy are publicly available online, and videos are available on the FM YouTube channel.

#### 3.2.4 FM Approved Types

Battery-powered material handling vehicles are available in four types, specially designed and safeguarded for use in locations ranging in hazard from ordinary to extra:

- A. Type E material handling vehicles have the minimum necessary safeguards and are for use in ordinary-hazard areas.
- B. Type ES material handling vehicles have additional safeguards to prevent emission of sparks from the electrical system and to limit surface temperatures. They are recommended for areas where easily ignitable fibers are stored or handled (except in the process of manufacturing).
- C. Type EE material handling vehicles have their electric motor and all other electrical equipment completely enclosed and are recommended for use in hazardous locations other than those that require Type EX.
- D. Type EX material handling vehicles are of explosion-proof (Class I, Group D), or dust-tight (Class II, Group G) construction and are recommended for areas where explosive mixtures of flammable vapor or combustible dust are likely during normal operations.

### 3.3 Gasoline-Powered Material Handling Vehicles

Most of the reported fires involving gasoline-powered material handling vehicles were the result of gasoline spills during refueling. Other fires resulted from breaks or leaks in gasoline connections. The released gasoline can be ignited by the hot engine, by the ignition system when starting, by other electrical equipment, and by exhaust or other sparks. Other fires can result from defective insulation on wiring, greasy deposits or leaking hydraulic oil. Some are caused by exhaust sparks igniting combustibles in the vicinity, and some result from upsets and collisions.



Potential fire sources that cannot be completely eliminated by safeguards include gasoline that may leak from the fuel, starting and ignition systems, and sparks from the exhaust system. Recommend limitations on locations in which gasoline-powered material handling vehicles may be used.

Two types of FM Approved gasoline-powered material handling vehicles are available: Type G and Type GS. Type G material handling vehicles have the minimum necessary safeguards and are recommended for use in occupancies of light fire hazard. Type GS material handling vehicles have additional safeguards in the electrical exhaust and fuel systems and are recommended for occupancies where readily-ignited, combustible materials are likely, as outlined in Table 2.8.1. When ordering, specify the complete listed type designation to ensure the proper safeguards will be supplied.

### 3.4 Diesel-Powered Material Handling Vehicles

Diesel-powered material handling vehicles, except the specially safeguarded Type DY, are similar to gasoline-powered material handling vehicles. However, the fuel hazard is less than that of gasoline-powered material handling vehicles because of the higher flash point of diesel fuel. Loss experience with diesel-powered material handling vehicles has been limited. Less than 5% of the reported industrial material handling vehicles losses involved diesel-powered trucks.

Three types of FM Approved material handling vehicles are available: Types D, DS, and DY. The fire hazard of Types D and DS are considered comparable to Types G and GS gasoline-powered material handling vehicles, respectively.

The Type DY diesel-powered material handling vehicles is equipped with additional safeguards that make it less hazardous than a Type DS material handling vehicle. Surface and exhaust gas temperatures are limited to a maximum of 325°F (163°C), no electrical system is present, and other safeguards are provided to minimize the fire hazard normally associated with internal-combustion engines.

### 3.5 LPG-Powered Material Handling Vehicles

LPG-powered material handling vehicles not only present the same hazards as gasoline-powered material handling vehicles, but also those of a combustible gas under high pressure.

The greatest potential danger is gas leaking from poorly maintained fuel connections and igniting during the operation of the relief valve. Overfilling, fire exposure to the container, and high local temperatures near ovens, furnaces or other high-temperature equipment can cause the relief valve to operate. About two-thirds of the fires and explosions involving LPG material handling vehicles result from breaks or leaks in the fuel connections.

Special safeguards can reduce the hazard of gas leakage during normal operation and refueling (see Figure 3.5). As with gasoline-powered material handling vehicles, the hazards of LPG-powered material handling vehicles cannot be eliminated completely by safeguards. Therefore, locations in which they may be used should be limited.

A liquid-withdrawal system is illustrated. In a vapor-withdrawal system, the vaporizer would be omitted; but the regulator would be retained, the hot water lines would be omitted, and the hydrostatic relief valve would not be required.

Composite and aluminum cylinders are just as vulnerable to heat and corrosion as a composite LPG cylinder.

Two types of FM Approved material handling vehicles are available: Type LP and Type LPS. The fire hazard of these material handling vehicles is comparable to Types G and GS gasoline-powered material handling vehicles, respectively.

### 3.6 Dual Fuel-Powered Material Handling Vehicles

Dual fuel-powered material handling vehicles that are factory assembled have been FM Approved. These material handling vehicles are capable of being powered by either gasoline or LPG. They are available as Type G/LP and Type GS/LPS. They have the hazards and limitations of both gasoline and LPG-powered industrial material handling vehicles.



