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 the Middle East. This practice of moving cylinders in a horizontal position poses many safety risks. The delivery of cylinders in an upright and secured manner has several advantages when compared to horizontal cylinder delivery.

This document makes recommendations for the safe handling and transportation 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
- Pressure Drums

It does not cover transportation of cylinders in cars and vans.

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 iron 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).
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.
- Cylinders that has in it liquefied gases and are equipped with Pressure Relief Devices may release gases in the liquid state if these relief devices are activated in a fire.

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.

![NOT RECOMMENDED](image)

Figure 2 - Bringing a cylinder to vertical position
NOT RECOMMENDED

Figure 3 - Personnel handling horizontally loaded cylinders

NOT RECOMMENDED

Figure 4 - Cylinders rolling during unloading
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 bar 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 that 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 4500 kg. Chains should be minimum 1 cm size 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.
- **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.
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.
• 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.

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, Bundles and Pressure Drums

Pallets, bundles and pressure drums 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
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.
Figures 18, 19 and 20

In this system, the pallets are secured by hooks which are installed in the middle of the platform. A warning light shows in the cabin when the hooks are up and the hooks will close when the brakes are released.

Figure 18
Figures 21 to 25

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.
For the transport of medical gas cylinders, special covered trucks with pallets for small cylinders and hooks at both sides are used.

**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 26**

Load securing by belts on standard vehicles

**Figures 27 and 28**

In this system, strap fixing points are attached to the vehicle’s frame below the load platform. Transverse straps secure the load.
Sharp corners will easily destroy the load securing belts.

**Figures 30 to 32**

Figures 30 to 32 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 30). The securing rails are positioned over the plates and secured there by pins (figure 31). The securing rails serve both to secure against load movement as well as for tie down (figure 32).
Figure 32

Figure 33 shows a pallet secured to a reinforced panel with a strap. The lashing straps could be protected at the edges of the pallet.

Figure 33

Figure 34 shows a cylinder bundle secured to a reinforced body panel.

Figure 34
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 35).

![Figure 34](image)

Figure 34

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 36 and 37** show liquid cylinders secured to the side panel with straps.

![Figure 35 - Sample small cylinder crates](image)
Figure 36

Figure 37

Figure 38 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.
5.7. Pressure Drums
Pressure drums need to be fixed by wedges and wood if they are not in a protective frame.
Figures 39 to 41 – Pressure drums secured by straps, with wooden chocks

6. INFORMATION AND MOTIVATION

6.1. Information

To ensure safe loading of industrial gas consignments adequate information shall be provided to all persons involved, not only to the gas companies’ personnel, but also to freight forwarders, warehouses and transport contractors. The information should provide details of what to secure, why it has to be secured and how it can be secured. The information should be clear, concise and include:

- the legal background (regulations, guidance)
- vehicle suitability (load limits)
- loading of the cargo
- methods of securing the various types of goods that are loaded
- load securing principles

6.2. Motivation

All persons involved including, drivers, independent freight forwards and customers shall be repeatedly encouraged to use load securing techniques. Practical training shall be given to gas company personnel and transport contractors.

Methods of motivation include:

**Training:**

- induction training
• refresher training

**Visual opportunities:**
• leaflets
• posters
• stickers
• corporate literature

**Verbal opportunities:**
• reminders about load securing
• offer advice about load securing
• point out deficiencies
• support correct load securing with praise

**Practical opportunities:**
• assist in implementing load securing
• demonstrate correct load securing
• audits

**Legal opportunities:**
• call attention to the possible legal and liability consequences of inadequate load securing

Motivation needs to be a continuous process, not a one-time measure.

7. **LOAD DISTRIBUTION**

7.1. **General Principles**

**Vehicles load limits**

*Do not exceed the permissible loading.*

The weight of the payload shall not cause the permissible gross vehicle weight or the permissible axle loads to be exceeded. 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 model to model, and a typical example is shown below.
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 the total weight of the load forward and half of the weight of the load rearwards and sideways. Vertical movements may occur but these should be overcome if the latter conditions are met.
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.

7.2. 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, such as 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.

8. References

- AIGA 038/06 - Vertical Cylinder Handling and Transportation