



Load restraint for LP Gas cylinder distribution



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 - Department of the Premier and Cabinet, SA
 - Engineers Australia
 - Fire Protection Association Australia
 - Gas Appliance Manufacturers Association of Australia
 - Gas Energy Australia
 - The Australian Gas Association
 - WorkCover New South Wales
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Australian Standard[®]

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee ME-015, Storage and Handling—Liquefied Petroleum Gases. After consultation with stakeholders in both countries, Standards Australia and Standards New Zealand decided to develop this Standard as an Australian Standard rather than an Australian/New Zealand Standard.

The objective of this Standard is to provide industry with specific requirements and guidance for load restraint systems for typical LP Gas cylinder loads that facilitate compliance with the National Transport Commission's Load Restraint Guide.

This Standard does not replace statutory regulations, which take precedence at all times. It should be read in conjunction with the latest edition of AS/NZS 1596, *The storage and handling of LP Gas*, and the National Transport Commission's *Load Restraint Guide* and *Australian Code for the Transport of Dangerous Goods by Road and Rail* (ADG Code).

Statements expressed in mandatory terms in notes to figures are deemed to be requirements of this Standard.

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STANDARDS AUSTRALIA

Australian Standard

Load restraint for LP Gas cylinder distribution

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard specifies requirements and recommendations for the design and construction of load restraint systems for typical LP Gas cylinder loads to prevent loss of the load or movement of the LP Gas cylinders that affects stability of the vehicle. The requirements facilitate conformance with the requirements of the National Transport Commission's *Load Restraint Guide* to the transport of LP Gas cylinders.

1.2 REFERENCED DOCUMENTS

The following documents are referred to in this Australian Standard:

AS/NZS

1596 The storage and handling of LP Gas

National Transport Commission (NTC)

Load Restraint Guide

1.3 DEFINITIONS

For the purpose of this Standard, the definitions given in AS/NZS 1596 and the *Load Restraint Guide* 2004 apply.

1.4 REQUIREMENTS**1.4.1 General load restraint performance requirement**

Loads shall be restrained to prevent unacceptable movement during all normal conditions of on road operation. The load restraint system shall, therefore, satisfy the following requirements:

- (a) The load shall not become dislodged from the vehicle.
- (b) Cylinders shall be restrained to remain upright.
- (c) Any load movement shall be limited, such that in all cases where movement occurs, the vehicle's stability and weight distribution are not adversely affected.

Loads that are permitted to move relative to the vehicle include loads that are effectively contained within the sides or enclosure of the vehicle body, such as loads that are restrained from moving horizontally. Limited vertical movement is permissible. Also see Clause 3.1.1.

To achieve this, the load restraint system shall be capable of withstanding the forces (see Figure 1.1) that would result if the laden vehicle were subjected to each of the following separately:

- (i) 0.8g deceleration in a forward direction.
- (ii) 0.5g deceleration in a rearward direction.
- (iii) 0.5g acceleration in a lateral direction.
- (iv) 0.2g acceleration relative to the load in a vertical direction.

NOTE: *g* is the acceleration due to gravity.

1.4.2 General requirements for load restraint

Every load shall be restrained to prevent unacceptable movement during all expected conditions of operation. The load restraint system shall meet the performance requirements detailed in Clause 1.4.

NOTE: Figure 1.1 shows typical road restraint forces.