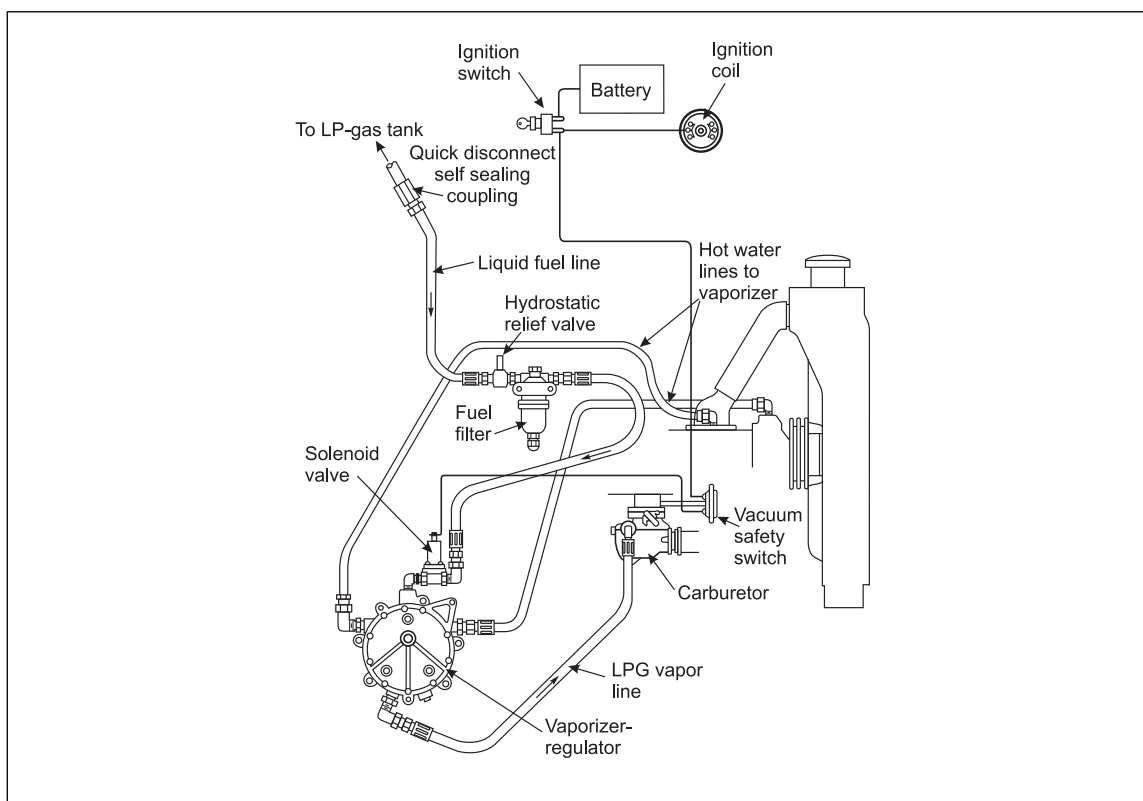


Fig. 3.5. Arrangement of components of LPG fuel system for material handling vehicles

### 3.7 CNG-Powered Material Handling Vehicles

CNG-powered material handling vehicles are similar to LPG-powered material handling vehicles. Loss history for CNG-powered material handling vehicles is limited, which may be due to their restricted use in industry.

Recent losses in the automotive industry, where CNG-powered material handling vehicles are becoming more common, are similar to those of LPG with one exception. The cylinders for CNG are made of a composite material that is susceptible not only to mechanical damage but to breakdown if exposed to corrosive environments and can weaken if constantly overfilled.

As with LPG-powered material handling vehicles, CNG-powered material handling vehicles are fitted with special safeguards to reduce the hazard of gas leakage during normal operations and refueling. However, the hazard cannot be eliminated completely by safeguards. Therefore, locations in which they may be used should be limited.

Constant overfilling (more than 1.25 times rated working pressure) of composite tanks, commonly used for CNG fuels, will result in a failure of the liner within the tank. Loss of the liner will destroy the integrity of the cylinder and allow the uncontrolled release of compressed natural gas.

Composite and aluminum cylinders are more vulnerable to heat and corrosive environments, increasing the potential for failure. Composite cylinders are acceptable for CNG- and hydrogen-powered material handling vehicles because steel cylinders are not readily available for these gases.

