



# VERTICAL CYLINDER HANDLING AND TRANSPORTATION

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## 1 Introduction

The transportation of large quantities of cylinders lying horizontally is still widely practiced and the accepted norm in some countries in Asia. This practice of moving cylinders in a horizontal position poses many safety risks. The vertical delivery of cylinders has several advantages when compared to horizontal cylinder delivery.

This document recommends vertical cylinder handling and transportation, and also defines guidelines for the proper handling of cylinders in order to make transportation a safer operation.

## 2 Scope

This document covers recommended practices for the transportation, securing, loading, and unloading of:

- Individual cylinders, or cylinders in pallets or crates
- Cylinders connected together by a manifold and enclosed in a cage
- Small cylinders and liquid cylinders

It does not cover battery vehicles where the cylinders are permanently secured to the vehicle. It does not cover transportation of cylinders in cars and vans.

This document is based in part on EIGA 52/21 – Load securing of class 2 receptacles.

## 3 Definitions

*Basket, cage, crate, pallet:* A contraption, usually made of metal that is used to carry a number of cylinders. One side is usually open for the loading and unloading of cylinders.

*Bundle:* A group of cylinders of the same size, connected together by a manifold and enclosed in a protective metal cage.

## 4 Horizontal cylinder handling and transportation

### 4.1 General description

The cylinders are stacked on top of one another along the width of the delivery truck (figure 1).



Figure 1 - Typical delivery vehicle loaded with cylinders in horizontal position

### 4.2 Risks associated with horizontal cylinder handling

Numerous risks are involved when cylinders are loaded horizontally onto delivery trucks. Some of these risks include:

- Personnel loading and unloading cylinders constantly bend their backs. This is not good for the spinal column and over time may cause injury to the spinal column and chronic back pain.
- A cylinder valve may shear any time during loading, unloading or transportation, and a full cylinder will be propelled from the delivery vehicle like a rocket, causing possible injuries or fatalities and damage to property. It is recommended that valve guards on cylinders should be used .
- Acetylene cylinder should not be transported horizontally
- Cylinders stacked on top of one another may start to roll during loading and unloading. This will likely lead to very serious accidents.
- There is a need to bring cylinders from a vertical position to a horizontal position during loading and vice versa when unloading. The more steps there are in a process, the more likely an accident can happen.
- The hands and fingers of personnel loading and unloading the cylinders can easily get caught between cylinders.
- Personnel stand on top of the cylinders to roll them when loading or unloading.
- It is impossible to use a forklift and pallets to move the cylinders.
- Cylinders laid horizontally on a truck bed are difficult to secure.
- Personnel usually hold the cylinder valve when bringing the cylinder up to a vertical position (Figure 2). Cylinder valves are not designed for such a purpose.

The above list is only a small selection of the possible risks associated with horizontal cylinder loading. Most of the above risks are minimized if not totally eliminated when cylinders are loaded vertically and should suffice as a rationale for adopting vertical cylinder delivery.



Figure 2 - Bringing a cylinder to vertical position



Figure 3 - Personnel handling horizontally loaded cylinders



Figure 4 - Cylinders rolling during unloading



Figure 5 - Rolling cylinders by foot

## 5 Vertical cylinder handling and transportation

### 5.1 Rationale for vertical cylinder handling

- **Storage:**  
Production companies store cylinders in a vertical position. In this position, they need less space and it is easy to distinguish among an increasing number of gas types in the storage room.
- **Position of cylinders when in use:**  
Most customers use the cylinders in a vertical position. There is no need to change the position of the cylinder from horizontal to vertical.

- Future use of higher pressure cylinders:  
The working pressure of cylinders are progressively being upgraded from 150 bars to 200 bars or higher pressures. The higher pressure cylinders will be heavier, and it will be easier to move the cylinders between the users and the filling station in a vertical position.
- Ease of cylinder segregation for multiple deliveries:  
Segregating cylinders in the delivery vehicle is easier when the cylinders are in a vertical position than when they are lying horizontally.

## 5.2 Methods of vertical handling

Cylinders may be handled in three ways when loaded vertically into delivery vehicles:

- as individual cylinders,
- cylinders in pallets, or
- cylinder bundles.