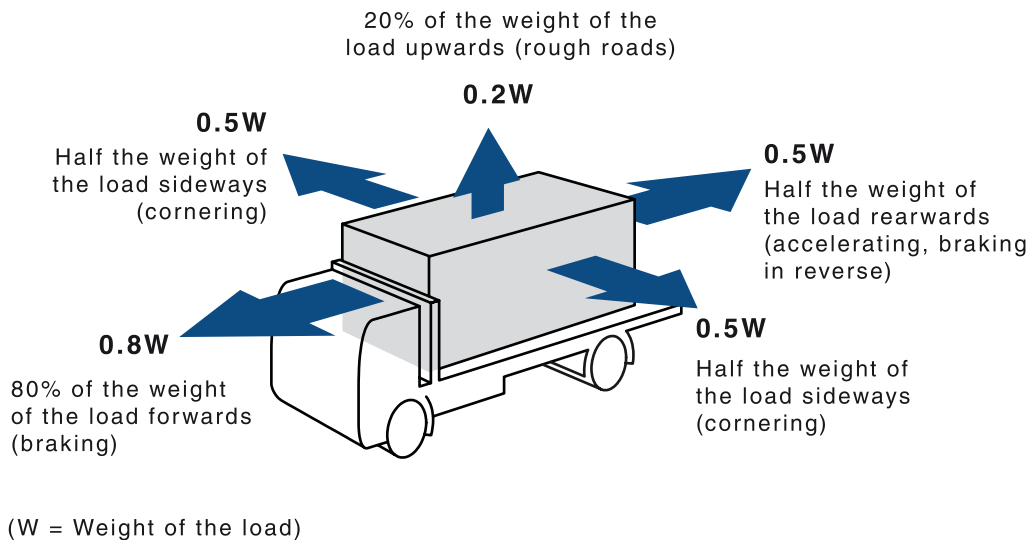


FIGURE 1.1 LOAD RESTRAINT FORCES

1.4.3 Means of restraint

The primary means of restraint is achieved by the use of strapping, wrapping or mechanical restraints.

The secondary means of restraint is achieved by the use of gates, fixed side panels, stillages or cages constructed to provide adequate strength to contain a load of filled cylinders.

NOTE: This is important where the gate is at the rear and vertical forces when driving over a bump may dislodge the gate.

To satisfy the above requirements, the gates shall—

- (a) be tied down;
- (b) have a locking device fitted that positively affixes the gates to the tray; or
- (c) be hinged and permanently fixed to the tray.

1.5 FORCES ACTING ON LP GAS CYLINDER LOADS

1.5.1 General

The loads and modes of failure include the following:

- (a) Cylinders sliding sideways when the vehicle is subjected to a lateral acceleration of $0.5g$.
- (b) Cylinders tipping over sideways when the vehicle is subjected to a lateral acceleration of $0.5g$.
- (c) Cylinders thrown upwards when the truck drives over a speed bump or similar giving a vertical acceleration of $0.2g$.
- (d) Cylinders bending or shearing the headboard when the vehicle is subject to a braking deceleration of $0.8g$.

1.5.2 Tipping versus sliding—Single cylinder

Where a cylinder is subject to decelerations of 0.5g or 0.8g, a force is generated through the centre of mass and will result in either the cylinder sliding across the surface or tipping over.

The relevant forces are shown in Figure 1.2.

With a very low friction surface, all objects will tend to slide rather than tip. With a very high friction surface, almost all objects will tend to tip rather than slide.

Depending on the geometry of an object, there is a friction factor below which the object will slide, and above which the object will tip. Table 1.1 gives the relevant values for the typical range of cylinders. Table 1.1 shows the values when the LP Gas cylinders are full.