### 3.8 Hydrogen-Powered Material Handling Vehicles (HPLTs)

The power source for HPLTs is typically a battery replacement module (BRM) that contains a fuel cell or a hybrid fuel cell/battery system designed to replace conventional battery packs. Hydrogen gas is stored in an onboard reservoir with a typical water capacity of up to 4.8 gal (18 L) at a very high pressure. As an example, an H35-rated material handling vehicle has a nominal working (service) pressure of 5100 psi (35 MPA; 350 bar). These high pressures are necessary to fill the reservoir with sufficient hydrogen (approximately 4.4 lb [2 kg]) to operate the material handling vehicle for several hours before the next fueling.

### 3.9 Loss History

Hundreds of losses involving lift trucks were reported to FM during a recent 20-year period. The vast majority of these incidents have been the result of impact, including collapse of racking, damaged process equipment, broken service lines (water, electricity, and gas) and water damage from broken sprinkler systems.

The causes of fire included the following:

- A battery in a AGV exploded, igniting a fire throughout the building.
- A gas leak from a forklift involved a roll paper storage area.
- A forklift hit a gas line, and the gas was ignited by the exhaust of the lift truck.
- An electrical spark ignited flammable vapor.
- Propane leaked from a fuel cylinder and ignited on the exhaust.
- A forklift ignited nearby wastepaper.
- A drum containing diesel fuel was ruptured by a lift truck during transport, and the fuel was ignited.

### 4.0 REFERENCES

#### 4.1 FM

Data Sheet 5-1, *Electrical Equipment in Hazardous Locations*

Data Sheet 7-50, *Compressed Gases in Portable Cylinders and Bulk Storage*

Data Sheet 7-55, *Liquefied Petroleum Gas (LPG) in Stationary Installations*

Data Sheet 7-91, *Hydrogen*

#### 4.2 Other

National Fire Protection Association (NFPA). *National Electrical Code*. NFPA 70.

National Fire Protection Association (NFPA). *Powered Industrial Trucks Including Type Designations, Areas of Use, Conversion, Maintenance, and Operations*. NFPA 505.

### APPENDIX A GLOSSARY OF TERMS

**FM Approved:** Products and services that have satisfied the criteria for Approval by FM Approvals. Refer to the *Approval Guide* for a complete list of products and services that are FM Approved.

**Ignitable liquid:** Any liquid or liquid mixture that has a measurable flash point. The hazard of a liquid depends on its ability to sustain combustion or create a flammable vapor-air mixture above its surface. Flash point is one way of understanding if a liquid can create that flammable vapor-air mixture. For a liquid to burn in a pool, it must have a fire point as well as a flash point. Ignitable liquids include flammable liquids, combustible liquids, inflammable liquids or any other term for a liquid that will burn.

### APPENDIX B DOCUMENT REVISION HISTORY

The purpose of this appendix is to capture the changes that were made to this document each time it was published. Please note that section numbers refer specifically to those in the version published on the date shown (i.e., the section numbers are not always the same from version to version).

**April 2025.** A full revision was completed to remove redundant recommendations and content.

**October 2024.** Interim revision. The following changes were made:

- A. The document was renamed Material Handling Vehicles to reflect the wider scope of vehicles covered by the Data Sheet.
- B. Added recommendations for Automated Guided Vehicles (AGVs).
- C. Provided new guidance on charging stations.
- D. Updated loss data for the recent 20-year period (2004-2024).

**January 2023.** Interim revision. The following changes were made:

A. Updated guidance for li-ion battery powered trucks.

B. Updated the definition for ignitable liquids to align with Data Sheet 7-32, *Ignitable Liquid Operations*.

**January 2021.** Interim revision. Hydrogen storage and dispensing recommendations were relocated to Data Sheet 7-91, *Hydrogen*.

**October 2015.** A new section was added to address safeguards for indoor fueling of lift trucks powered by hydrogen fuel cells (Section 2.9).

**July 2014.** A new section was added to address safeguards for indoor dispensing of lift trucks powered by hydrogen fuel cells (Section 2.9).

**July 2013.** Minimum separation distance was revised in recommendations 2.1.2.1 and 2.1.2.2.

**October 2011.** The following changes have been made:

A. Changed the title of the data sheet to better reflect the scope.

B. Added recommendations for hydrogen-powered and compressed natural gas-powered industrial trucks.

C. Added information on ventilation requirements for battery-charging areas.

D. Changed the guidance for areas where multiple batteries are charged; a cutoff room is now recommended.

E. Added recommendations for operator training, and certification of equipment after repair by certified technicians.

**January 2000.** The document has been reorganized to provide a consistent format.

**February 1991.** The document was completely revised.