## 5.3 Individual cylinders

### 5.3.1 Vehicle design for individual cylinder transportation

- Cylinder pen or bay  
For ease of load securing using tie-down straps, the delivery vehicle may be divided into cylinder pens or bays. The dividing panels for the bays should be designed to withstand a force not less than the full weight of the cylinders in the bay forward and rearward within a bay.
- Side panels  
Side panels should be designed to withstand a force of not less than half of the full weight of the load sideways. The height of the side panel should be 20% higher than the center-of-gravity of the bulk of the cylinders being handled.
- Front panels  
Front panels should be designed to withstand a force not less than the full weight of the load forward. The height should be equal to the height of the bulk of the cylinders being handled.



Figure 6 - Vehicle with cylinder pens and load secured by straps

- Cylinder restraint  
Cylinders must be secured by means of securing straps, chains, or transverse slats.

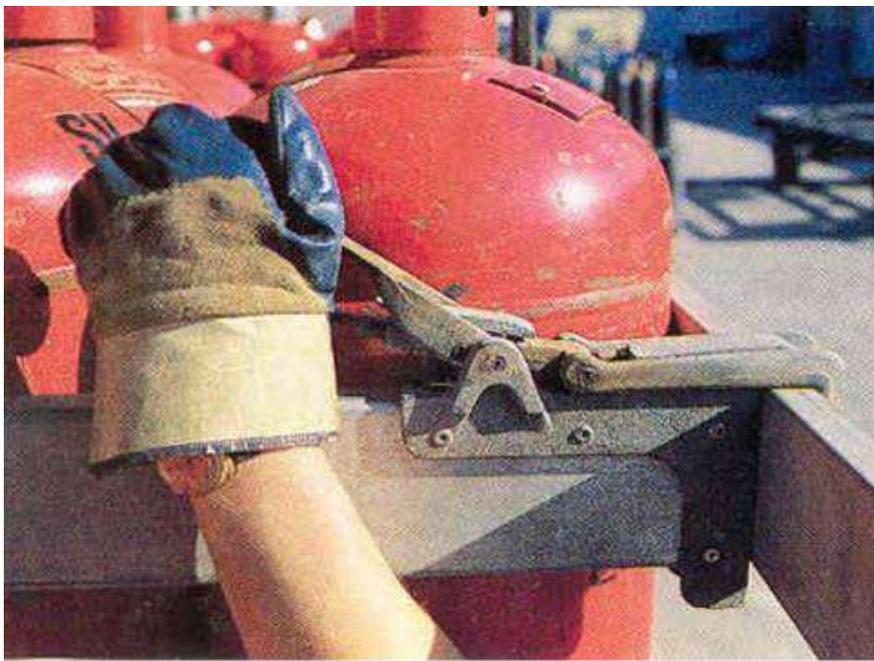


Figure 7 - Transverse slats with rapid clamping device

When not using pens, crates/pallets or transverse slats cylinders grouped together on vehicles are to be secured with two web straps or chains, which should be tested to 10,000 lb. Chains should be 3/8" and used only with ratchet type binders. "Lever" chain binders that break-over and snap into position are prohibited. Cylinders may be restrained by only one web or chain

along the cylinder height, positioned and tightened enough to prevent the cylinder from slipping through the web or chain.

- Lift gates
  - Cylinders must be unloaded from the delivery vehicle properly. The cylinders must never be dropped from the delivery vehicle during unloading. The use of lift gates is the most recommended method of unloading.
  - Lift gates that move vertically along two vertical guide rails are recommended. Lift gates that pivot using a mechanism underneath the rear side of the cargo area are not recommended.
  - Although lift gates make the work of loading and unloading cylinders easier and safer, they are themselves not free of risk.
    - Lift gates must be provided with side panels during loading and unloading to prevent cylinders from falling. The rear end must be fully closed with chains or bars unless the cylinders on the lift gate are fastened securely.
    - Lift gates cannot be used as a bridge between the docks and the delivery vehicle.
    - Lift gates should be properly designed for the full load of cylinders it is meant to carry.
    - Lift gates can either be installed at the rear or at the side of the vehicle.
    - Never ride the lift gate
    - Never exceed the lift gate's rated capacity.
    - Lift gates must be properly designed for the weight they will carry.
    - Safe procedures for the use of lift gates should be established and employees using the lift gates should be properly trained on these procedures.