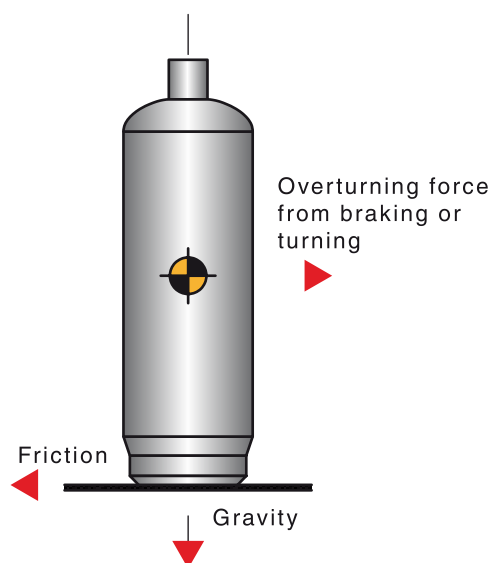


FIGURE 1.2 FORCES ON SINGLE CYLINDER

TABLE 1.1
CRITICAL FRICTION FACTORS FOR SINGLE CYLINDERS

Cylinder description	Height mm	Diameter mm	Tare kg	LP Gas kg	Gross kg	Centre of mass mm
2.15 kg	283	132	3.0	2.15	5.2	122
4 kg	310	260	5.0	4.0	9.0	132
9 kg	481	310	8.0	9.0	17.0	197
18 kg	840	310	18.0	18.0	36.0	357
18 kg steel forklift	840	310	21.0	18.0	39.0	361
15 kg aluminium forklift	840	310	10.0	15.0	25.0	301
45 kg domestic	1235	375	33.0	45.0	78.0	525
90 kg	1340	508	70.0	90.0	160.0	583
190 kg	1350	760	125.0	190.0	315.0	561
210 kg	1390	760	130.0	210.0	310.0	591

NOTE: With design friction factors greater than 0.4 cylinders would slide rather than tip if tested as a single cylinder. 45 kg cylinders will always tip rather than slide if tested as a single cylinder because its critical friction factor is below 0.36.

1.5.3 Tipping versus sliding—Multiple cylinders

With multiple cylinders the circumstances are altered because each cylinder pushes against the next introducing friction between the cylinders.

This friction provides additional resistance to tipping.

Experience has shown that a group of cylinders will not tip over when the cylinders are pulled together by a webbing strap or bound using industrial cling wrap material when palletised.

The relevant forces are shown in Figure 1.3.

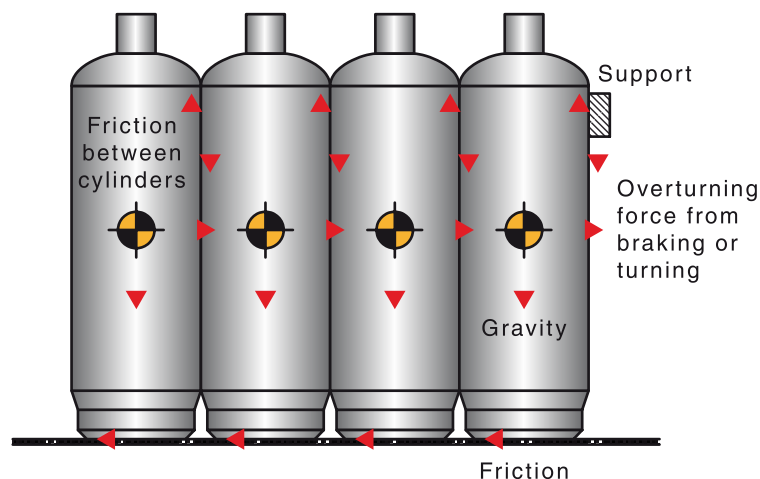


FIGURE 1.3 FORCES ON MULTIPLE CYLINDERS

1.5.4 Cylinders being thrown vertically

Legislation in Australia allows rear overhang to be a maximum of 3.7 m or 60% of the wheel base.

When designing and specifying LP Gas cylinder delivery vehicles, minimization of the rear overhang as a percentage of the wheel base shall be a primary consideration.

The two situations illustrated in Figure 1.4 show the differing effects when the front and rear axles go over a speed bump.

Where the steer axle goes over a speed bump so that the tyres and suspension are compressed, the front of the truck is driven upwards. Generally, drivers will drive at a speed that will avoid being propelled out of their seat and in this case the upward acceleration will be less than 1.0g.

In contrast, when the rear axle goes over the same bump the situation is very different. In this case, the upwards acceleration of the drive axle is increased by up to 60% at the rear of the tray. The upward acceleration of 0.4g to 0.6g will become $0.4g \times 160\%$ to $0.6g \times 160\%$, i.e. 0.64g to 0.96g. This is on the verge of propelling the cylinders at the rear into the air.

The photograph in Figure 1.5 illustrates cylinder dislodgement where the upwards 'g' force at the rear has been excessive.