Figure 8 - Rear lift gate



Figure 9 - Side lift gate

#### Cylinder carts or trolleys:

Vehicles delivering cylinders individually must carry a cylinder cart or trolley for moving the cylinders after they are unloaded. Where the use of cylinder cart is impractical, cylinders may be manually rolled in a vertical position, provided the cylinders are rolled no further than necessary.



Figure 10 - Sample cylinder trolley

Cylinders may be placed together in a pallet to form one delivery module. The pallets may be loaded or unloaded by the following methods:

- Truck mounted cranes  
Truck mounted cranes may also be used to unload cylinders or cylinder packs.



Figure 11 - Cylinder truck with crane



Figure 12 - Cylinders secured with a strap inside a pallet

- Lifting magnets or slings must never be used to move cylinders with a crane; the cylinders must be in specially designed cages or cradles. Single cylinders must not be unloaded by holding the cylinder valve or cap.
- Booms other than cranes are not allowed for unloading cylinders.
- If a crane is used to unload individual cylinders, the cylinders must be first loaded into a pallet and secured.
- Although cranes make the work of loading and unloading cylinders easier and safer, they are themselves not free of risk.
  - Cranes must be properly designed for the maximum load they will carry.
  - Safe procedures for the use of cranes should be established and employees using the cranes should be properly trained on these procedures.

- Trucks with forklifts  
Cylinder trucks may be designed to carry a forklift at the rear.



Figure 13 - Cylinder truck with forklift

Although forklifts make the work of loading and unloading cylinders easier and safer, they are themselves not free of risk.

- Forklifts must be properly designed for the maximum load they will carry.
- Safe procedures for the use of forklifts should be established and employees using the forklift should be properly trained on these procedures.

#### 5.4 Cylinder pallets and bundles

Pallets and bundles may be secured on purpose built vehicles or standard vehicles equipped with supplementary facilities.

In the case of special-purpose vehicles, load securing is based upon the principle of a positive connection between pallets or bundles and a specially designed cargo area. The vehicle equipment and the pallet design are structurally matched to one another. This enables the forces generated on the load to be absorbed. Some vehicles are equipped with securing hooks, which secure the pallets or bundles when changes in direction of forces are encountered.

Load securing that incorporates additional facilities on standard vehicles is less sophisticated, consisting of retaining devices on the cargo area or on the side panels. Similarly to securing individual cylinders, the side panel of the cargo area can be raised. Vehicle specific tie down systems, possibly incorporating reinforced tie down strap anchors, secure the pallets or bundles against slipping or tipping. Variable stop and tie down points are especially suitable for frequently changing loading conditions. Tie down strap cuffs (e.g. rubber) are a proven means of protecting the straps if they have to be secured around sharp edges. The use of several different methods of additional securing devices is advisable in order to achieve well-secured pallets and bundles.

**Purpose designed pallet location system****Figures 14 and 15**

Figures 14 and 15 show a system which has locating pins built into the outer edges of the load platform. The pallets have mating pockets which when engaged restrain the pallets in all directions. This type of system eliminates the need for additional loader operated securing devices.



Figure 14



Figure 15

**Figures 16 and 17**

Figures 16 and 17 show a system which positions purpose built pallets into recesses in the load platform. Pallet security is achieved with a system of hooks which engage the pallet from beneath the load platform. If the hooks are not engaged, an in-built safety system immobilises the vehicle. In this system, if the hooks do not engage, the drive axle brake will not release.



Figure 16

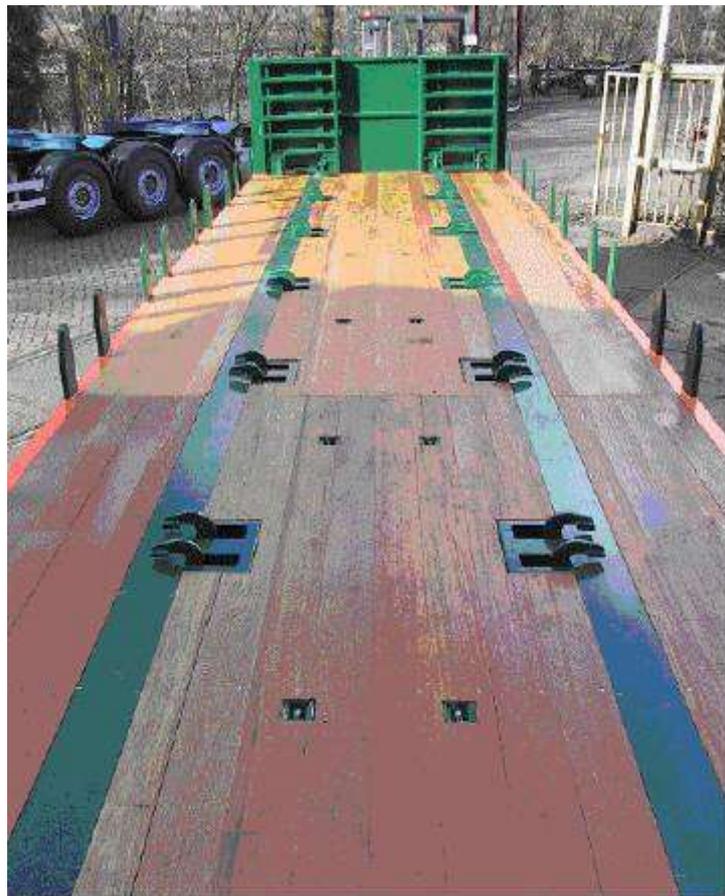


Figure 17

**Figures 18 to 21**

This is another system which positions purpose built pallets into recesses in the load platform. Pallet security is achieved with a system of hooks which engage the pallet from beneath the load platform. The hooks are pneumatically operated from the cab.



Figure 18



Figure 19



Figure 20



Figure 21

**Figure 22**

Covered trucks with ventilation are used for the transport of medical gas cylinders. There exist also specific designed pallets for small cylinders.

*NOTE : Cylinders transported in any enclosed container or van should be provided with adequate ventilation to prevent the accumulation of any gas inside the enclosure. This is usually achieved by ventilating louvers at both the low and high points of the wall panels.*



Figure 22

**Load securing by belts on standard vehicles**

In this system, strap fixing points are attached to the vehicle's frame below the load platform. Transverse straps secure the load.

**Figures 23 and 24**

Figure 23



Figure 24

**Figure 25**

Sharp corners will easily destroy the load securing belts.



Figure 25

**Figures 26 to 28**

Figures 26 to 28 show a standard vehicle fitted with locking plates in the load platform and attachable brackets.

Plates are recessed in the load platform and secured to the vehicle's frame (figure 26). The securing rails are positioned over the plates and secured there by pins (figure 27). The securing rails serve both to secure against load movement as well as for tie down (figure 28).



Figure 26

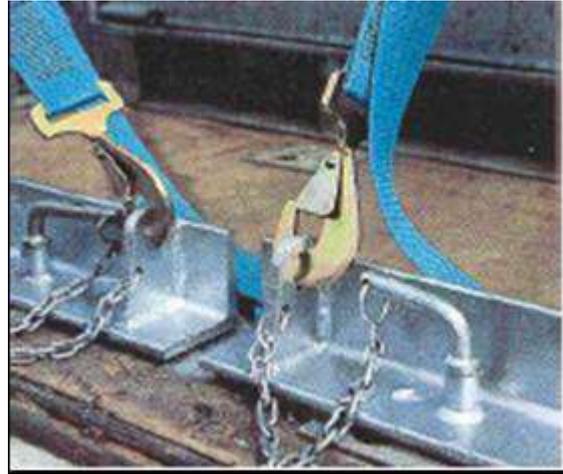


Figure 27



Figure 28

**Figure 29**

Figure 29 shows a pallet secured to a reinforced panel with a strap. The lashing straps could be protected at the edges of the pallet.



Figure 29

**Figure 30**

Figure 30 shows a cylinder bundle secured to a reinforced body panel.



Figure 30

### 5.5 Small cylinders

Small cylinders should not be transported loose but should be placed inside cylinder baskets or crates specifically designed for the small cylinders (figure 31).



Figure 31 - Sample small cylinder crates

### 5.6 Cryogenic liquid cylinders and small tank containers

Although cryogenic liquid cylinders and small tank containers are secured in a similar way to cylinders, bundles or pallets there are differences resulting from their size and weight.

They are transported on specially equipped vehicles, or on pallets, or secured to the vehicle side panels.

Figures 32 and 33 show liquid cylinders secured to the side panel with straps.



Figure 32



Figure 33

**Figure 34** shows a standard cylinder pallet fitted with wooden cradles hung on the pallet back frame. The frame and the cradle can be changed to match the circumference of the liquid gas container.



Figure 34

## 6 Load Distribution

### 6.1 General Principles

#### Vehicles load limits

##### Do not exceed the permissible loading.

There are two main considerations when a vehicle is loaded. The weight of the payload shall not exceed the permissible gross vehicle weight. In some instances, this may mean that not all the loading space can be utilised.

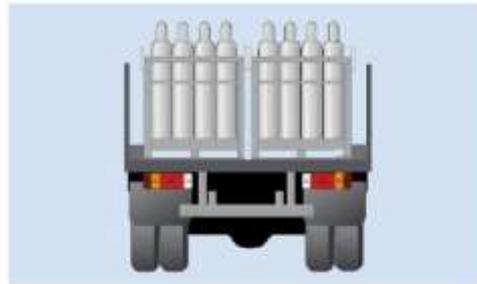


#### Distribute load correctly



Load distribution diagrams are a valuable aid in determining the most favourable or the permissible distribution of the load. These diagrams, vary from vehicle manufacturer and model and a typical example is shown above.

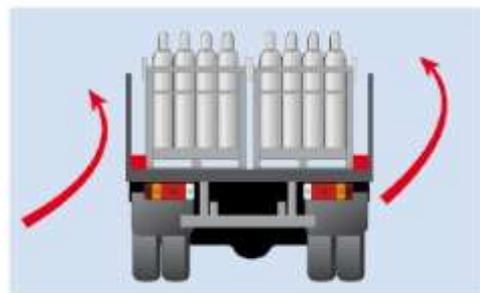
**Do not exceed load capacity of the cargo area**



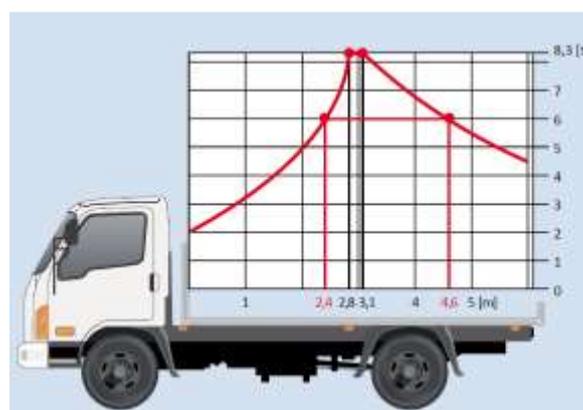
The permissible load rating of the cargo area should be obtained from the supplier.

**Maintain transverse load security**

Forces are generated on the load when the vehicle changes direction.



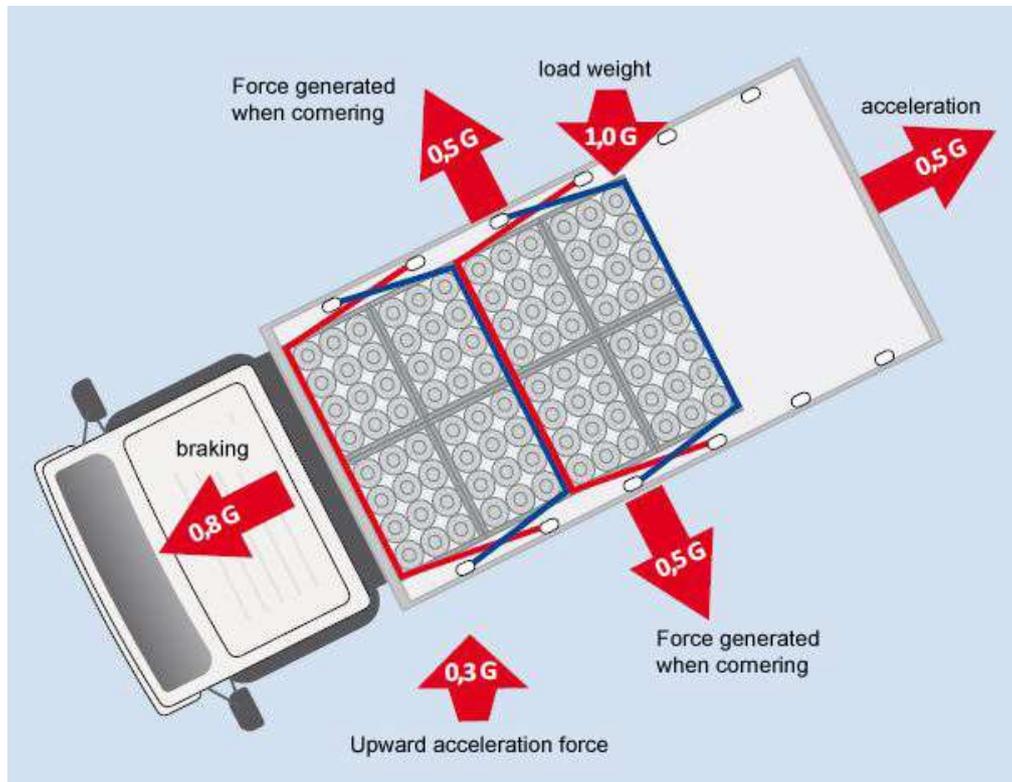
**Load distribution diagram**



The vehicle manufacturer's technical data should be checked for the effect of load distribution on the maximum permissible vehicle and axle loads.

### Forces affecting load securing

The basic principles upon which load securing is based is that the combined strength of the load restraint system must be sufficient to withstand a force not less than 0.8 times the total weight of the load forward and half of the weight of the load rearwards and sideways, according to EN 12195[1]. Vertical movements and movements when braking can occur, but these should be overcome if the above conditions are met.



Note: For tilting loads such as bundles the sideways load applied should be 0.7 rather than 0.5

These principles are valid for normal road use, they are not intended to cover abnormal situations (e.g. road traffic accident) where forces may be substantially increased.

## 6.2 Load Securing

- Selection of the best means of securing a load to a vehicle will depend on the type and composition of the load to be carried, pallets, bundles etc.
- Bundles and pallets are lashed diagonally and downwards to tie down points on specially constructed vehicles or by using special fastening systems. Suitable devices for use in load security are steel wire or nylon ropes, chains, nylon webbing harnesses etc. In the case of nylon ropes and harnesses, sleeves and corner protectors should be used to avoid damage.
- All equipment used for securing loads should be regularly inspected for wear or damage.
- Reference should always be made to the manufacturer's instructions regarding the repair and use of load securing equipment.

## 7 Labelling

Product integrity can be enhanced with the use of proper labelling for clear product identification. It is recommended that the product identification labels be securely affixed to all of the following:

- All cylinders being transported
- The front of the vehicle should have the proper diamond labels indicating the gases it is transporting.

Additionally all road vehicles should carry labels indicating:

- Supplier name and logo
- Emergency contact number of the gas supplier
- MSDS and emergency procedure for each of the gases it is transporting

## 8 References

- [1] AIGA 005, Fire hazards of oxygen and oxygen enriched atmospheres [www.asiaiga.org](http://www.asiaiga.org)
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- [5] AIGA 017, Labelling of gas containers (including associated equipment) [www.asiaiga.org](http://www.asiaiga.org)
- [6] AIGA 018, Safe handling of electronic specialty gases [www.asiaiga.org](http://www.asiaiga.org)
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